ENVIRONMENTAL FRAGILITY IN THE SAHEL

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BETTER POLICIES FOR BETTER LIVES

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A companion to the OECD *States of Fragility 2022* report, this paper analyses the drivers and effects of climate and environmental risks in the Sahel, focusing on increasing food insecurity, rapid urbanisation and intensified mining. It outlines options for improved policy responses by providers of development co-operation.

Key messages

- Environmental fragility exacerbates multiple types of risks for Sahel populations, including food insecurity, reduced resilience, conflict and stagnant development. In particular:
  - With crop yields projected to drop by 11.3% by 2050, *food insecurity* is one of the main channels through which climate change influences conflict and fragility.
  - *Unregulated urban expansion* increases exposure to climate hazards and pollution.
  - *Unregulated mining* exacerbates risks of environmental damage, elite capture and illicit financing of armed groups.
- Close to one-third of bilateral official development assistance in the region has climate- and environment-related objectives, but its use is often based on an inadequate understanding of how those environmental risks affect the economic, political, security, societal and human dimensions of fragility.
- Donor engagement at times suffers from limited conflict sensitivity, or insufficient consideration of environmental aspects in humanitarian and peace interventions. Moreover, urban planning and governance of the mining sector are poorly prioritised.
- To improve their responses to environmental fragility in the Sahel, governments and their development partners should adopt multidimensional approaches more widely. This can be achieved by:
  1. strengthening analysis of interactions between humans and ecosystems, so as to better plan for local livelihoods and food systems, in concertation with local actors
  2. increasing support to more balanced and sustainable urbanisation
  3. building a greater understanding of environmental fragility across humanitarian, development and peace actors.

The Sahel – Mauritania, Mali, Burkina Faso, Niger and Chad, also referred to in this paper as the 'G5 Sahel' – has become an 'environmental fragility' hotspot. In addition to poverty, social tensions and political volatility, insecurity continues to rise: fatalities from armed violence went from 1 601 in 2017 to 6 569 in 2021 (ACLED, 2022[1]). At the same time, Sahel countries excluding Mauritania feature in the top 15% of countries most vulnerable to climate change, according to the 2020 ND-GAIN Index (University of Notre Dame, 2022[2]). Climate change and environmental degradation come on top of other fragilities and exacerbate vulnerability. Yet, policy responses remain fragmented, often failing to capture interconnections between environmental risks and other types of risks.

This paper starts by making the case for multidimensional environmental fragility analysis. The second section provides a synthesis of existing knowledge on links between climate change, environmental degradation and other risks. In the third section, the paper unpacks three emblematic trends of environmental fragility in the Sahel: (i) growing food insecurity, (ii) rapid urbanisation and (iii) intensified mining. The fourth section focuses on donor responses, analysing patterns of climate- and environment-related (CER) official development assistance (ODA) in G5 countries and highlighting blind spots. The last section outlines options for policymakers, donors and development actors seeking to address environmental fragility going forward.

Improving policy responses requires analysing how environmental risks affect other dimensions of fragility

Fatalities from armed conflicts in the G5 reached record levels in 2019-21 (ACLED, 2022[3]). State capacities are overstretched, yet crises multiply: next to conflict, food insecurity and displacement have reached unprecedented levels. Recurring crises deepen structural development issues, including high poverty rates and poor access to health and education. In the latest Human Development Index Report (2020), all G5 countries scored in the bottom 20% of countries globally (UNDP, 2020[4]).

Environmental vulnerabilities have become increasingly apparent. All available climate models predict temperature increases in the region, ranging between two and four degrees by 2080, depending on the scenario (UNHCR, UNISS and PIK, 2021[5]). Models foresee more erratic rainfall patterns and higher drought and flooding frequencies (Rameshwaran et al., 2021[6]). Urban and agricultural expansion, a larger livestock population, and other human activities such as mining all put pressure on biodiversity and local ecosystems through land degradation, soil pollution, and water and biomass consumption. Risks stemming from disruptions in local ecosystems and hydrological cycles combine with those related to politics, markets, insecurity and social tensions.

Policies to address environmental risks in the Sahel lack direction, focus and coherence with other sectors. At the international level, co-operation on the Sahel concentrates on a handful of themes, of which climate-induced migration (IOM, 2022[7]), the adaptation finance gap or the Great Green Wall are the most common ones (IFAD, 2021[8]) (UNCCD, 2022[9]). Regional environmental policy at ECOWAS and UEMOA is rather restricted in scope and is often merely a component of agricultural policy. The Liptako-Gourma Authority, the G5 Sahel, the Alliance Sahel or the Sahel Coalition have environmental 'strategic pillars', with diverse approaches and aims. The Lake Chad Commission and the Niger Basin Authority are important knowledge hubs on regional ecosystems, but their low political leverage and financial constraints limit their influence on policymaking. Conscious of this situation, the Office of Special Co-ordinator for Development in the Sahel is preparing a more co-ordinated regional development vision, with a strong role for ecosystems, resilience and peace.[1]

Interconnections between climate, environmental and other types of risks, and a fragmented policy landscape, show the need for a multidimensional analysis of climate and environmental vulnerabilities in the Sahel. This paper seeks to provide a better understanding of links between environmental fragility and other dimensions of fragility. The OECD characterises fragility as the combination of exposure to risk and insufficient coping capacity of the state, systems and/or communities to manage, absorb or mitigate those risks. It considers six dimensions of fragility: economic, political, security, societal, environmental and human. Environmental fragility analysis thus involves looking at causes, effects and coping capacities for environmental risks across dimensions of fragility and ecosystem scales (Box 1). For example, unregulated and intensified mining may not only create *environmental* risks through soil and water degradation, but also *economic* and *political* risks by hampering economic diversification and strengthening elite capture of natural resource rents.

Box 1. What is environmental fragility?

In line with the general definition of fragility, environmental fragility is the combination of exposure to climate, environmental and health risks and insufficient coping capacity of the state, systems and/or communities to manage, absorb or mitigate those risks (OECD, 2020[10]). Environmental fragility should be understood holistically, in a systems-thinking rather than in a linear way. Environmental issues are inseparable from the political, economic, security, institutional and social conditions in which they materialise. 'Fixing' the environmental component of fragility alone is elusive: one needs to understand how environmental problems emerge within a given structure of human-ecosystem interactions, incorporating the role of markets, politics, security and social relationships.

Environmental fragility analysis is not restricted to the effects of climate change but considers ecosystem health at large across different scales. Next to climate change, key environmental risks include: soil depletion, deforestation (biomass loss), biodiversity collapse, depletion of oceanic resources, and depletion of proximate and global hydrological cycles. These risks span across countries and continents. For example, deforestation along the Gulf of Guinea or the melting of polar ice have implications for rainfall patterns in the Sahel. Also, environmental risks in the region can have their origins elsewhere: demand for minerals or energy from developed economies may lead to environmental degradation in the region through intensified mining. Acknowledging interactions across these different scales is critical to shifting the paradigm on climate and environmental risks in fragile contexts. Rather than responding to new 'threats', the challenge for policy makers and development actors is to build effective and fragility-sensitive ways to promote environmental regeneration and better collective governance of 'environmental commons' (Lazard and Youngs, 2021[11]).

How environmental risks influence other dimensions of fragility

Evidence from a range of sources (including local farmer and pastoralist organisations, scientific literature and policy reports) suggests no direct causal links between climate change, environmental degradation and conflicts in the Sahel at present. There is a consensus that climate change in particular is currently not a direct cause of conflict (SIDA, 2018[12]), or at least not the only cause of conflict in present circumstances (IISD, 2015[13]), and that labels such as 'climate wars' or 'environmental wars' are not adequate in the Sahel context. Other factors said to play a role in local conflicts include politics, the presence of armed groups and military interventions (DIIS, 2022[14]), natural resource governance (OECD, 2022[15]), markets, policies, injustice (Funder, Cold-Ravnkilde and Ginsborg, 2012[16]) and poverty.

However, by acting as 'risk multipliers', climate change and environmental degradation have an important indirect influence on fragility (Yanda and Bronkhorst, 2011[17]). The literature identifies the following channels for environmental fragility in the Sahel region:[2]

- **Access to natural resources and livelihoods**: climate, environmental and human pressures coupled with governance deficits have an impact on access to natural resources, and therefore on livelihoods and fragility. The effect through natural resources and livelihoods can operate at a local level, such as when farmers and herders compete for land, biomass and water (UNOWAS, 2018[20]), but also at the national or regional levels; for example, when tensions arise around the management of transboundary water resources (World Bank, 2021[21]).
- **Food insecurity and volatile food prices**: climate change and environmental degradation generate food supply and food security risks. Although displacement and conflict are among the primary causes of current food insecurity, Sahelian agriculture is also strongly vulnerable to variations in ecosystem parameters such as temperature and rainfall due, for example, to low

irrigation coverage. Risks of environment-related food supply shocks are expected to increase globally in the coming decades (IPCC, 2019[22]).

- **Extreme weather events and hazards**: increased extension, intensity and occurrence of droughts, wildfires and floods fuel fragility, especially in the Sahel where livelihoods are often vulnerable and coping capacities low. Exposure to other extreme events, such as locust swarms or epidemics, also increases with climate change.
- **Migration and displacement**: floods are creating substantial displacement in the region, especially in Chad and Niger (UNOCHA, 2022[23]). While climate and environmental hazards are not the main driver of current displacement, they are a key risk to watch for. Extreme heat, for example, is fuelling climate migration in other parts the world and could lead to similar displacements in the Sahel (Xu et al., 2020[24]).
- **Overwhelmed state institutions**: state capacities and resources in the Sahel are more limited than in other parts of the world and will remain so in the coming decades given the pace of demographic growth (SWAC/OECD, 2021[25]). As a result, tasks such as the restoration of damaged local ecosystems, the upgrade of water or waste management infrastructure, or the preparation for extreme weather events will largely rest on the people themselves. It also means that climate and environmental risks may further erode the social contract and the fragile legitimacy of Sahelian states.
- **Unintended consequences of the climate transition and adaptation policies**: the global climate transition is affecting the Sahel in multiple ways, including through intensified mining, both industrial and small-scale, and geopolitical tensions around access to natural resources. Adaptation policies such as the Great Green Wall or conservation measures may have unintended consequences for vulnerable groups, especially nomadic and transhumant groups, by restricting mobility and access to natural resources, or aggravating existing grievances against state authorities (Turner et al., 2021[24]).
- **Illicit economies and armed groups:** coupled with low state control and governance failures, a degraded, non-resilient natural environment generates additional opportunities for armed groups. Increased difficulties in making a living from agriculture or livestock make recruitment easier. Armed groups can also weaponise natural resources by restricting access to land or water. In highly fragile contexts, conservation can also work to the favour of armed groups, which can use protected areas to hide and thrive.

Three emblematic trends in environmental fragility in the Sahel: Growing food insecurity, rapid urbanisation and intensified mining

Although lists of channels linking climate change and environmental degradation with other aspects of fragility help paint a general overview of the dynamics at play, their level of detail can be too low to effectively inform policymaking. They do not provide much visibility on the deeper determinants of environmental fragility. This section takes a detailed look at three emblematic trends that carry multiple interconnected environmental and non-environmental risks: food insecurity, unregulated urban expansion and unregulated mining.

Climate change raises risks of food insecurity and conflict

The recent IPCC Sixth Assessment Report acknowledges that climate change has already contributed to irreversible adverse changes in terrestrial, freshwater, coastal and marine ecosystems. Despite global increases in agricultural productivity, climate change has hindered progress towards ending world hunger and contributed to food insecurity in several parts of the world. For instance, droughts and floods led to

increments in acute food insecurity and malnutrition in Africa and Central and South America (IPCC, 2022[25]). The poorer and more marginalised groups, such as indigenous people, women and children, are more vulnerable to climate impacts in those regions (IPCC, 2014[26]).

Climate change can exacerbate food insecurity through its impact on its four different pillars: availability, access, utilisation and stability. Most studies focus on availability through projected impacts on food production via decreases in the productivity of crops, livestock and fish, yet IPCC evidence shows that the other three pillars of food security will also suffer the impact of climate change (Mbow et al., 2019[27]).

Climate change jeopardises food security, creating additional fragility

In the Sahel, drought episodes can affect 80% of total land and 50% of arable land in any given year (Läderach et al., 2022[28]) (Rojas, Vrieling and Rembold, 2011[29]). The 2022 Global Report on Food Crises found that rainfall deficits in 2021 contributed to an 11% decrease in crop production in Sahel countries during the agricultural season, affecting livelihoods and food production, especially in northern Mauritania, north-eastern Mali, Niger and southern Chad (GRFC, 2022[30]). Next to non-climatic factors (conflict, insecurity and COVID-19-related socio-economic shocks), climate factors like widespread floods and prolonged droughts contributed to doubling the number of people suffering from high acute food insecurity (phase 3 or above of the IPC Acute Food Insecurity classification), from 12.7 to 24.8 million people between 2019 and 2020 (ibid.). Production of key staple crops such as millet and sorghum is at risk under current climate change projections, which could create additional food insecurity (IPCC, 2014[26]) (CIAT, ICRISAT and BFS/USAID, 2020[31]) (CIAT, ICRISAT and BFS/USAID, 2020[32]) (CIAT et al., 2021[33]) According to current projections, climate change is set to reduce crop yields in the Sahel by 11.3% by 2050 (Knox et al., 2012[34]).

Climate change also undermines food security through its impact on livestock production. Increasing rainfall variability and rising temperatures – widely observed in Sahelian countries – can affect livestock production both directly, by undermining animal health and animal production and reproduction, and indirectly through its adverse impact on water availability, the quality and quantity of pastures and fodder, and the risk of animal diseases (Mbow et al., 2019[27]) (CIAT, ICRISAT and BFS/USAID, 2020[32]) (CIAT et al., 2021[33]). The availability of fodder is particularly threatened in Niger and Mauritania, as well as the northern parts of Mali and Chad (GRFC, 2022[30]). Some studies estimate that rangelands in West Africa will witness a 46% decrease by 2050 (Boone et al. 2018). Likewise, projections estimate that droughts may decrease West African calving rates from 60-70% to 25-30% (USAID, 2017[35]).[3]

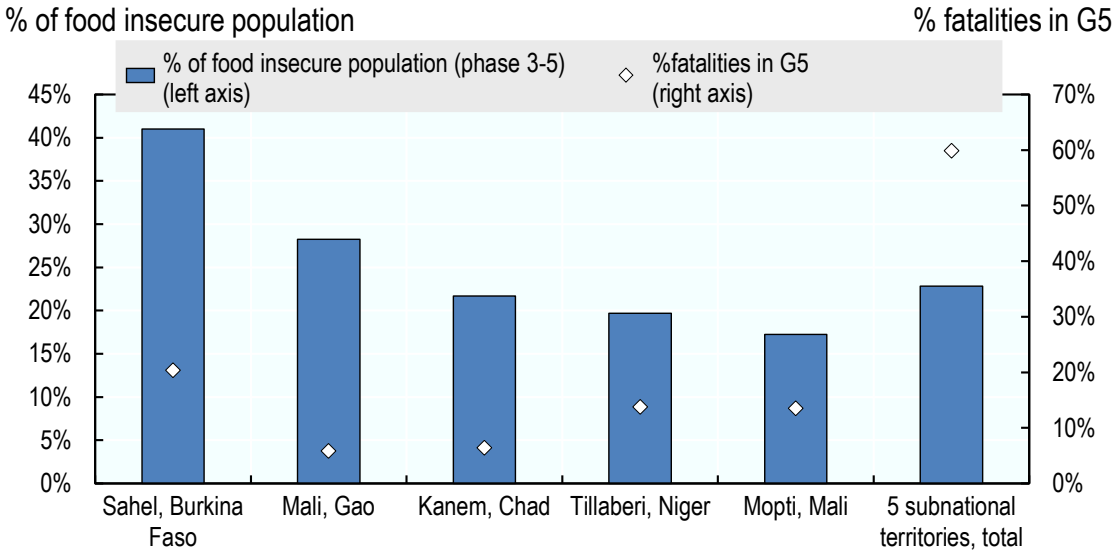
In the Sahel, 95% of food production occurs under rainfed conditions, making it particularly vulnerable to climate variability and change (Läderach et al., 2022[28]) (Moorhead, 2009[36]). The potential negative impact of climate variability on the Sahelian population became clear during the long-term drought that took place from 1968 to 1993. This episode destabilised climate-sensitive livelihoods, sparked a major humanitarian crisis and contributed to the context leading up to the Tuareg armed rebellions in the 1990s (Läderach et al., 2022[28]) (Benjaminsen, 2008[37]).

There is growing evidence of the role that food insecurity plays in sparking and sustaining social unrest, protests, and civil and communal conflicts (Brinkman and Hendrix, 2011[38]) (FAO, 2016[39]) (Brück et al., 2016[40]) (Delgado, Murugani and Tschunkert, 2021[41]). Studies such as Goldstone (1991[42]) and Diamond (2005[43]) illustrate the role that food price increases have played historically in the breakout of rebellions and insurgencies, while more recent studies highlight the link between shocks in food prices and the Arab Spring (Maystadt, Trinh Tan and Breisinger, 2014[44]) (Johnstone and Mazo, 2011[45]). Food price increases, which often push many vulnerable households into food insecurity, can act as a catalyst for instability and fragility when interacting with local socio-economic and political vulnerabilities. More specifically, food insecurity can aggravate horizontal inequalities and compound grievances against the state, increasing the likelihood of vulnerable communities to support and/or engage in different types of violence.

CGIAR econometric analyses show how climate can influence conflict intensity and occurrence indirectly in Senegal and Mali (Villa et al., 2021[46]) (Kangogo, Läderach and Pacillo, 2021[47]). These studies observe, first, that the presence of increasing climate anomalies affects the likelihood of food and nutritional insecurity at the household level. Second, they show that food and nutritional insecurity correlates with conflict intensity. Overall, conflict is particularly likely to take place where climate stress and food insecurity coincide. Econometric analysis thus corroborates the understanding of climate change as a risk multiplier through the food insecurity channel.

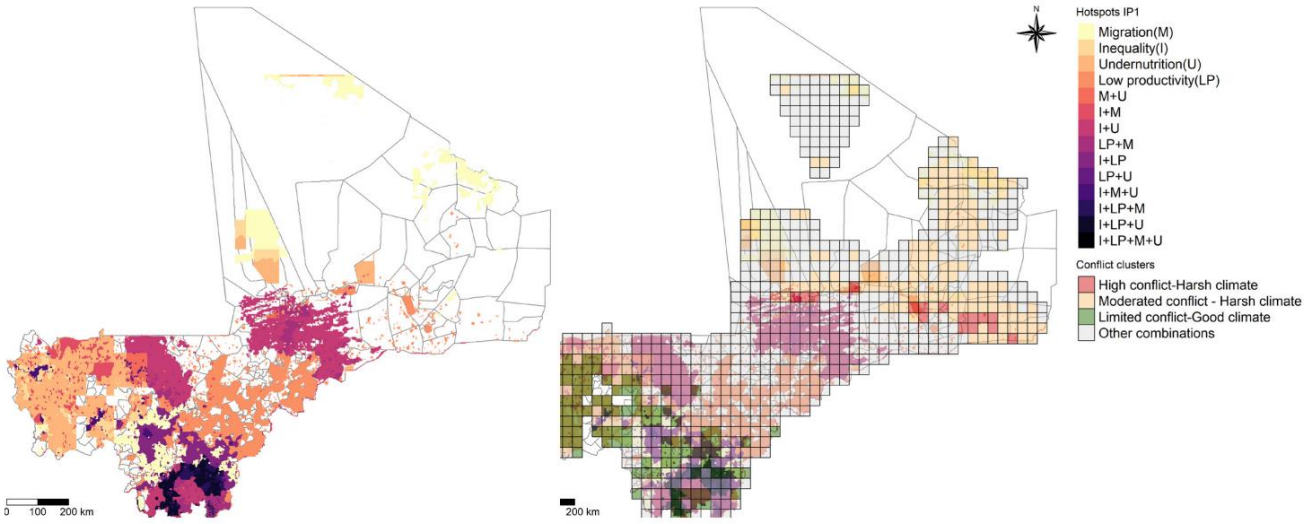
Relationships between climate vulnerability, food insecurity and fragility are complex. First, although high food insecurity typically accompanies conflict, the relationship is not linear. Figure 1 shows food insecurity levels in the five subnational territories of G5 countries that witnessed the most violence in 2021. Together, the five subnational territories concentrated 60% of fatalities from armed violence in 2021. Food insecurity levels in the five subnational territories were high overall, ranging from 17% (Mopti, Mali) to 41% (Sahel, Burkina Faso) and averaging 23%. However, in some territories conflict intensity was higher despite lower food insecurity, showing other factors at play. Second, the respective influences of climate, food insecurity or other vulnerabilities on security vary greatly depending on the exact location. Geospatial data allow for more precise identification of areas facing a confluence of climate, conflict and other risks, showing that not all areas face the same types of risks. A spatial analysis focused on Mali identified hotspots of high levels of conflict and harsh climate conditions in the north-eastern part of the country: the communes of Tele, Douekire, Banicane, Gounzoureye, Menaka and Anderamboukane (conflict clusters combining high conflict and harsh climate on Map 1) (Achicanoy et al., 2021[48]). Map 1 shows that high exposure to both harsh climate conditions and conflict only occurs in specific locations, where other vulnerabilities (inequality, undernutrition) are also present.

Figure 1. Food insecurity in Sahel subnational territories witnessing most violence



Source: Authors using ACLED (2022[1]) and RPCA (2022[49]).

Map 1. Spatial hotspots of climate-security interactions in Mali



Source: Achicanoy, Ramirez-Villegas, Mendez, Läderach, & Pacillo (2021[48]).

Fragility is a source of food insecurity

Around 490 million of the 800 million people in the world who suffer chronic food insecurity live in conflict-affected countries (WFP, 2018[50]). While sometimes violence and insecurity linked to fragility may be fuelled by food insecurity or sudden spikes in food prices, conflicts themselves also undermine food security in various ways. Conflicts hamper the ability of governments and humanitarian actors to assist affected populations (FAO, 2016[39]), prevent access to markets and increase food prices. Conflict and violence also have a detrimental effect on food security because of the destruction of crops, agricultural infrastructure and assets, the injury, displacement and killing of agricultural workers, and disruptions of local food markets and the food supply chain (Läderach et al., 2021[51]) (Dago, 2021[52]) (Delgado, Murugani and Tschunkert, 2021[41]). Countries with the highest levels of undernourishment tend to be those ravaged by war (FAO, 2016[39]). This evinces how fragility, conflict and food insecurity can reinforce one another. In the Sahel, violent conflict and displacement are still the main drivers of food insecurity, especially in Mali, Niger and Burkina Faso, due to the ongoing crisis in the Liptako-Gourma. Conflict in the Sahel critically undermined livelihoods, disrupted markets, triggered large-scale displacement and contributed to high food prices in 2021 (GRFC, 2022[30]).

Rapid and uncontrolled urbanisation creates additional environmental risks

Rapid and uncontrolled urbanisation fuels environmental fragility in the Sahel by causing biodiversity losses and degrading ecosystem health. It also exposes rapidly growing cities to higher environmental risks like floods, landslides and urban heat islands. Urban-related environmental risks are particularly high in the region due to the speed of urbanisation. The fragility context also plays a role, as displacement acts as a further boost to urbanisation.

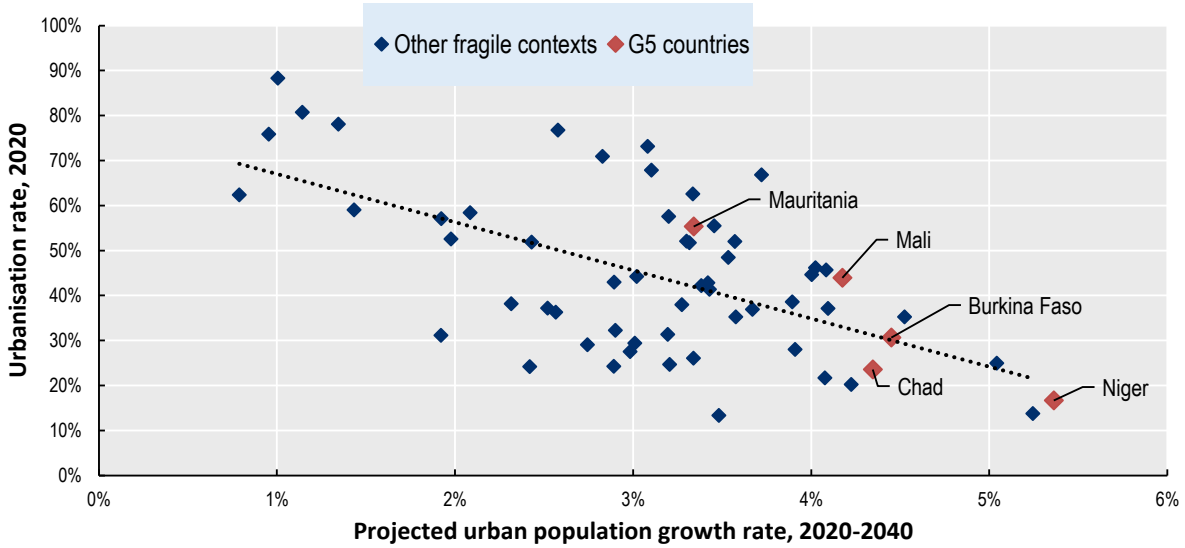
The impacts of urbanisation on biodiversity and ecosystem health materialise through three main channels: the expanded use and consumption of natural resources, the conversion of natural environment into built areas, and waste generation (emissions, waste water or solid waste) (World Bank, 2017[53]). Demand for cooking fuel in urban settings is an important source of pressure on biomass. In Niger, 87.5% of households use wood fuel for cooking (World Bank, 2020[54]). Urban encroachment of natural areas is growing fast in the region: between 1992 and 2019, urban land cover increased by 1 256km^2, about the

equivalent in surface terms of three to four cities such as Lomé, Cotonou or Yaoundé (OECD/SWAC, 2022[55]). The spread of built-up areas affects biodiversity, often benefiting invasive species and imperilling others.[4] Emissions in the Sahel are currently small relative to other world regions, but they may increase rapidly as cities grow larger.[5] Solid waste production jeopardises soil and water quality and disrupts hydrological cycles. In Nouakchott, only 5% of sewage is treated before being discharged (IEA, 2021[56]).

Exposure to environmental hazards is high in rapidly expanding informal settlements. For example, poor-quality buildings and increased coverage of paved roads reducing water absorption in the ground amplify flood disasters. In 2021, floods affected 256 000 people in Chad, 250 000 people in Niger and 34 000 people in Burkina Faso. The number of houses damaged or destroyed amounted to 41 000 in Chad and 21 000 in Niger (UNOCHA, 2022[21]). Risks of landslide also increase as rainfall becomes more concentrated in time due to climate change. Lastly, unplanned urbanisation in the Sahel increases risks of urban heat islands, especially in informal settlements with few green spaces and high use of iron roofing.[6]

Environmental risks attached to urban growth are particularly high in the Sahel because of exceptionally high urban growth rates. Projected urban population growth rates for 2020-40 range between 3.3% (Mauritania) and 5.4% (Niger) (UN DESA, 2018[57]). All Sahel countries but Mauritania are in the top 15% of fragile contexts and top 20% of African countries in terms of projected urban growth for 2020-40 (Figure 2). With the exception of Mauritania, Sahel countries are still in the first phase of the urban transition, characterised by rapid urban population growth. About 30% of the population is now concentrated in urban areas, with variations across countries (70% for Mauritania, 54% for Mali, 26% for Burkina Faso, 9% in Chad and 4% in Niger) (World Bank, 2022[58]). All of these values are still below or far below the OECD average of 81%, suggesting urban growth is there to stay (ibid.).

Figure 2. Urbanisation rate and projected urban population growth in 60 fragile contexts

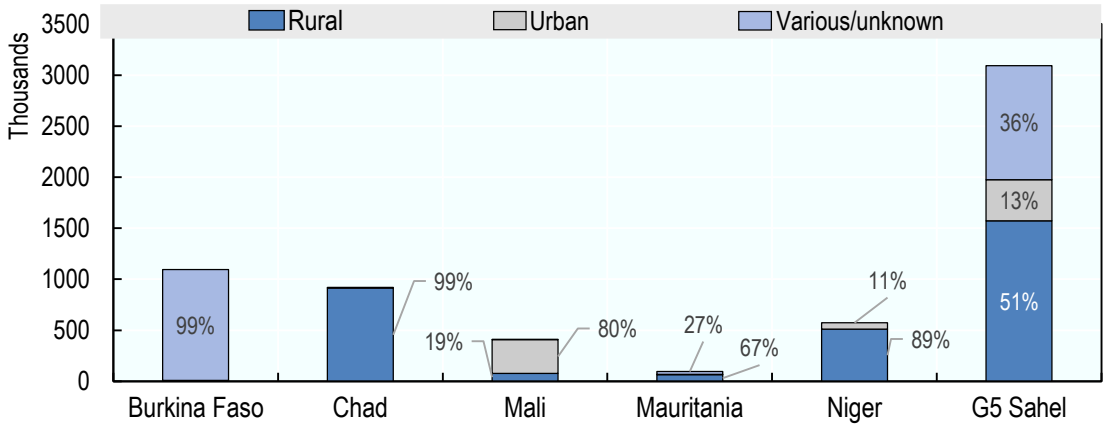


Source: authors using OECD (2022[59]) (for the list of fragile contexts) and UN DESA (2018[57]) (for urbanisation rates and projections).

Moreover, the fragility context accelerates urbanisation even more. Available studies suggest displacement boosts urban growth, either through influxes into existing cities or through the emergence of new cities.[7] No disaggregation of location is available for Burkina Faso, which now hosts the largest forcibly displaced population in the region. However, in Mali, 80% out of 410 000 forcibly displaced people are in urban areas according to UNHCR data (Figure 3). The number of internally displaced persons (IDPs) has increased steeply since 2016 (Figure 4). According to UNHCR (2021[60]), in 2020 there were 3.01 million forcibly

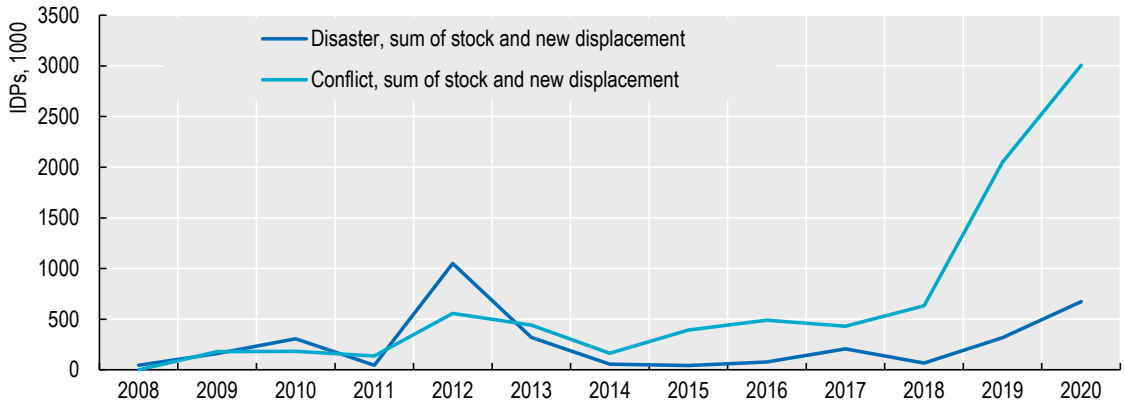
displaced people in G5 countries. Seventy percent of the 2019 surge is driven by the increase in IDPs in Burkina Faso. Displacement is mostly due to conflict and violence, although natural disasters also played a role.[8]

Figure 3. Forcibly displaced populations by location (urban/rural or unknown) in Sahel countries, 2020



Source: authors using UNHCR (2021[60]), sourced from UNOCHA (2022[61]).

Figure 4. Internal displacement in Sahel countries: conflict-led versus natural disaster-led



Source: Authors using IDMC (2022[62]).

Unregulated mining exacerbates risks of environmental damage, elite capture and illicit financing of armed groups

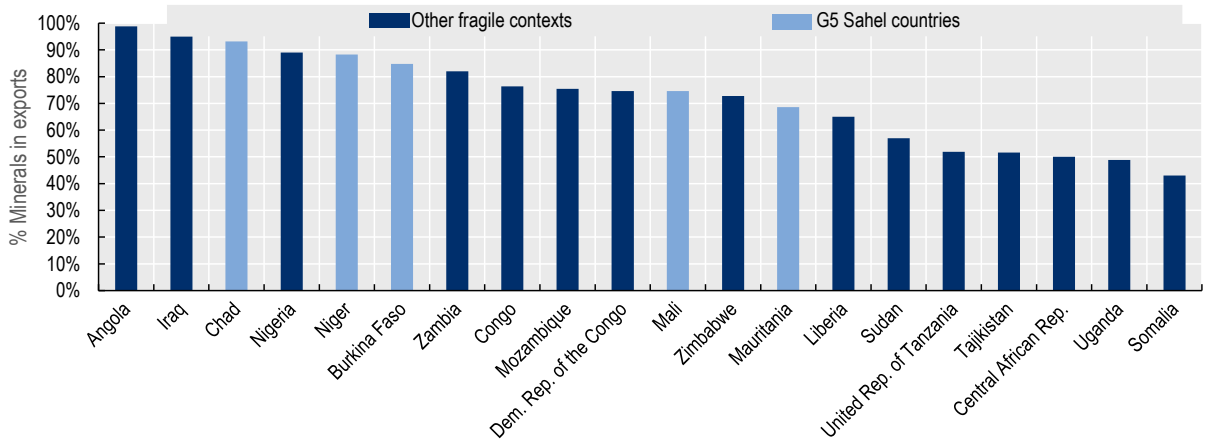
Next to urbanisation, intensified natural resource extraction and mining are another key driver of environmental fragility. Although oil production and mines emit large amounts of CO_2, in the Sahel context pollution represents the most direct environmental risk. There have been several reports of environmental disasters related to oil production in the Doba Basin, south of Chad, such as frequent spills along the pipeline linking Chad to Cameroon (Temper, del Bene and Martinez-Alier, 2015[63]), with harmful consequences for ecosystems and local populations (Murrey, 2015[64]). Data for mining is scarce, but available case studies for both industrial and artisanal and small-scale mining (ASM) of gold suggest

severe pollution of local water, soils and plants.[9] Incidentally, water scarcity also threatens the economic viability of mines (McKinsey, 2020[65]).

The lack of regulation in extractive industries and mining also increases risks in the political, economic and security dimensions of fragility (OECD, 2022[66]). On a political level, it fosters elite capture of natural resource rents and corruption, both of which are detrimental to government effectiveness. Economically, it prevents the equal sharing of mining revenues across the labour force. In Chad, for example, the estimated number of salaried workers in the extractives sector is 725 according to EITI data (2022[67]) – although only an estimate, it shows natural resource extraction is yet to benefit larger shares of the labour force. From a security perspective, the absence of supervision in the ASM sector reinforces the transnational illicit economies on which armed groups rely for funding. The environmental footprint of ASM also adds to fragility; for example, by rendering soils unsuitable for agriculture, which means that in some areas ASM or joining armed groups become the only remaining options for young people.

Natural resource extraction and mining are expected to intensify because of their central role in the countries' economies and current market trends. Extractive resources (or minerals) indeed dominate Sahel trade. Oil, precious metals (gold, diamonds) and metals (ores, including iron, copper and uranium) jointly represent 69% of total exports in Mauritania, 75% in Mali, 85% in Burkina Faso, 88% in Niger, 93% in Chad and 80% for the total of G5 Sahel (Figure 5).

Figure 5. Share of minerals (including oil and metals) in exports, 2019 or latest available year: Top 33% of fragile contexts with highest shares



Note: HS Comtrade commodity codes used in the numerator of the ratio are 26, 27, 71, 72, 73, 74, 75, 76, 78, 79, 80, 81, 82 and 83.
Source: Authors using Observatory of Economic Complexity (2022[68]) (for Chad) and UN Trade Statistics (2022[69]) (for all other countries).

High commodity prices encourage further natural resource extraction and mining activity. Since 2000 and despite a setback during 2013-16, prices of key Sahel commodity exports have been growing. Between 2000 and 2021, crude oil prices increased by 194% in real terms, iron ore prices by 444% and gold prices by 510% (World Bank, 2022[70]). The increasing trend of gold prices has fuelled the continuous expansion of ASM ever since a vast gold deposit stretching from east to west of the Sahara was discovered in 2012 (ICG, 2019[71]).

The presence of so-called 'green' minerals in the Sahel also suggests mining is likely to intensify. Green minerals are essential for the global climate transition. Table 1 compiles available data on estimated reserves of eight green minerals in Mauritania, Mali and Burkina Faso. These are necessary for solar and wind technology, electric vehicles and energy storage (IISD, 2018[72]). Bauxite, copper, lithium and manganese reserves in particular are significant. Although projected demand increases are variable due

to uncertainties about recycling rates (McKinsey, 2020[65]), the presence of these 'green mineral' reserves could fuel additional extractive activity in the region.

Table 1. 'Green minerals' in Mauritania, Mali and Burkina Faso

	Estimated reserves (1 000 tons)				Estimated share of world reserves			
	Mauritania	Mali	Burkina Faso	Total	Mauritania	Mali	Burkina Faso	Total
Bauxite and Alumina Reserves (MT)		1 200 000	12 700	1 212 700		2.4%	0.0%	2.4%
Copper Reserves (MT)	28 000		70 000	98 000	0.5%		1.3%	1.8%
Graphite Reserves (MT)			9	9			0.0%	0.0%
Iron Ore Reserves (MT)	1 500 000	2 000 000	66 000	3 566 000	0.2%	0.3%	0.0%	0.4%
Lithium Reserves (MT)		700		700		0.8%		0.8%
Manganese Reserves (MT)		10 000	8 550	18 550		0.7%	0.6%	1.2%
Nickel Reserves (MT)			450	450			0.47%	0.5%
Zinc Reserves (MT)		1 700		1 700		0.1%		0.1%

Source: authors using EITI (2022[73]) country pages and reports on Sahel countries and the US Geological Survey (2022[74]).

Official development assistance resources for climate and environment are significant, but there are blind spots in donor approaches

Looking at donor policies in the region, data from the OECD Creditor Reporting System (CRS) shows that, overall, climate and environment are an important part of the ODA landscape in the Sahel. However, some sectors are clearly prioritised over others. There are also blind spots in donor approaches: there can be a lack of conflict sensitivity in environmental projects, or a limited integration of environmental aspects in humanitarian and peace interventions.

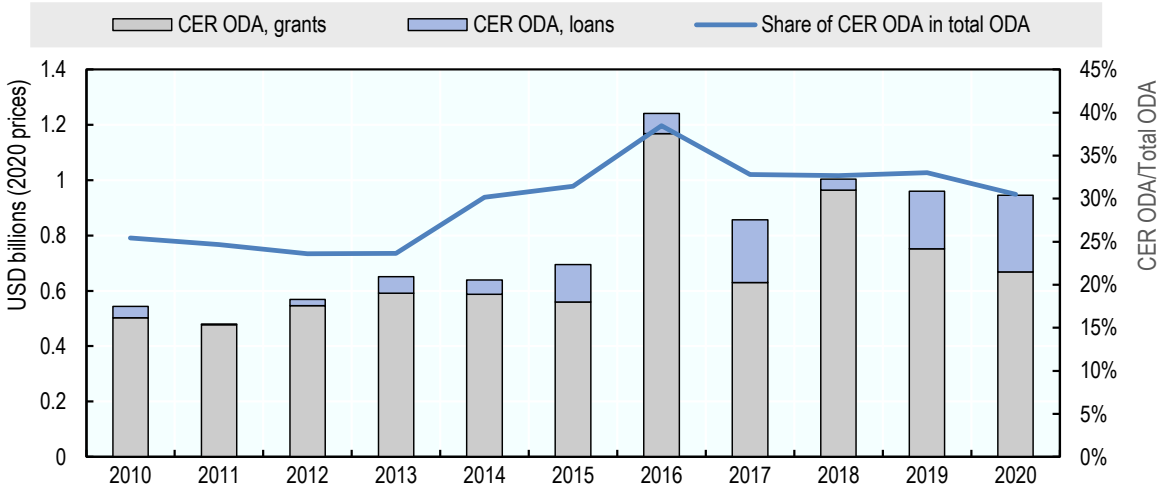
Trends in climate- and environment-related official development assistance

This section uses the environment marker and the Rio Markers in the OECD CRS to review trends in bilateral (i.e. funded by Development Assistance Committee (DAC) members) allocable CER ODA in the Sahel, so as to identify gaps and entry points for improved support and effectiveness.[10]

In the G5 Sahel, bilateral CER ODA increased moderately over the past decade before declining slightly, reaching USD 946 million in 2020 (Figure 6). The share of CER ODA in total ODA was 31% in 2020. Grants represent the majority of bilateral CER ODA to G5 Sahel (70% in 2020), even though the use of loans increased from 2018 onwards.

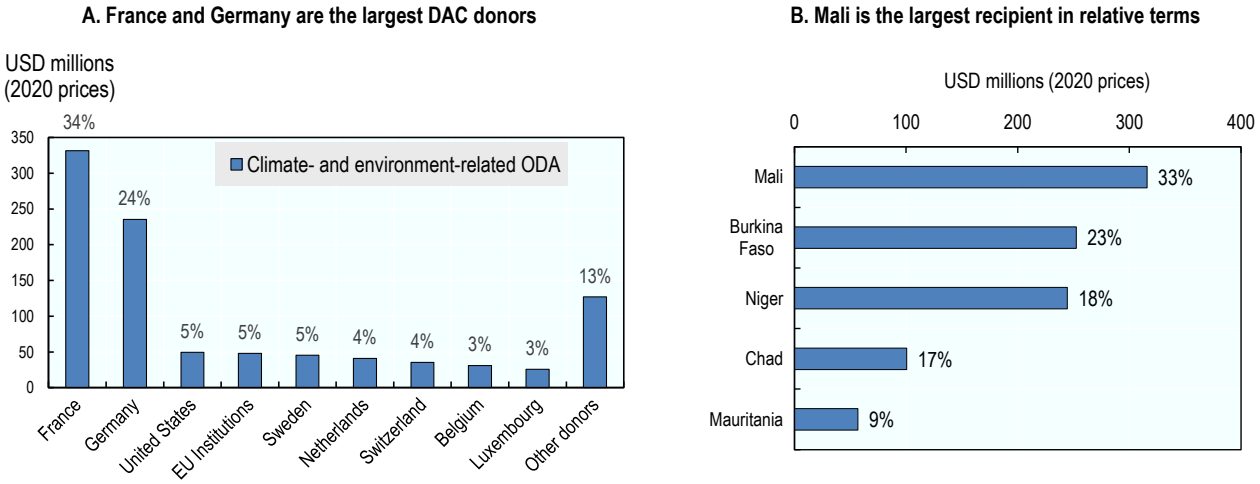
France and Germany together account for 58% of bilateral allocable CER ODA commitments in the G5, followed by the United States, European Union (EU) institutions and other donors, all accounting individually for less than 5% of commitments (Figure 7). Mali was the largest recipient of CER ODA during 2018-20, concentrating one-third of financial allocations. Commitments to Chad and Mauritania were markedly lower.

Figure 6. Bilateral allocable climate- and environment-related official development assistance commitments in the Sahel



Source: Authors using OECD (2022[75]) (CRS dataset).

Figure 7. Bilateral allocable climate- and environment-related official development assistance commitments in the Sahel across DAC donors and countries, average 2018-20

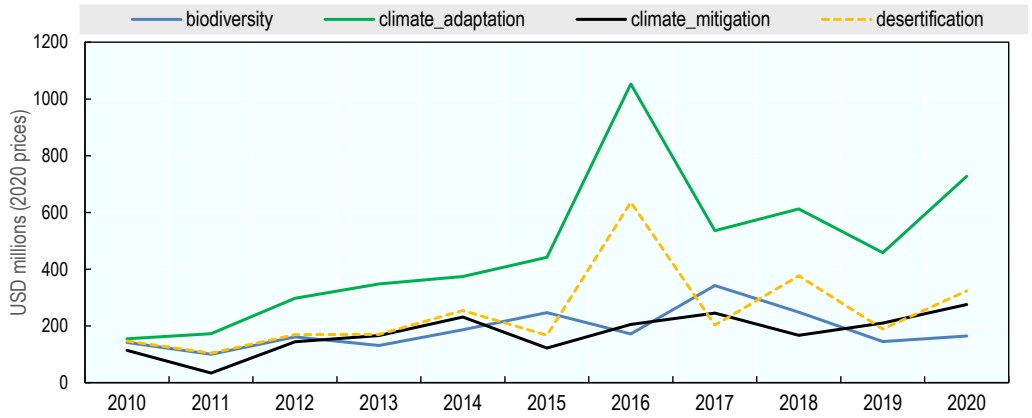


Source: Authors using OECD (2022[75]) (CRS dataset).

Climate change adaptation is the most common objective of CER ODA in Sahel countries (Figure 8). The disaggregation of 2018-20 ODA across purposes shows 56% of bilateral CER ODA in Sahel countries concentrates on three categories: (i) agriculture, forestry and fishing (25.5%); (ii) water supply and sanitation (19%); and (iii) energy (11.5%). Examples of some the largest bilaterally funded projects in terms of financial commitments are the Yeleen solar electricity production project in Burkina Faso (AFD, EU and AfDB, 2018[76]), the Small-Scale Irrigation and Food Security Program in Niger with KfW support (Magoum, 2021[77]) and the Water Supply Program in Secondary Cities in Mali (AFD, 2014[78]). Although agriculture, forestry and fishing attract a significant share of bilateral CER ODA (more than one-quarter), urban

planning and mining-related activities each represent less than 1% of both CER and total bilateral allocable ODA.

Figure 8. Bilateral allocable climate- and environment-related official development assistance in the Sahel: Disaggregation across Rio Markers



Note: one activity can be tagged to multiple Rio Markers.
Source: Authors using OECD (2022[75]) (CRS dataset).

Multilateral finance is the other important part of the ODA landscape in the G5. Box 2 discusses the level, sources and allocations of multilateral climate-related ODA. Due to differences in the way bilateral and multilateral donors report on ODA to the OECD, Box 2 focuses exclusively on multilateral climate-related ODA and not on CER ODA (see endnote 10).

Box 2. Multilateral climate-related official development assistance commitments in the G5 Sahel

Multilateral climate-related official development assistance (ODA) commitments in the G5 Sahel reached USD 971 million in 2020, or about 93% of bilateral climate- and environment-related (CER) ODA. Contrary to DAC member commitments, this multilateral financing increased each year since 2014, showing a growing engagement of multilateral actors on climate in the region. The World Bank/IDA has been the leading donor, representing 56% of climate-related ODA commitments on average during 2018-20, followed by the African Development Bank (18%) and the International Fund for Agricultural Development (7%). While Mali attracted the largest share of DAC resources, multilaterals channelled a greater share of climate-related ODA to Niger and Burkina Faso, respectively 32% and 27% of multilateral climate-related ODA commitments in 2018-20. As with DAC-funded projects, multilateral climate projects mostly pursue climate change adaptation objectives, as opposed to mitigation. Multilateral commitments to activities with adaptation as a principal objective were 3.2 times higher than commitments with mitigation as a principal objective for the 2018-20 period.

The key multilateral climate funds, namely the Global Environment Facility, the Green Climate Fund (GCF), the Adaptation Fund and the Climate Investment Funds play a non-negligible role in the Sahel. These funds provided 10% of total multilateral climate-related ODA commitments to G5 countries on average for 2018-20. The funds committed 2.1% of their portfolios to G5 countries in 2018-20, as opposed to 1.7% for other donors. Hence, in the past few years the Sahel has been firmly on the radar of the climate funds in terms of ODA commitments.

Current blind spots: Lack of conflict sensitivity and limited consideration of environment-related drivers of fragility

Close to one-third of bilateral ODA in the region has CER objectives, but its use is often based on an inadequate understanding of how those environmental risks affect the economic, political, security, societal and human dimensions of fragility. Urban planning and mining-related activities are poorly prioritised. More broadly, policies and programmes in the Sahel display a number of blind spots. First, in addition to funding imbalances (i.e. the low prioritisation of urban planning or mining-related activities), the design and implementation of environmental projects often fails to take potential impacts on local grievances and conflicts into account. For example, the donor-funded Kandadji dam project in Niger raises concerns of increased displacement and tensions around land and water (DaoudaDiallo, 2021[79]). Reforestation programmes, including the Great Green Wall initiative, can aggravate grievances of marginalised communities through fines for firewood collection or informal taxation by forest service officers (Raineri, 2020[80]). Similarly, even though past experiences with solar farm projects in other countries did at times create tensions around natural resource access, there is limited information on the impact of solar farms on land and water availability in the Sahel context.[11] Better conflict sensitivity analysis remains a necessity when engaging in fragile contexts like the Sahel.

Second, humanitarian and peace interventions may not be aware of or lack capacity to act upon environment-related drivers of fragility. Peacekeeping missions and stabilisation programmes tend to pay only marginal attention to the environment, keeping the focus on eliminating violent threats. This approach overlooks the role and quality of interactions between humans and ecosystems in the viability of peace solutions. Recent increases in numbers of civilian deaths from armed violence, coupled with high political volatility, reinforce the tendency to concentrate on the security dimensions of crises in the Sahel. Regional fragility is at times reduced to a security problem involving religious extremism, farmer-herder conflicts or ethnic tensions. This not only neglects the role of ecosystems but also the impact of wider trends, such as the global increase in demand for minerals, which sustains dependence and low diversification in Sahel

economies. Achieving peace will not be possible without healthy ecosystems, adequate environmental stewardship and inclusive rules on access to natural resources; equally, it will not be possible to manage mineral wealth and regulate the ASM sector without an effective policy framework.

Given these blind spots, only a small number of policies and programmes try to address conflict and fragility through environmental activities (or vice-versa). Partly, this is due to the difficulty of incorporating rather complex evidence on climate or environmental fragility links in short programme design phases. Toolboxes have been developed in response to this challenge (Adelphi, UNEP and EU, 2019[81]). Yet, the more fundamental problem is that environmental and peace actors often work in 'separate worlds', pursuing different objectives and following different agendas.

How to improve responses to environmental fragility

Environmental fragility emerges "from a complex interaction of factors (…) within and across systems". It calls for 'systems thinking': "actors cannot understand systems by studying their parts alone" (Desai and Forsberg, 2020[82]). Responding to environmental fragility requires multidimensional approaches that reflect an understanding of how climate change and environmental damage influence the different dimensions of fragility. In this spirit, this section discusses three ways to broaden and improve responses to environmental fragility.

Strengthen the analysis of interactions between humans and ecosystems to plan for local livelihoods and food systems

Given the food insecurity situation and current blind spots in ODA responses, fragility-sensitive support to food systems should be a key part of Sahel strategies. With 80% of the labour force working in the food sector, healthy ecosystems are central to life in the region. For development actors, good design and effective implementation should start by analysing interactions between humans and ecosystems, and plan around local livelihoods and food systems as key reference points. This involves:

- Acquiring a detailed understanding of how local ecosystems work, which services they provide to local populations, and who can access which service and under which conditions. In other words, there needs to be an evidence base on the local political economy of food systems and natural resource use. Box 3 provides a good practice example of a project based on such evidence.
- Relying on and engaging with networks, alliances and coalitions of local actors to facilitate information management, in accordance with principles of localised and bottom-up peacebuilding (Tschunkert and Delgado, 2022[87]). Local actors are often better equipped to understand how fast-changing local ecosystem issues and natural resource governance realities relate to conflict patterns. Key local actors include farmer and pastoralist organisations, associations of other relevant groups (fisherfolks, traders…), state and customary authorities, as well as representatives of youth and women. A preliminary step in this regard is to conduct mappings of local actors in target areas to identify reliable partners (DIIS, 2022[16]).
- Strengthening these local networks, alliances and coalitions through adequate capacity development activities (especially on ecosystem data collection), and, if necessary, through financial resource transfers. Scanning the local networks, alliances and coalitions to identify instances of promising initiatives for potential scale-up. As much as possible, the programme or policy needs to be an upgraded version of what local actors are already doing and has been found to work.[12]
- Agreeing on a mutually beneficial co-operation framework between local and external actors linking motivations, transparency and accountability. Agreement not only on what to work on, but also on 'how we work together' is necessary. Co-operation frameworks need to acknowledge positive

contributions from all actors; for example, while local actors can have better access to information on local dynamics, external actors can have better visibility on national- or regional-level evolutions.

- Regularly monitoring the extent to which the activity is contributing to local environmental regeneration, well-performing food systems and better natural resource use. The emphasis on ecosystem health and food reflects the fact that agri-food systems are a powerful driving force towards ending hunger and food insecurity in all its forms, and thus a key component in fostering peace and adapting to climate change (Läderach et al., 2021[88]).

Box 3. Putting human-ecosystem interactions, local livelihoods and food systems at the centre

Good-practice example[13]

The PAFHa+ (*Projet d'appui à la filière halieutique*, 2016-24) project seeks to promote peace through enhanced livelihoods, natural resource and ecosystem management, and food security. The project supports fishing resources in the Mopti and Segou subnational territories in Mali. It started with initial EU funding to Enabel as implementing partner. The *Agence française de développement* (AFD) then complemented that with additional funding (EUR 5 million) and conflict sensitivity requirements sourced from the methodology of the AFD Minka fund. The conflict sensitivity requirements led to a first context analysis prior to implementing the AFD funding, to identify the causes of conflicts linked to the governance of fishing resources. A second analysis then examined the 12 locations targeted by the project, as each location has its own customary rules for fishing resource management, and relationships between customary and administrative rules. The result is a project oriented towards fishing resource "co-management" (*cogestion*) within a network of local fishery users, based on a refined understanding of customary rules in each location.

Similar insights apply to humanitarian and peace actors. Engaging with a broad set of local stakeholders, and especially representatives of farmers, pastoralists and other groups involved in food production and trade, can help get a better sense of local ecosystem and natural resource realities, and of how interventions may influence access to ecosystem services for different communities and food supply chains. In addition, humanitarian and peace actors still have much scope to reduce their environmental footprint. There have been reports of how humanitarian and peace missions use sand from Niger River banks to build offices requiring air conditioning powered by highly polluting oil-fuelled power generators; or of how missions engage in water borehole drilling without abiding by national water plans, putting additional pressure on scarce water resources.[14] Ensuring humanitarian and peace activities do not put additional stress on local ecosystems is a first step to addressing environmental fragility.

Support balanced and sustainable urbanisation

The increase of environmental fragility in urban settings, including through the impact of displacement on urban development, generates new types of risks. In the absence of adequate planning and regulatory frameworks, rapid urban growth can cause severe environmental degradation, and increase exposure to extreme weather events such as heat islands, floods and landslides. Tensions may arise between displaced and host communities, fuelling marginalisation and urban violence. Below are three entry points to address the increasingly important 'urban' component of environmental fragility.

- **Data and information**: several initiatives are leveraging the potential of satellite imagery to provide a more precise and dynamic picture of urban dynamics in African countries.[15] Building on the latest urban data in combination with geolocalised data on forcibly displaced populations would allow the identification of areas facing a coalescence of urban, displacement and environment-related risks.

- **Supporting local networks, alliances and coalitions of urban actors**: policy makers, development, humanitarian and peace actors can facilitate network build-up around urban fragility issues. Local governments, city councils and mayors, civil society organisations (associations representing urban districts or communities, such as displaced people, refugees, street vendors, traders, women, etc.) who are on the frontline of urban transformations are key stakeholders in this regard. Building networks can foster innovative dialogue, bring new voices to the table, get a better understanding of vulnerabilities and needs, and support transformative action.[16]
- **Contribution to a regional urban agenda**: there is need for in-depth policy reflections on the future of Sahelian cities from the perspective of environmental fragility, considering climate change effects and pressurised ecosystems, limited state resources, increasing displacement, and the need to provide services as well as economic opportunities to new urban populations. Sahel countries adopted Agenda 2030, of which SDG 11 aims to make cities and human settlements inclusive, safe, resilient and sustainable. Several goals and priority areas in the African Union's Agenda 2063 relate to sustainable urban development, and Sahel countries also participate in UN Habitat's New Urban Agenda. A strong regional urban vision is, however, still missing. Key questions to be raised include: which local initiatives are building environmental resilience in the Sahel's growing cities and what support do they need? How can the 'greening' of Sahel cities generate new economic opportunities and improve social cohesion? How can principles of sustainable urban planning inform humanitarian interventions? How can the peace and security sector respond to increasing risks of urban violence?

Build greater understanding of environmental fragility across humanitarian, development and peace actors

It is important to disseminate environmental fragility analysis across humanitarian, development and peace (HDP) actors to avoid restrictive and ineffective responses to Sahelian crises. Awareness of the drivers and implications of tensions around natural resource access for food production, of urbanisation and displacement, of the rapid growth of the ASM sector and low economic diversification, and of the interplay with environmental issues can be limited among HDP actors. Awareness is, however, necessary to nuance narratives on the causes of crises in the Sahel, elevate policy debates and improve international responses. For example, conducting counter-insurgency campaigns may prove a never-ending effort if revenues from an unregulated, booming and environmentally damaging ASM sector keep flowing to armed groups.

Nuance and systems thinking are even more necessary given the securitisation tendencies at work in Sahel policy debates, which may result in reduced attention to environmental issues and livelihoods. Between 2019 and 2020, total ODA commitments towards humanitarian and peace activities increased in all Sahel countries, reflecting the growing prioritisation of humanitarian and security aspects (OECD, 2020[85]). To be effective, humanitarian and peace efforts need to be coherent with development policy. As mentioned in the recent HDP Nexus Interim Progress Review, "short-term interventions for peace must, and can, be better connected to development objectives by enhancing mutual understanding and information sharing among HDP actors" (OECD, 2022[86]).

HDP dialogue on the basis of environmental fragility analysis can help craft more integrated and balanced development visions and strategies. Outlining how climate and environmental risks interact with economic, political, security, social and human risks is a powerful starting point to achieving greater alignment between national governments, regional organisations (ECOWAS, UEMOA, the Liptako-Gourma Authority, the Niger Basin Authority and the Lake Chad Commission), donors and International Financial Institutions. It is also required to streamline climate and environment across sectors and actors. Policy makers and donors working on climate and the environment often operate in their own 'bubble', focusing on processes like the UNFCCC, adaptation measures or climate finance. Similarly, while development

actors underline the economic potential of the Sahel's youthful population and growing cities, humanitarian and peace actors concentrate on crisis responses and insecurity. The recent work of the Office of the UN Special Coordinator for Development in the Sahel on crafting a 'Sahel Vision' is an opportunity to gather stakeholders round the table and promote a shared understanding of environmental fragility.

Notes

[1] Consultation with UNISS, April 2022, around the forthcoming 'Sahel Vision' report.

[2] Adapted from Adelphi et al (2015[99]).

[3] "The calving rate is defined as the number of calves actually produced by a cow divided by the number of potential calves" (Wilkanowska and Kokoszyński, 2015[100]).

[4] Simkin et al (2022[87]) compute global estimates for 2015-50 and find that under business-as-usual scenarios, global unmitigated urbanisation will cause habitat loss for about one-third of the 30 393 surveyed species and be a direct driver of imperilment for 855 species.

[5] For example, Onitsha (Nigeria) is the most polluted city in the world in terms of small particulate matter concentration (WHO, 2022[88]).

[6] Looking at Lagos (Nigeria), Nairobi (Kenya), Addis Ababa (Ethiopia) and Lusaka (Zambia), Simwanda et al (2019[90]) found differences between the mean temperatures of impervious (built) surfaces and green spaces ranging between 1.8 and 4.9C, suggesting the presence of strong urban heat island effects in these African cities.

[7] A 2019 study from the Center for Global Development, covering 17 countries and 9 million IDPs estimated that about 50% of IDPs globally are in urban settings (CGD, 2019[89]).

[8] Most commonly floods according to IDMC (2022[62]) data.

[9] See Keita et al (2018[92]) and Bokar et al (2020[93]) (on environmental impacts of industrial and ASM gold mining in Mali), Okonkwo et al (2021[91]) (on environmental impacts of ASM in Niger).

[10] The paper uses the CRS dataset to capture CER development finance. CRS allows the identification of ODA flows disaggregated at the project or activity level. For ODA coming from DAC members, the following rule was applied: climate- or environment-related activities have the environment marker or at least one Rio Marker scoring 'significant' or 'principal'. There are four Rio Markers: 'climate adaptation', 'climate mitigation'; 'biodiversity' and 'desertification'. Allocable aid is used: "bilateral allocable aid is the basis of calculation used for all markers (gender equality and environmental markers). It covers bilateral ODA with types of aid A02 (sector budget support), B01 (core support to NGOs), B03 (specific funds managed by international organisation), B04 (pooled funding), C01 (projects), D01 (donor country personnel), D02 (other technical assistance) and E01 (scholarships)" (OECD, 2022[101]). This methodology only applies to bilateral ODA from DAC members. For multilateral ODA, providers report climate-related ODA to the OECD using a different methodology called the *Climate Components*, focused on climate adaptation and mitigation (OECD, 2022[97]). Only climate-related multilateral ODA is therefore reported in Multilateral finance is the other important part of the ODA landscape in the G5. Box 2 discusses the level, sources and allocations of multilateral climate-related ODA. Due to differences in the way bilateral and multilateral donors report on ODA to the OECD, Box 2 focuses exclusively on multilateral climate-related ODA and not on CER ODA (see endnote 10).

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[11] See Smith (2018[94]) and CEOBS (2021[95]) for examples from Morocco and Yemen.

[12] The limited resources of Sahelian states further reinforces the need for such 'people-centred' approaches and a reliance on the subsidiarity principle. Sahel state capacities and resources are likely to

remain limited in the coming decades. A recent prospective report of the OECD Sahel and West Africa Club makes the point clear: “in the landlocked Sahelian countries, general government revenue (the government’s own income excluding aid) is now between USD 200 and USD 450 per capita per year (compared with about USD 4 000 in Algeria and USD 25 000 in France). There are also very few civil servants (e.g. six civil servants per 1 000 population in Mali, compared with 70 in the United States and 90 in France) (…) The budgetary resources and the number of civil servants would need to double in the next 20 years to cope with the doubling of the population, just to maintain these low levels of government expenditure and staff” (SWAC/OECD, 2021[23]).

[13] Identification of the good practice example presented in the box occurred through a Sahel session organised by the OECD International Network on Conflict and Fragility (INCAF) in April 2022. The AFD provided complementary information on the example.

[14] Consultation with MINUSMA, April 2022.

[15] See e.g. OECD/UN ECA/AfDB (2022[96]).

[16] Policies and programmes linking urbanisation, displacement and environmental resilience with a focus on local networks, alliances or coalitions for change are still limited in number, but some initiatives emerge. For example, in Northern Uganda, the Danish Refugee Council (DRC)’s ‘Resilience in Displacement’ initiative supported by DANIDA/NURI has been “working with refugees, IDPs and host communities to support agro-biodiversity including forestry to meet needs of Food, Fodder, Fiber, Fuel and Fertility, blending indigenous species with locally responsible market-oriented tree crops”. Among other work areas, the initiative supports “urban ecology for livelihoods in camps: (i) Reduce Heat Island Effect and public health risks due to extreme heat; (ii) Food forest: Increase biodiversity for food, fodder, fibre, fuel and fertility” (DRC and DDG, 2021[98]).

References

Achicanoy, H. et al. (2021), *Where are the most vulnerable areas to climate induced insecurities and risks in Mali?*, CGIAR, https://cgspace.cgiar.org/bitstream/handle/10568/116506/SA_Mali%20%281%29.pdf?sequence=4&isAllowed=y (accessed on 27 May 2022). [48]

ACLED (2022), *10 Conflicts to Worry About in 2022 - The Sahel - Persistent, expanding, and escalating instability*, ACLED, https://acleddata.com/10-conflicts-to-worry-about-in-2022/sahel/ (accessed on 24 May 2022). [3]

ACLED (2022), *Data Export Tool*, https://acleddata.com/data-export-tool/ (accessed on 15 June 2022). [1]

Adelphi, International Alert, Woodrow Wilson International Center for Scholars, European Union Institute for Security Studies (2015), *A New Climate for Peace: Taking Action on Climate and Security Risks - An independent report commissioned by the G7 members*. [99]

Adelphi, UNEP and EU (2019), *Toolbox: addressing climate-fragility risks linking peacebuilding, climate change adaptation and sustainable livelihoods*. [81]

AFD (2014), *Programme d'alimentation en eau potable des villes secondaires*, https://www.afd.fr/fr/carte-des-projets/programme-dalimentation-en-eau-potable-des-villes-secondaires (accessed on 26 May 2022). [78]

AFD, EU and AfDB (2018), *Yeleen: Developing solar electricity production and facilitating its integration into the grid in Burkina Faso*, https://www.afd.fr/en/carte-des-projets/yeleen-developing-solar-electricity-production-and-facilitating-its-integration-grid (accessed on 26 May 2022). [76]

Benjaminsen, T. (2008), "Does Supply-Induced Scarcity Drive Violent Conflicts in the African Sahel? The Case of the Tuareg Rebellion in Northern Mali", *Journal of Peace Research*, Vol. 45/6, pp. 819-836, https://doi.org/10.1177/0022343308096158. [37]

Bokar, H. et al. (2020), "Geogenic influence and impact of mining activities on water soil and plants in surrounding areas of Morila Mine, Mali", *Journal of Geochemical Exploration*, Vol. 209. [93]

Brinkman, H. and C. Hendrix (2011), *Food Insecurity and Violent Conflict: Causes, Consequences, and Addressing the Challenges*, WFP Occasional Paper. [38]

Brück, T. et al. (2016), *The Relationship between Food Security and Violent Conflict: Report to FAO*, ISDC – International Security and Development Center, http://www.isd-center.org (accessed on 20 June 2022). [40]

CEOBS (2021), *Report: Groundwater depletion clouds Yemen's solar energy revolution*, CEOBS, https://ceobs.org/groundwater-depletion-clouds-yemens-solar-energy-revolution/ (accessed on 11 May 2022). [95]

CGD (2019), *How Urban are IDPs and What Does It Mean For Their Economic Integration?*, CGD Note, by Cindy Huang and Jimmy Graham. [89]

CIAT, ICRISAT and BFS/USAID (2020), *Climate-Smart Agriculture in Mali*, CSA Country Profiles for Africa Series. International Center for Tropical Agriculture (CIAT); Bureau for Food Security, United States Agency for International Development (BFS/USAID). [31]

CIAT, ICRISAT and BFS/USAID (2020), *Climate-Smart Agriculture in Niger*, International Center for Tropical Agriculture (CIAT); International Crops Research Institute for the Semi-Arid Tropics (ICRISAT); Bureau for Food Security, United States Agency for International Development (BFS/ USAID). [32]

CIAT et al. (2021), *Climate-Smart Agriculture in Chad*, The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT); the International Crops Research Institute for the Semi-Arid Tropics; Food and Agriculture Organization of the United Nations (FAO) and World Bank, Washington DC. [33]

Dago, E. (2021), *Armed conflicts and food insecurity - a short literature review*, INRAe/CIRAD/Alliance of Bioversity International and CIAT, Montpellier (France), https://cgspace.cgiar.org/handle/10568/114586 (accessed on 20 June 2022). [52]

DaoudaDiallo, B. (2021), *Niger's Kandadji Dam project: conflict concerns*, Climate Diplomacy, https://climate-diplomacy.org/magazine/environment/nigers-kandadji-dam-project-conflict-concerns (accessed on 11 May 2022). [79]

Delgado, C., V. Murugani and K. Tschunkert (2021), *Food Systems in Conflict and Peacebuilding Settings: Pathways and Interconnections*, SIPRI. [41]

Desai, H. and E. Forsberg (2020), "Multidimensional fragility in 2020"*, OECD Development Co-operation Working Papers*, No. 79, OECD Publishing, Paris. [82]

Diamond, J. (2005), *Collapse: How Societies Choose to Fail or Succeed*, Penguin Books. [43]

DIIS (2022), *Unpacking 'new climate wars': actors and drivers of conflict in the Sahel*, DISS. [14]

DRC and DDG (2021), *Resilience in Displacement*, https://collaboratif.cirad.fr/alfresco/s/d/workspace/SpacesStore/7643b2f6-46de-445d-b675-d80cb8cc199d?attach=true (accessed on 15 June 2022). [98]

EITI (2022), *EITI country profiles*, https://eiti.org/countries (accessed on 13 April 2022). [73]

EITI (2022), *ITIE Tchad: Rapport ITIE Tchad 2019*, ITIE, https://eiti.org/sites/default/files/attachments/rapport-itie-tchad-2019.pdf. [67]

FAO (2016), *Peace, Conflict, and Food Security: What Do We Know about the Linkages?*, FAO, Rome. [39]

Funder, M., S. Cold-Ravnkilde and I. Ginsborg (2012), *Addressing climate change and conflict in development cooperation : experiences from natural resource management*, Danish Institute for International Studies. [16]

Goldstone, J. (1991), *Revolution and Rebellion in the Early Modern World*, University of California Press, Los Angeles, CA. [42]

GRFC (2022), *Global Report on Food Crises - 2022*. [30]

ICG (2019), *Getting a Grip on Central Sahel's Gold Rush*, International Crisis Group. [71]

IDMC (2022), *Global Internal Displacement Database*, https://www.internal-displacement.org/database. [62]

IEA (2021), *Clean Energy Transitions in the Sahel*, IEA. [56]

IFAD (2021), *COP26: New US$143 million investment to restore Great Green Wall ecosystems and increase climate resilience in the Sahel, announce IFAD and GCF*, https://www.ifad.org/en/web/latest/-/ifad-and-gcf-to-restore-great-green-wall-ecosystems-and-increase-climate-resilience-in-the-sahel (accessed on 13 June 2022). [8]

IISD (2018), *Green Conflict Minerals: The fuels of conflict in the transition to a low-carbon economy*, International Institute for Sustainable Development. [72]

IISD (2015), *Promoting climate-resilient peacebuilding in fragile states*, The International Institute for Sustainable Development. [13]

IOM (2022), *COP26 Event, West Africa and the Sahel: Migration and Displacement in the Era of the Climate Emergency*, https://environmentalmigration.iom.int/stories/cop26-event-west-africa-and-sahel-migration-and-displacement-era-climate-emergency (accessed on 13 June 2022). [7]

IPCC (2022), *Climate Change 2022 - Impacts, Adaptation and Vulnerability - Summary for Policymakers*, https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_SummaryForPolicymakers.pdf (accessed on 27 May 2022). [25]

IPCC (2019), *Climate Change and Land - An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, https://www.ipcc.ch/site/assets/uploads/2019/08/4.-SPM_Approved_Microsite_FINAL.pdf (accessed on 21 May 2022). [20]

IPCC (2014), *Climate Change 2014 Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects*, IPCC. [26]

Johnstone, S. and J. Mazo (2011), "Global Warming and the Arab Spring", *Survival*, Vol. 53/2, pp. 11-17, https://doi.org/10.1080/00396338.2011.571006. [45]

Kangogo, D., P. Läderach and G. Pacillo (2021), *How does climate exacerbate root causes of conflict in Mali? An econometric analysis*, CGIAR FOCUS Climate Security, https://cgspace.cgiar.org/handle/10568/116312 (accessed on 20 June 2022). [47]

Keita, M. et al. (2018), "Impacts of artisanal gold mining on water quality: a case study of tangandougou commune in sikasso region, Mali", *Journal of Environmental Health and Sustainable Development*, pp. 621-629. [92]

Knox, J. et al. (2012), "Climate change impacts on crop productivity in Africa and South Asia", *Environmental Research Letters*, Vol. 7/3, p. 034032, https://doi.org/10.1088/1748-9326/7/3/034032. [34]

Läderach, P. et al. (2021), *Climate Action to transform food systems. Linking the UN Food Systems Summit and COP26 through initiatives that support greater resilience to climate change*, CGIAR, Rome, https://cgspace.cgiar.org/handle/10568/115035 (accessed on 27 May 2022). [51]

Läderach, P. et al. (2021), "Food systems for peace and security in a climate crisis", *The Lancet Planetary Health*, Vol. 5/5, pp. e249-e250, https://doi.org/10.1016/S2542-5196(21)00056-5. [84]

Läderach, P. et al. (2022), "The importance of food systems in a climate crisis for peace and security in the Sahel", *International Review of the Red Cross* 918, pp. 995-1028, https://doi.org/10.1017/S1816383122000170. [28]

Lazard, O. and R. Youngs (2021), *The EU and Climate Security: Toward Ecological Diplomacy*. [11]

Magoum, I. (2021), "NIGER: Pisa II program for irrigation in three regions | Afrik 21", *Afrik21*, https://www.afrik21.africa/en/niger-pisa-ii-program-for-irrigation-in-three-regions/ (accessed on 26 May 2022). [77]

Maystadt, J., J. Trinh Tan and C. Breisinger (2014), "Does food security matter for transition in Arab countries?", *Food Policy*, Vol. 46, pp. 106-115, https://doi.org/10.1016/J.FOODPOL.2014.01.005. [44]

Mbow, C. et al. (2019), *Food security, in Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*, IPCC. [27]

McKinsey (2020), *Climate risk and decarbonization: What every mining CEO needs to know*, McKinsey. [65]

Moorhead, A. (2009), *Climate, Agriculture and Food Security: A Strategy for Change*, CGIAR, Rome. [36]

Murrey, A. (2015), "Narratives of life and violence along the Chad-Cameroon oil pipeline", *Human Geography*, Vol. 8/1, pp. 15-39. [64]

Observatory of Economic Complexity (OEC) (2022), *Observatory of Economic Complexity*, https://oec.world/en. [68]

OECD (2022), *Climate-related Official Development Assistance (ODA): A snapshot*, https://www.oecd.org/dac/financing-sustainable-development/development-finance-data/climate-related-official-development-assistance-2019.pdf (accessed on 26 May 2022). [97]

OECD (2022), *Creditor Reporting System*, OECD.stats, https://stats.oecd.org/ (accessed on 15 June 2022). [75]

OECD (2022), "Methodological notes on the Development Co-operation Profiles 2022", https://www.oecd-ilibrary.org/sites/2dcf1367-en/1/3/3/1/index.html?itemId=/content/publication/2dcf1367-en&_csp_=177392f5df53d89c9678d0628e39a2c2&itemIGO=oecd&itemContentType=book# (accessed on 12 July 2022). [101]

OECD (2022), *Natural resource governance and fragility in the Sahel*, OECD Development Co-operation Directorate, OECD Publishing. [15]

OECD (2022), *Natural Resource Governance and Fragility in the Sahel*, https://www.oecd.org/dac/2022_Natural_resource_governance_fragility_Sahel.pdf (accessed on 31 August 2022). [66]

OECD (2022), *States of Fragility platform*, https://www3.compareyourcountry.org/states-of-fragility/overview/0/ (accessed on 31 August 2022). [59]

OECD (2022), *The Humanitarian-Development-Peace Nexus Interim Progress Review*, OECD Publishing, Paris. [86]

OECD (2020), *States of Fragility 2020*, OECD Publishing, Paris. [10]

OECD (2020), *States of Fragility 2020 platform - Fragile context profiles*, OECD, https://www3.compareyourcountry.org/states-of-fragility/countries/0/ (accessed on 24 May 2022). [85]

OECD/SWAC (2022), *Africapolis database*, https://africapolis.org/en. [55]

OECD/UN ECA/AfDB (2022), *Africa's Urbanisation Dynamics 2022: The Economic Power of Africa's Cities*, OECD Publishing. [96]

Okonkwo, S. et al. (2021), "Assessment of selected heavy metal concentrations in soils from a mining area in Minna, Niger state", *Environmental Monitoring and Assessment*, Vol. 193/3, pp. 1-8. [91]

Raineri, L. (2020), "Sahel climate conflicts? When (fighting) climate change fuels terrorism", *EUISS Conflict Series*. [80]

Rameshwaran, P. et al. (2021), "How might climate change affect river flows across West Africa?", *Climatic Change*, Vol. 169/3-4, pp. 1-27, https://doi.org/10.1007/S10584-021-03256-0/FIGURES/7. [6]

Rojas, O., A. Vrieling and F. Rembold (2011), "Assessing drought probability for agricultural areas in Africa with coarse resolution remote sensing imagery", *Remote Sensing of Environment*, Vol. 115/2, pp. 343-352, https://doi.org/10.1016/J.RSE.2010.09.006. [29]

RPCA (2022), *Analyses (food security situation and data)*, https://www.food-security.net/en/visualise/ (accessed on 15 June 2022). [49]

SIDA (2018), *Climate change and conflict risks –what do we know, what should we do? A summary of a Sida working paper on the interlinkages*, SIDA. [12]

Simkin, R. et al. (2022), "Biodiversity impacts and conservation implications of urban land expansion projected to 2050", *Proceedings of the National Academy of Sciences*. [87]

Simwanda, M. et al. (2019), "Spatial Analysis of Surface Urban Heat Islands in Four Rapidly Growing African Cities", *Remote Sensing*, pp. 11, 1645. [90]

Smith, O. (2018), *The Dark Side of the Sun: Avoiding Conflict Over Solar Energy's Land and Water Demands*, New Security Beat. [94]

SWAC/OECD (2021), *Sahel to Come: What Today Tells us About Tomorrow*, OECD Sahel and West Africa Club. [23]

Temper, L., D. del Bene and J. Martinez-Alier (2015), "Mapping the frontiers and front lines of global environmental justice: the EJAtlas", *Journal of Political Ecology*, pp. 22: 255-278. [63]

Tschunkert, K. and C. Delgado (2022), *Food systems in conflict and peacebuilding settings: ways forward*, SIPRI. [83]

Turner, M. et al. (2021), "Environmental rehabilitation and the vulnerability of the poor: The case of the Great Green Wall", *Land Use Policy*, Vol. 111, p. 105750, https://doi.org/10.1016/J.LANDUSEPOL.2021.105750. [24]

UN DESA (2018), *World Urbanization Prospects 2018*, UN Department of Economic and Social Affairs - Population Dynamics, https://population.un.org/wup/ (accessed on 15 June 2022). [57]

UN Trade Statistics (2022), *UN Comtrade database*, https://comtrade.un.org/ (accessed on 28 March 2022). [69]

UNCCD (2022), *United Global Call to Act on Land Degradation and Drought Concludes Major UN Meeting in Côte d'Ivoire*, UNCCD Press Release, https://www.unccd.int/sites/default/files/2022-05/Press%20release%20COP15%20-%20ENG.pdf (accessed on 27 June 2022). [9]

UNDP (2020), *Human Development Index Report*, https://hdr.undp.org/data-center/human-development-index#/indicies/HDI (accessed on 13 June 2022). [4]

UNHCR (2021), *Data on forcibly displaced populations and stateless persons*, UNHCR. [60]

UNHCR, UNISS and PIK (2021), *Climate Risk Profile: Sahel*, Potsdam Institute for Climate Impact Research (PIK). [5]

University of Notre Dame (2022), *ND-GAIN: Notre Dame Global Adaptation Initiative 2020 Ranking*, https://gain.nd.edu/our-work/country-index/ ((accessed on 30 August 2022). [2]

UNOCHA (2022), *The Humanitarian Data Exchange*, https://data.humdata.org/. [61]

UNOCHA (2022), *West and Central Africa Flooding Situation Overview (January - December 2021)*, http://www.reliefweb.int. [21]

UNOWAS (2018), *Pastoralism and Security in West Africa and the Sahel: Towards Peaceful Coexistence*, United Nations Office for West Africa and the Sahel, Dakar. [18]

US Geological Survey (2022), *Mineral Commodity Summaries*, USGS. [74]

USAID (2017), *Climate Change Risk Profile: West Africa Sahel*, USAID, Washington DC. [35]

Villa, V. et al. (2021), "How does climate exacerbate root causes of conflict in Senegal?", *CGIAR Climate Security Observatory Series*, Vol. 11, http://www.climatesecurity.cgiar.org (accessed on 16 June 2022). [46]

WFP (2018), *Fact Sheet: Hunger & Conflict*, WFP. [50]

WHO (2022), *Global Urban Ambient Air Pollution Database*, https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/ambient-air-pollution. [88]

Wilkanowska, A. and D. Kokoszyński (2015), "Effect of Diet and Physical Activity of Farm Animals on their Health and Reproductive Performance", *Handbook of Fertility: Nutrition, Diet, Lifestyle and Reproductive Health*, pp. 159-171, https://doi.org/10.1016/B978-0-12-800872-0.00014-7. [100]

World Bank (2022), *Commodity Markets, 'Pink Sheet' data*, https://thedocs.worldbank.org/en/doc/5d903e848db1d1b83e0ec8f744e55570-0350012021/related/CMO-Historical-Data-Monthly.xlsx. [70]

World Bank (2022), *Databank*, https://databank.worldbank.org/reports.aspx?source=world-development-indicators. [58]

World Bank (2021), *Strengthening Regional Water Security for Greater Resilience in the G5 Sahel*, http://www. (accessed on 13 June 2022). [19]

World Bank (2020), *Niger : Beyond Connections - Energy Access Diagnostic Report Based on the Multi-Tier Framework*, https://openknowledge.worldbank.org/handle/10986/34712 (accessed on 15 June 2022). [54]

World Bank (2017), *Greening Africa's cities: enhancing the relationship between urbanization, environmental assets and ecosystem services*, World Bank. [53]

Xu, C. et al. (2020), "Future of the human climate niche", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 117/21, https://doi.org/10.1073/PNAS.1910114117/SUPPL_FILE/PNAS.1910114117.SAPP.PDF. [22]

Yanda, P. and S. Bronkhorst (2011), *Climate change and conflict: conflict-sensitive climate change adaptation in Africa*, ACCORD. [17]