Anticipating Trends in the Sahel: Summary for Policy Makers

A draft report from the Predictive Analytics project in support of the United Nations Integrated Strategy for the Sahel (UNISS)
The following agencies operating in the Sahel were consulted and/or provided data to inform the consortium’s models: 1

1 This is a non-exhaustive list of partners involved in the Predictive Analytics project who have not formally signed off this report. Hence, the contents of this summary should not be seen as reflective of their institutional positions.
Acknowledgements

The authors would like to thank all partners of the Predictive Analytics project for their contributions to this report, in particular the colleagues from UNHCR, Andrew Harper, Jana Birner and Tasha Carter-Gordon, for their coordination and helpful inputs in the development of this paper. The authors are also grateful for the leadership and guidance received from Abdoulaye Mar Dieye, the United Nations Special Coordinator for development in the Sahel. Please note that the summary herein is a draft for consultation and does not necessarily reflect the positions of the partners of the Predictive Analytics project.
Preface

In January 2021 Secretary General Antonio Guterres appointed me as the UN Special Coordinator for Development in the Sahel. I bear the privilege and responsibility of coordinating the implementation of the UN Integrated Strategy for the Sahel. UNISS was born in 2013 in response to the crisis in Mali and has since evolved to meet the changing needs and priorities of the ten UNISS Sahelian countries. It is implemented through the UN Sahel Support Plan as a way to ensure greater coherence and efficiency of the UN’s and its partners’ development agenda across this vast, and often troubled, region.

I am a Sahelian too, and as a child of the Sahel, I am deeply concerned by the many interlinked challenges we are confronted with as a people. These include poverty, underdevelopment, insecurity, and vulnerability to climate change that leave the region prone to conflict. They weigh heavily on our collective future, and particularly the futures of our talented and dynamic young people.

But these problems are not insurmountable. In my home country of Senegal we have a saying: C'est la pluie qui tombe petit à petit qui remplit le fleuve (It is the rain that falls little by little that fills the river). We must work together to address the root causes that perpetuate poverty and instability in the region. We need to encourage cross-border cooperation, promote economic revitalization and inclusive growth, tackle climate vulnerability, provide clean energy, and empower women and young people.

Doing all this requires a clear-eyed understanding of where we are now, and where the trends are leading us. This is why I am delighted to introduce the first summary of the findings on the Sahel of the Predictive Analytics project. This unprecedented collaboration, facilitated by our friends at UNHCR, has brought together more than a dozen of the finest research organizations and universities to share their information and analysis on the long-term economic, social, political, and environmental trends that are shaping the region. This analysis is a work in progress and is far from being the final word on the future of the Sahel. But collectively, this initiative has created a ‘river’ of data and analysis that will, I hope, provide us with new insights and ideas on how the Sahel can fulfil its great potential.

Our problems are solvable, but require extreme commitment and dedication, from all. Truly, the best way to get to where you want to be is to know where you are starting from, and to be able to anticipate the hurdles in your path. I entrust this report to you as a small contribution towards that goal.

Mr. Abdoulaye Mar Dieye
United Nations Special Coordinator for development in the Sahel
Executive Summary

PREDICTIVE ANALYTICS IN THE SAHEL

Demographics (long-term)
- Increase in total population

Climate (long-term)
- Increase in very hot days
- Rising temperatures
- Increase in heat-related mortality
- More rainfall (high uncertainty)
- Increase in days with heavy precipitation
- Increase in surface runoff

Water resources (long-term)
- Decline in water availability per capita when accounting for population change

Agriculture (long-term)
- Decline in crop yields, but some crops benefit from higher CO₂ concentrations

Food insecurity (short-term)
- "Crisis" to "Emergency" levels of food insecurity in some regions

Conflict drivers
- Conflicts over scarce resources
- Group marginalisation & lack of social cohesion
- Ineffective climate adaptation
- Terrorism & organised crime
- Demographic pressures

Migration & displacement
- Increase in forced displacements
- Increase in internal climate migration

Conflict & violence (short-term)
- Increase in probability of violence
- Increase in number of conflict fatalities
- Emergence of protests & riots to remain stable
- Increase in number of security-related incidents

Moderating factors
- Governance & state-citizen relations
- Agricultural productivity & technologies
- Investments in adaptation, capacity-building
- Trade & access to markets
- Economic structure & opportunities
- Peaceful coexistence
- Social relations
- Resource & conflict management

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<td>AA</td>
<td>German Federal Foreign Office</td>
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<tr>
<td>ACLED</td>
<td>Armed Conflict Location and Event Data Project</td>
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<tr>
<td>AgMIP</td>
<td>Agricultural Model Intercomparison and Improvement Project</td>
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<tr>
<td>CEB</td>
<td>United Nations System Chief Executives Board for Coordination</td>
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<td>CESM</td>
<td>Community Earth System Model</td>
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<td>CHC</td>
<td>Climate Hazards Center</td>
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<td>CHIRPS</td>
<td>Climate Hazards Infrared Precipitation with Stations</td>
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<tr>
<td>CIDOB</td>
<td>Barcelona Centre for International Affairs</td>
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<td>CIDR</td>
<td>City University of New York Institute for Demographic Research</td>
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<td>CIESIN</td>
<td>Center for International Earth Science Information Network</td>
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<td>CSU</td>
<td>Colorado State University</td>
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<td>CUNY</td>
<td>City University of New York</td>
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<td>DPLE</td>
<td>Decadal Prediction Large Ensemble</td>
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<td>DRC</td>
<td>Danish Refugee Council</td>
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<td>ECA</td>
<td>Economic Commission for Africa</td>
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<td>ECOWAS</td>
<td>Economic Community of West African States</td>
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<td>GDP</td>
<td>Gross domestic product</td>
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<td>GEFS</td>
<td>Global Ensemble Forecast System</td>
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<td>HLCP</td>
<td>United Nations High-level Committee on Programmes</td>
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<td>IDMC</td>
<td>Internal Displacement Monitoring Centre</td>
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<td>IDP</td>
<td>Internally Displaced Person</td>
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<td>IPAR</td>
<td>Initiative Prospective Agricole et Rurale</td>
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<td>ND-GAIN</td>
<td>Notre Dame Global Adaptation Initiative</td>
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<td>NGO</td>
<td>Non-governmental organisation</td>
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<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<td>PA</td>
<td>Predictive Analytics</td>
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<td>PAC</td>
<td>Predictive Analytics contribution</td>
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<td>PIK</td>
<td>Potsdam Institute for Climate Impact Research</td>
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<td>PREVIEW</td>
<td>Predictions-Visualisation-Early Warning team</td>
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<td>PVCCCI</td>
<td>Index of Physical Vulnerability to Climate Change</td>
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<td>RCP</td>
<td>Representative Concentration Pathway</td>
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<td>SDG</td>
<td>Sustainable Development Goal</td>
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<td>SDSN</td>
<td>Sustainable Development Solutions Network</td>
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<td>Acronym</td>
<td>Full Name</td>
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<td>SIPRI</td>
<td>Stockholm International Peace Research Institute</td>
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<td>SSP</td>
<td>Shared Socio-economic Pathway</td>
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<td>SubX</td>
<td>Experimental Subseasonal Forecasts</td>
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<td>UCDP</td>
<td>Uppsala Conflict Data Program</td>
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<td>UCSB</td>
<td>University of California Santa Barbara</td>
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<td>UN</td>
<td>United Nations</td>
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<td>UNDESA</td>
<td>United Nations Department of Economic and Social Affairs</td>
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<td>UNDP</td>
<td>United Nations Development Programme</td>
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<td>UNDRR</td>
<td>United Nations Office for Disaster Risk Reduction</td>
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<td>UNECA</td>
<td>United Nations Economic Commission for Africa</td>
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<td>UNHCR</td>
<td>United Nations High Commissioner for Refugees</td>
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<td>UNISS</td>
<td>United Nations Integrated Strategy for the Sahel</td>
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<td>UNOCC</td>
<td>United Nations Operations and Crisis Centre</td>
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<td>UNSP</td>
<td>United Nations Sahel Support Plan</td>
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<tr>
<td>UNU</td>
<td>United Nations University</td>
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<td>ViEWS</td>
<td>Violence Early-Warning System</td>
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Introduction

The objective of this report is to support the UN Integrated Strategy for the Sahel (UNISS) in promoting data-driven and evidence-based approaches in the Sahel, a region with numerous interconnected risks across the humanitarian, development and peacebuilding pillars. The ten Sahelian countries considered in this report include Burkina Faso, Cameroon, Chad, the Gambia, Guinea, Mali, Mauritania, Niger, Nigeria, and Senegal.

This report synthesises predictive analytics and strategic foresights from a total of 14 contributions, received through the Predictive Analytics (PA) project. This is a research consortium, facilitated by the UN Refugee Agency (UNHCR), consisting of world leading organisations that unite best practices in predictive modelling from different scientific disciplines. Each contribution focused on a specific research area - such as climate impacts, natural resources, security, livelihoods and human mobility - and provided predictive analysis to anticipate trends in the Sahel. Through this, the PA project aims to promote data-sharing, preparedness and evidence-based decision-making at the policy level.

Predictive modeling and analysis have certain limitations, namely that history cannot with certainty predict the future. New and unexpected variables will always influence future pathways. Despite these ‘unknown unknowns’, modelling and projections enable policymakers to consider alternative futures and plan more strategically. Predictive analysis allows deeper reflection on different scenarios across different sectors, which can then steer action in a more desired direction.

This report provides an overview of the current and past situation in the Sahel, and presents a series of projections on multiple themes and along different time scales. It then examines cross-cutting trends and highlights the implications for policymakers.

About the Predictive Analytics Project

The first seed of the PA project was planted in October 2019, during the 38th session of the UN High-level Committee on Programmes (HLCP). Member Organizations discussed innovative ways to enhance data-driven and evidence-based support for sustainable development, and called for the establishment of a cross-pillar, inter-agency project on predictive analytics. The PA project launched in February 2020 under the coordination of the Office of UNHCR and with the Sahel region selected as a pilot. UNHCR first held consultations amongst UN entities, academic institutions, NGOs, and private sector research institutions to understand the needs and challenges for predictive analytics in the Sahel. Exploratory research confirmed that responsible data sharing was still not common practice in the UN system, with data and statistics remaining dispersed across and within organisations. Huge data gaps and standardisation issues were common, as data formats, indicators and general management processes lacked consistency. The Sahel region had no centralised data repository that brought together humanitarian, development and security information.
The PA project was launched to address the need for improved data sharing and accessibility, as well as to enhance coordination on data innovation. This will facilitate information-sharing across the UN system and help to avoid duplication of efforts. The project focuses specifically on uniting predictive modelling, strategic foresight, and machine learning techniques to assess the likelihood of future outcomes in the Sahel region. By gathering innovative data from different scientific disciplines, it aims to better understand their interconnectedness and, through this, enhance linkages between the research world and policymakers. It is grounded in the belief that science plays a critical role in guiding decision-making. Through these broad goals, the PA project directly supports the UN Integrated Strategy for the Sahel (UNISS), the UN Sahel Support Plan (UNSP) and the UN Special Coordinator for Development in the Sahel in increasing the UN’s preparedness to respond to growing multi-causal and interconnected risks and challenges in the Sahel.

The PA project is in line with the System-wide Road Map for Innovating UN Data and Statistics and the UN Secretary-General’s Data Strategy. It is the first whole-of-UN system approach of its kind, going beyond siloed predictive analytics initiatives developed by different organisations in the past.

The partner organisations of the PA project are the City University of New York (CUNY), the Violence Early-Warning System (ViEWS) project from Uppsala University, the Potsdam Institute for Climate Impact Research (PIK), Initiative Prospective Agricole et Rurale (IPAR), Danish Refugee Council (DRC), the Predictions-Visualisation-Early Warning team (PREVIEW) from the German Federal Foreign Office (AA), Columbia University, adelphi, Barcelona Centre for International Affairs (CIDOB), Walker Institute from University of Reading, the Climate Hazards Center (CHC) from University of California Santa Barbara (UCSB), Colorado State University (CSU), as well as the United Nations University (UNU).

About UNISS and UNSP

The UN Integrated Strategy for the Sahel (UNISS) was developed in 2013 in response to the Malian crisis and aims to tackle the structural problems of the Sahel that make the region vulnerable to conflicts, such as poverty, underdevelopment, and governance challenges. The strategy covers the period 2018-2030 and promotes an integrated and regional approach to the activities of the UN and key actors in the Sahel, to tackle the problems and bring greater coherence to broader international interventions in the region. It targets 10 countries, namely Burkina Faso, Cameroon, Chad, the Gambia, Guinea, Mali, Mauritania, Niger, Nigeria, and Senegal, and aims to help implement identified priorities to achieve the 2030 Agenda for Sustainable Development and the African Union Agenda 2063.

In 2018, the implementation of the UNISS was given greater effect through the operationalisation of the UN Sahel Support Plan (UNSP) – an instrument aimed at promoting coherence and coordination for greater efficiency and the achievement of results within the framework of the UNISS. The UNISS and UNSP are interlinked around specific pillars, priority areas and thematic areas (see Figure 1).

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2 UN System Chief Executives Board for Coordination (CEB) (CEB/2020/1/Add.1); UNSG Data Strategy (2020-22)
In response to Member States calling for strengthened collective and integrated engagement across the Sahel region,⁴ the Secretary-General appointed a Special Coordinator who leads collective efforts, including financing, to implement the UNISS and its Support Plan for a scaled-up UN development response for the Sahel. Since January 2021, Mr. Abdoulaye Mar Dieye of Senegal has acted as the Special Coordinator for Development in the Sahel.

In line with the UNISS and UNSP, the Economic Commission for Africa (ECA) prepared a study, entitled *Sahel 2043: towards a resilient, inclusive and prosperous Sahel region (2019)*, that provides a comprehensive, forward-looking strategic orientation to build national and international partners’ effectiveness towards the structural transformation agenda of the Sahel.⁵

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⁴ UNECA (2019)
Current context in the Sahel

The Sahel is a vast geographic area with numerous nations and subregions. While each of these are unique, some broad drivers of risks to national and regional stability can be identified. This chapter presents the current context in the Sahel and how recent history has shaped the characteristics of the region. It focuses specifically on the socioeconomic situation and demographics, the political and security situation, and climate change and the environment.

Socioeconomic situation and demographics

In the Sahel, the population amounts to over 350 million people, Nigeria being the most populous country with 206 million inhabitants. Despite relative high mortality rates of children under five, the region is home to some of the fastest growing societies in the world in terms of population. The Sahel is also home to one of the youngest populations in the world, since 64.5% of the population are below the age of 25 (PAC6). While fertility has been declining throughout the region, current levels remain very high, with average fertility ranging from 4.4 births per woman to 6.8 births per woman. Estimates of life expectancy at birth range from 55 years in Chad to 68 years in Senegal (PAC10). Child mortality in 2020 was estimated to range from 40 deaths under age 5 per 1,000 live births in Senegal to 117 per 1,000 in Chad. While child mortality has been declining, none of the UNISS countries is on track to achieve the SDG target of 25 per 1,000 by 2030 (PAC10).

Countries of the Sahel are almost uniformly categorised as “least developed” by the UN, based on low per capita income, extremely poor health and education indicators, and high economic vulnerability to shocks. Nearly 50% of the region lives in extreme poverty, and the Sahel countries represent the bottom of the Human Development Index (PAC9). The states of the Gambia and Cameroon represent exceptions since only a relatively small proportion of the population, namely 10% and 26%, live in extreme poverty. Apart from a recent general economic recession due to the COVID-19 pandemic, the region is marked by steady economic growth. The economic growth rate varies widely within the region and GDP per capita covers the spectrum from 565 US dollars in Niger to 2,091 US dollars in Nigeria. The overall economic growth rate in the Sahel is higher than the continental average and is based on the export of primary goods (PAC6). However, this growth has not led to a broader reduction in risks or improvements in living standards, in part because of the rapid population increases, and also because growth has not been inclusive. Rural areas in particular have not been able to benefit from economic growth and continue to lack access to social services and basic infrastructure (PAC11).

At the macroeconomic level, the countries of the Sahel region are mainly characterised by low economic diversification and low levels of productivity and competitiveness

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5 World Bank Group, DataBank
7 UNIGME, Data Base
8 UNDESA, Index of Least Developed Countries (LDCs)
9 UNDP (2020), Human Development Report
in regional and global markets.\textsuperscript{10} About two-thirds of the population in the ten Sahel countries relies on agriculture, fishing and pastoralism for livelihoods, with nearly no diversification of income sources.\textsuperscript{11} The agricultural sector employs more than 70\% of the population in Mali and Niger and more than four-fifths of the population in Burkina Faso. Even though agriculture contributes greatly to GDP in the region, it has remained rudimentary at the subsistence level (PAC1).

The \textit{rentier models} of the Sahel countries, based on the export of agricultural or mining commodities, have shown their structural limits whereby their economies have struggled to make any real progress in transformation processes, and in economic or sustained accumulation. Despite the high agricultural, forest and pastoral potential, many Sahel countries have directed their focus to proceeds from oil and mining. While this approach produced economic gains in the past, there has been major volatility in the markets in recent years, particularly for oil, metals and minerals.\textsuperscript{12}

\textbf{Security and humanitarian situation}

The Sahel region has been among the most violent areas in Africa the past decades, experiencing conflicts, political crises, communal violence and violent extremism. The 2011 collapse of the Libyan regime and subsequent armed uprisings in northern Mali have created a surge in armed activity across many parts of the Sahel, fuelled by massive weapons flows and the movement of armed groups into the region.\textsuperscript{13} Porous national borders have allowed international criminal groups to spread in the region and establish vast trafficking networks. Despite the transnational nature of insecurity, each country has experienced different patterns of violence (PAC11).

Several \textit{governance deficits} contributed to instability and conflict in the Sahel countries, ranging from issues of state authority and capabilities, the consolidation of democracy, resource management, the rule of law, transparency and accountability, to social exclusion and human rights violations.\textsuperscript{14} State corruption levels across the region are some of the highest in the world. The failure of state institutions to adequately service marginalised populations has been a driving cause behind armed insurgencies and violent extremism (PAC11).\textsuperscript{15} ACLED data show that abuses by government forces are inherent to prevailing conflict dynamics in the central Sahel, and these actors routinely commit atrocities with impunity.\textsuperscript{16}

While \textit{communal conflicts}, such as between farmers and herders, have been present in the Sahel for centuries, the proliferation of weapons and involvement of political elites and armed groups have made communal conflicts more violent and deadly in recent years, especially in Burkina Faso, Mali, Niger and Nigeria.\textsuperscript{17} Historical grievances and social inequalities, as well as incongruous or biased rules for governing the access to resources are important factors underpinning communal violence in the Central Sahel (PAC1). \textit{Violent extremist groups}, such as Al Qaeda in the Islamic Maghreb (active

\begin{itemize}
\item \textsuperscript{10} UNECA (2019)
\item \textsuperscript{11} Heinrigs (2011)
\item \textsuperscript{12} UNECA (2019)
\item \textsuperscript{13} Koné (12 February 2020)
\item \textsuperscript{14} UNECA (2019).
\item \textsuperscript{15} Nett, et al. (October 2016); International Alert (27 June 2018)
\item \textsuperscript{16} Nsaibia (2020)
\item \textsuperscript{17} Nsaibia et al. (2021)
\end{itemize}
across parts of Mauritania, Mali and Niger) and Boko Haram (active in Nigeria and the Lake Chad Basin), have exploited local grievances and social inequalities (PAC1). In 2020 and 2021, conflict hotspots are localised in Nigeria, Mali and Burkina Faso (see Figure 2).

When looking at the different types of violence across three sub-regions in the Sahel, only the coastal areas experienced a downward trend. In the Central Sahel (Liptako Gourma sub-region, covering parts of Mali, Niger and Burkina Faso) and the Lake Chad Basin, instances of violence surged in the past years (PAC10) (see Figure 3).

The Sahel has traditionally been characterised by high levels of human mobility, in particular seasonal and circular migration as a means to secure livelihoods and cope with weather conditions. Such mobility includes nomadism, transhumance, rural-urban migration and temporary migration to neighbouring countries (PAC1). The Sahelian countries have protocols on free movement of people, adopted by ECOWAS in 1979 and a specific protocol on transhumance in 1998. As a result of the wide-spread insecurity and socio-economic pressure, the entire region – except for Mauritania, Guinea, the Gambia and Senegal - have experienced large-scale displacement, which rose progressively in recent years (see Figure 4). Nearly 6 million Sahelians are currently displaced by conflicts, with hundreds of thousands seeking shelter outside of their

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18 Faleg et al. (2021)
19 Opanike et al. (2015); Leonhardt (2017)
country of origin. The ten Sahel countries host nearly 1 million refugees.\textsuperscript{20} Most Internally displaced people (IDPs) are clustered along the border areas of Niger, Chad and Nigeria, or in the Liptako Gourma sub-region. The impact of population movements is often felt most acutely along the borders of countries, where state capacity is often weakest, and where other dynamics such as cross-border violence and transnational illicit flows are most prevalent (PAC\textsuperscript{11}). In 2020, out of nearly 26 million people in need of humanitarian assistance, over 8 million people were not targeted. Of the 17.5 million people targeted, about 92\% were reached (PAC\textsuperscript{10}).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure4.png}
\caption{Total displacement across the ten UNISS countries (per thousands) (Sources: UNISS, UNHCR and IDMC).}
\end{figure}

**Climate and environmental situation**

The Sahel forms a zone of transition between the arid Sahara to the north and the humid savannas to the south. It is a semi-arid region with diverse agro-ecological zones and climates, which are largely influenced by latitude. Mean annual temperatures range from 21 °C to 31 °C with lower values in southern Cameroon and higher values in south-western Mauritania. Annual precipitation ranges from 10 mm in northern Niger, which has an arid desert climate, to 3,800 mm in western Cameroon, which is characterised by a tropical coastal climate. Most parts of the Sahel have one rainy season in the summer months of the northern hemisphere. Here, too, the length of the rains is influenced by latitude, with regions closer to the Saharan desert receiving very little rain around August. In regions further south, however, the rainy season is much longer, pausing only around December and January. Such is, for example, the case in southern Nigeria. (PAC\textsuperscript{6})

The Sahel region counts as a hotspot area for climate change across the globe. Since the 1970s, the region has experienced an increase in temperatures by at least 0.6°C to 0.8°C.\textsuperscript{21} It faces increasingly variable rainfall, and more frequent droughts and storms.

\textsuperscript{20} UNHCR, Data Portal
\textsuperscript{21} Niang et al. (2014); Crawford (June 2015)
The Sahel is traversed by 11 main rivers which flow through several hydrological regions and across national borders (PAC2). However, water resources in the Sahel are distributed unequally both over space and time. Some countries, such as Nigeria, are well endowed with water resources (at least on a per capita basis), while others, such as Burkina Faso, have to deal with water scarcity (PAC6). More than 40 percent of water supply in Mali and Chad and 90% in Mauritania and Niger come from outside each country’s boundaries. Surface water is limited and often seasonal, making groundwater a primary source of water for many people in the region (PAC2).

Sahel economies are highly reliant on farming and pastoralism, which means that livelihood and food security is intimately linked with weather trends and environmental conditions. Water scarcity and competition in river basins is strongly associated with low-level conflict at a community level (PAC1). In the past years, changes to the ecosystem – such as increasing rainfall variability, overexploitation of soil, overgrazing, and desertification – have contributed to a food scarcity crisis that continues to threaten over ten million Sahelians and sparked competition over resources (PAC11). In 2020, around 14.4 million people were at risk of food insecurity in Burkina Faso (3.5 m), Mali (7.1m) and Niger (3.8 m), a level that had not been reached since 2012 and two times more than the previous year (PAC1). Dependence on livestock and agriculture makes an approximate 50 million people in the Sahel highly vulnerable to the impacts of climate change. Evidence also suggests that degraded environmental conditions have affected north–south and rural–urban migration, especially in Burkina Faso, Mali and Niger (PAC2).

These risks are amplified by recurrent natural disasters over recent decades. Niger and Mauritania, for instance, are among the top 10 countries with the highest share of the populations affected by natural hazard-related disasters between 2000 and 2019 (PAC6). Desertification and shifting rainfall patterns have altered the routes of cattle herding communities, bringing them across farmland during the harvest season. This has provoked violent clashes between herdsmen and farmers, especially in countries such as Nigeria, Mali and Burkina Faso (PAC11).

In addition, weak government capacity and widespread corruption restrict the ability of Sahelian states to invest in climate adaptation. These factors make the Sahel extremely vulnerable to climate change. The Index of Physical Vulnerability to Climate Change (PVCCI) ranks the Sahelian countries as the most vulnerable to climate change, well above other African countries and most other least developed states, and projected to have temperature increases 1.5 times the global average in the coming years (PAC11).

Similarly, the ND-GAIN Country Index ranks all 10 Sahel countries amongst the most vulnerable nations in the world to climate change, with Chad ranked lowest

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22 These are part of the basins of Lake Chad, Niger, Queme, Volta, Comoé, Bandama, Sassandra, Senegal and Gambia-Gorubal.
23 Oyebande et al. (2010)
24 Crawford (June 2015)
25 Tall (16 April 2018)
26 UNDRR (2020)
27 Udeh (22 February 2018)
28 FERDI-PVCCI
globally in the Vulnerability and Adaptation Readiness Index (see Figure 5) and Niger scoring the lowest in the Vulnerability Index.\textsuperscript{29}

\textbf{Figure 5:} Climate Vulnerability and Adaptation Readiness Index, from 1 (most vulnerable) to 100 (least vulnerable) (Sources: ND-GAIN, SIPRI).

\textsuperscript{29} At the time of writing, out of 182 countries, the ND-GAIN Country Index provides the following rankings: Senegal (135), Mauritania (141), Cameroon (143), Gambia (145), Guinea (148), Burkina Faso (156), Nigeria (161), Mali (170), Niger (176), and Chad (182). Source: \url{https://gain.nd.edu/our-work/country-index/rankings/}. 


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Projections and cross-cutting trends

This chapter highlights the key findings of the various projections on climatic, environmental, socio-economic and conflict-related factors for the Sahel, based on contributions from the PA partner organisations.

An important caveat here is that these projections run on various time scales. Climate projections, for example, usually extend over longer time frames (e.g. decades or end-of-century), whereas projections on food security and conflict numbers tend to be short-term (e.g. months). As such, it is important to consider these temporal differences when interpreting the findings of these various projections.

To account for this disparity, this chapter starts with a number of key long-term projections on climatic variables and some of their direct impacts (e.g. heat-related mortality). It then proceeds to interpret these projections, along with other shorter-term projections (e.g. food insecurity, conflict fatalities), to provide a cross-cutting analysis of how climate triggers are linked to conflict and displacement outcomes.

Key climate projections

- **Temperatures** are projected to rise by 2.0-4.3°C by 2080, compared to pre-industrial levels, with higher temperatures and more temperature extremes projected for the northern part of the region (PAC7; see also Figure 6).

  ![Figure 6: Temperature change projections in the Sahel, relative to pre-industrial levels, under RCP2.6 (blue) and RCP6.0 (red) (Source: PAC7; see Annex for a guide on reading the plot).](image)

- The annual number of very hot days (i.e. days with a maximum temperature above 35°C) is projected to rise substantially and with high certainty, in particular over north-eastern Guinea and south-western Mali (PAC7; see also Figure 7). This presents clear threats to future human health, animal health and crop production in the region (PAC6).

  ![Figure 7: Number of very hot days](image)

There are, however, a number of models that look at climate projections over shorter time frames, which could be useful for early warning systems and short-term forecasts. For example, the Climate Hazards Infrared Precipitation with Stations - Global Ensemble Forecast System (CHIRPS-GEFS) provides rainfall projections out to the next 15 days (PAC2). Similarly, the Experimental Subseasonal Forecasts (SubX) offer precipitation and temperature projections out to the next four weeks (PAC2). Regarding crop production, statistical weather-driven crop models have been developed to provide within-season forecasts of crop production one month before harvests, with very high agreement with actual observations (PAC7).
Heat-related mortality is projected to rise as a result of warming temperatures and the associated increase in frequency of heatwaves (PAC6; see also Figure 8).

At the same time, GDP exposure to heatwaves is expected to increase to 14.2% (RCP2.6) and 19.1% (RCP6.0) by 2080, as compared to 4.1% in 2000 (PAC6; see also Figure 9). This would imply a growing need for policy planners to identify heat-sensitive economic production sites and activities and integrate climate adaptation strategies accordingly (PAC6).
Precipitation projections are less certain; however, several models project an increase by 2080 compared to 2000 (PAC7; see also Figure 10). Changes in precipitation will have a direct impact on water availability and quality, as well as on crop production and food security (PAC6).

Number of days with heavy precipitation are projected to increase in general, particularly in northern Chad. Flooding, as a result of high precipitation amounts, can affect infrastructure such as roads and urban settlements. However, a decrease is projected in the western Sahel, specifically in Mauritania, Senegal and north-eastern Mali, a decrease is projected (PAC6; see also Figure 11).
Similarly, climate and groundwater modelling projections indicate that by the end of the century, most of West Africa will have a wetter climate, with an increase in surface runoff, with potential consequences for groundwater recharge. It is important to note that while average daily rainfall will increase, the number of rainy days will decline (PAC13; see also Figure 12).

Despite high uncertainties in water availability projections, some models project drought exposure of national crop land area to double over the period of 2000-2080 (PAC7).
Cross-cutting trends

Climate change presents a number of major challenges across the Sahel, with all countries in the region ranking among the world’s most vulnerable to climate change.\(^{31}\) For the Central Sahel, specific challenges relate to (PAC1):

- Livelihoods and food security
- Human mobility as an effective adaptation and economic diversification strategy
- Inter- and intra-communal conflicts
- Increasing influence of armed groups

While the precise causal impacts are not yet clear, expert analysis of current trends points to several links between climate change and insecurity in the Sahel (PAC11). One link that particularly resonates across all models, scenarios and expert analyses for the region is that of agriculture, and specifically, crop yields. Projections under RCP6.0 indicate a decline in yields of maize (-9.8%), millet and sorghum (-7.6%) (PAC6; see also Figure 13). Furthermore, a warming of 2.0°C will lead to lower yields than a 1.5°C warming scenario across the West African Sudan-Savanna region compared to the baseline period (2000-2015) (PAC4\(^ {32}\); see also Figure 14).

![Figure 13: Crop yield projections in the Sahel, relative to 2000, under RCP2.6 (blue) and RCP6.0 (red) (Source: PAC6; see Annex for a guide on reading the plot).](image)

However, some crops are projected to benefit from higher CO2 concentrations and a 2.0°C scenario. For example, projections under RCP6.0 point to an increase in yields of cassava (37.3%), cow peas (21.9%), groundnuts (12.6%) and rice (11.9%) (PAC6; see also Figure 13).

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31 Out of 182 countries, the ND-GAIN Country Index provides the following rankings: Senegal (135), Mauritania (141), Cameroon (143), Gambia (145), Guinea (148), Burkina Faso (156), Nigeria (161), Mali (170), Niger (176), and Chad (182). Source: https://gain.nd.edu/our-work/country-index/rankings/.

32 Agricultural Model Intercomparison and Improvement Project (AgMIP): https://agmip.org/west-africa-region/.
Figure 14: Crop yield projections in the West African Sudan-Savanna region, relative to 2000-2015, under 1.5°C and 2.0°C scenarios (Source: AgMIP: https://agmip.org/west-africa-region/).

While some yield changes may appear rather small at the regional level, they will likely increase more strongly in some countries and, conversely, decrease more strongly in other countries as a result of climate change. For example, the decreases of millet and sorghum are smaller than that of other declining crops; however, Figure 15 shows that south-western Mali will see decreases of up to 17%, while the eastern part of the country as well as parts of southern Niger will see increases of up to 55% (PAC6).

Figure 15: Millet and sorghum yield projections in the Sahel, relative to 2000, under RCP2.6 and RCP6.0 (Source: PAC6; see Annex for a guide on reading the maps).

Regardless of the direction of yield projections, it is clear that climate change will continue to have an impact on livelihoods that are dependent on agriculture, and ultimately, on food security. Projections in the medium term (i.e. October 2021 to January 2022) indicate that food insecurity will be at “crisis” levels in certain parts of the Sahel, for example, in the Liptako-Gourma sub-region, and in parts of north-western Nigeria bordering Niger. Meanwhile, “emergency” levels are projected in the region surrounding the Lake Chad Basin (PAC233; see also Figure 16).

33 FEWS NET food security classification data: www.fews.net.
Consequently, the interaction of food insecurity with conflict dynamics could heighten insecurity risks across the Sahel (PAC11). This is a particular cause for concern given that conflict projections in the short-term (i.e. by July 2022) point to a growing probability of violence in many parts of the Sahel. In particular, at the country level (PAC12; see also Figure 17):

- **State-based violence** (i.e. politically motivated violence involving a government of a state) is projected to be more likely in countries that have suffered such violence in recent months and years.

- **One-sided violence** (i.e. violence inflicted by a government or an armed group against unarmed civilians) is projected to be lower than that for state-based violence, but nevertheless reaches as high as 30–50% in half of the UNISS countries of the Sahel (Nigeria, Mali, Burkina Faso, Cameroon and Niger).

- **Non-state violence** (i.e. conflict between non-state armed groups) will remain relatively low (<10%), with the exception of Nigeria.
Figure 17: Forecasts of probability of state-based violence, one-sided violence and non-state violence in the Sahel, at the country-month (a, c, e) and sub-national-month (b, d, f) levels, for July 2022, relative to the last month of data. (Source: PAC12).
Furthermore, projections over the next three years (i.e. by July 2024) indicate that little will change with regards to these trends, neither nationally nor sub-nationally, for all types of violence (PAC12; see also Figure 18).

Other conflict-related indicators show similar trends. The number of conflict fatalities is projected to increase across several regions between Q3-2021 and Q2-2022, namely in north-eastern Mali (Gao and Kidal) and western Mali (Koulikoro) (PAC8; see also Figure 19). Similarly, the number of security-related incidents is projected to increase almost exclusively in Mali in the same period (PAC8; see also Figure 20). However, the emergence of protests and riots will remain stable across the Sahel for the forthcoming quartiles (PAC8).
Conflict dynamics could also have an impact on future economic growth in the Sahel. When correcting for the negative impacts of armed conflict, GDP per capita is expected to increase much more slowly by the end of the century (PAC12; see also Figure 21).
Of concern as well is what *drives* conflict in the Sahel. Based on the scientific literature, as well as assessments by regional, thematic and country experts, a number of factors have been identified that remain the core conflict drivers in the region, or have the potential to escalate climate-related conflicts (PAC8):

- Challenges to livelihoods and food security, driven by climate-related impacts
- Conflicts over scarce resources that exacerbate existing ethnic tensions – further reinforced by the emerging climate crisis
- Weak state capacity, along with high youth unemployment with a lack of economic perspectives
- High population growth in combination with lacking natural resources and economic instability
- Terrorism and organised crime that further weakens state capacity and spreads across border regions into previously unaffected countries
- Ethnic heterogeneity, along with ethnic fractionalisation, lack of social cohesion and group exclusion, as is the case with farmer-herder conflicts

It is clear from the above that demographic dynamics and natural resource use also play a key role in the climate-conflict linkage. One important projection in this regard is the *decline in water availability per capita* by 2080 compared to 2000, when taking into account population change (PAC7; see also Figure 22). This can be explained by the increase in irrigation for agriculture as well as rise in demand for drinking water supply, domestic use and hydropower generation, all of which are associated with population growth and increasing urbanisation (PAC6).
Figure 22: Projections of water availability from precipitation per capita in the Sahel with (A) national population held constant at year 2000, and (B) changing population in line with SSP2 projections, relative to 2000, under RCP2.6 (blue) and RCP6.0 (red) (Source: PAC7; see Annex for a guide on reading the plot).

Thus, projections of the total population in the Sahel reaching 455 million in 2030 and 712 million in 2050 could put additional pressure on these challenges (PAC10; see also Figure 23).

Figure 23: Population estimates for the UNISS countries, for 2030 and 2050 (Source: PAC10).

Ultimately, these dynamics can shape human mobility patterns in the future. Forced displacement, for example, will continue to increase in the Sahel, from approximately 7.0 million in 2020 to 9.4 million by the end of 2023 (Figure 24). Additionally, this increase has also been found to be strongly related with conflict trends (PAC3).
However, projections have also shown that some periods and regions do see changes in displacement without experiencing a high level of conflict locally. This can potentially be explained by a number of reasons, including violence in neighbouring regions and anticipatory displacement (PAC3). Food insecurity could also play a role in this regard: the effect of food insecurity in driving up displacement numbers has been established in a model that estimates the conditional effect of additional food security on new displacements (PAC3; see also Figure 25).

Looking at climate-related migration specifically, models that estimate internal migration in a selection of UNISS countries based on a combination of SSPs and RCPs indicate a general increase in internal climate migrants, reaching as high as 16 to 50 million on average in 2050 (PAC15; see also Figure 26).
Climate migration trends, however, are not uniform across the Sahel. By 2050, climate out-migration is projected in areas where livelihood systems are increasingly compromised by climate impacts, such as lower water availability and crop productivity. Conversely, climate in-migration will occur in areas with better livelihood opportunities, for example inland areas where impact models project higher water availability. In-migration hotspots are also projected near border areas due to favourable climatic projections (Figure 27). However, recent conflict in these areas may mitigate that growth or indeed lead to displacement out of these areas (PAC15).
The question of mobility is particularly important for pastoralist groups, whose identity is closely tied with their livelihood and livestock. Climate impacts are expected to feature more prominently as a conflict driver for pastoralists, particularly if no sufficient adaptive measures are taken (PAC7). Indeed, there is already evidence that desertification and shifting rainfall patterns have altered the routes of cattle herding communities, bringing them across farmland during, rather than after, the harvest season (PAC11). This contributes to the so-called "farmer-herder conflicts", which are themselves linked to other core conflict drivers in the Sahel, namely ethnic fractionalisation and lack of social cohesion (PAC8). As conflict and security levels are among the factors influencing pastoralist routing decisions, conflicts can themselves hinder the ability of pastoralists to move along traditional routes. We can expect these trends to escalate, given the long-term projections of temperature rise and rainfall variability, coupled with rapid population growth in the region.\(^{34}\)

It is important to note that these risks are not deterministic, but rather depend on a range of moderating (or conditioning) factors, the evolution of which would have implications on the vulnerability (but also resilience) of Sahelian communities. These factors can broadly be categorised into six groups (PAC1):

- Agricultural productivity and technologies
- Economic structure and opportunities
- Trade and access to markets

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\(^{34}\) Puig et al (June 2021)
Resource and conflict management
Governance and state-citizen relations
Social relations

There is evidence of how these moderating factors have played out, and how they may continue to do so. For example, the issue of *governance* has been found to contribute to the downward spiral of violence and strong feedback loops between climate impacts and conflict drivers (PAC7). Evidence shows that climatic shifts have driven recruitment into Boko Haram and other extremist groups, as instability and weak government responses to communities' needs disenfranchises marginalised people (PAC11).

Similarly, other factors that are particularly salient in terms of Sahelian conflict and fatality numbers include state income, group marginalisation and *agricultural dependence* (PAC8). Indeed, for the latter, models have consistently assigned a higher probability of conflict to locations that have a relatively high share of cultivated land, and a high percentage of people employed in agriculture. This is because households that are strongly dependent on agriculture are more vulnerable to climate shocks and related crop failures, particularly in terms of their income. This can foster communities' feelings of deprivation, enhance communities' grievances over basic rights, and expand militias' opportunities of mobilising deprived individuals (PAC14).

Even in countries where the probability of violence has been relatively stable (e.g. Mauritania and Guinea), the likelihood of violence over the next year could become “non-negligible” due to a combination of low state capacity, drought during the growing season, and heavy dependence on agriculture (PAC12).

To sum up, the projected levels of food insecurity in various parts of the Sahel in the medium term, driven in part by climate change, could be a cause for concern with regards to rising displacement numbers and conflict in the region. As we can expect this trend to continue into the future, given the long-term projections on climatic and agricultural factors, policymakers need to seriously consider the underlying factors that are driving food insecurity and impeding resilience. The following chapter will explore these implications in further detail.
Implications for policymakers

While the projections outlined in the previous sections provide cause for concern for the Sahel’s future, there are a number of silver linings in the region worth highlighting:

- **For the most part, peaceful coexistence and cooperation between community groups have prevailed**, and customary laws have often resulted in peaceful resolutions of local conflicts, although there have been tensions over time, which in some cases have turned violent, as in recent years.\(^{35}\)

- **The overall trend points to marginal improvements in terms of resilience and SDG** across the ten UNISS countries (UNISS rapid assessment of UN investments in the Sahel (2016-2020); see also Figure 28).

- With some exceptions, **GDP, GDP per capita and government spending have grown significantly** although admittedly starting from very low bases (UNOCC Sahel Fact Pack).

- **The Sahel is rich in natural resources** and, owing to its large population growth, has an **abundant workforce** which, if managed equitably and sustainably, “could turn the region’s fortunes around”.\(^{36}\)

- In this digital era, the Sahel is experiencing a “**technological dynamic**”, supported by a large penetration of mobile devices - this could provide new economic opportunities, particularly in the trade and financial services.\(^{37}\)

- **Modelling approaches specifically for the Sahel have made major progress in recent years.** One example is the Community Earth System Model Decadal Prediction Large Ensemble (CESM-DPLE), which shows high skill in predicting summer rainfall in the Sahel several years in advance (3-7 years ahead) (PAC5). Additionally, the model’s use of a large number of ensembles has led to a decrease in uncertainty associated with predictions (PAC5) - bearing in mind that uncertainty was a major issue behind precipitation projections.

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\(^{35}\) Puig et al (June 2021)  
\(^{36}\) UNECA (2019)  
\(^{37}\) UNECA (2019)
Thus, in order to keep the Sahel's development and security trajectories on the path towards peace and resilience, policymakers from the region as well as from the international community may wish to consider the following:

**Better data leads to more informed action.** The lack of availability and reliability of data was identified as a recurring challenge for developing projection models, such as on agricultural yield (PAC7), displacement (PAC3) and groundwater levels (PAC13). However, data and the ability to forecast risks are crucial to ensure that early warning systems remain effective, which consequently helps to keep actions well-informed. For example, a profound knowledge on prognosis of crop yields, precise weather developments and existing inter- and intra-group conflict will support improving predictions of humanitarian needs in the Sahel (PAC7). More broadly, predictive analytics should be strengthened to better assess the complex socio-economic-physical dynamics at play to build, target and coordinate capacities accordingly and proactively (PAC8).

In this regard, the range of recommendations for strengthening the evidence base is wide, and this includes (PAC7):

- Supporting statistical offices, meteorological agencies and agricultural ministries of the Sahel in collecting climate and agricultural data in a standardised manner and to facilitate timely exchanges.

- Supporting countries in building and maintaining weather stations and collecting weather data in a standardised manner.
● Gathering consecutive survey waves and consecutive qualitative data in order to monitor developments over time.
● Building a network of data sharing hubs to make existing data publicly available.
● Supporting joint international research with institutions in the Sahel, including online and in-person exchanges and training of researchers.

**Focusing on the local level.** The involvement of local experts and stakeholders in data collection, model development and scenario-building, particularly in the early stages, is a recurring recommendation in ensuring that models and projections remain relevant and valid (PAC1; PAC12; PAC13). Furthermore, a participatory approach which utilises the vast array of context-specific knowledge and skill sets on the ground can help adaptation measures be more acceptable by the local population (PAC7).

The findings from predictive analytics and strategic foresights could also help ensure the effectiveness of localised measures. For example, municipalities and regions that have been identified through predictive analytics as areas of heightened vulnerability should be prioritised, and additional (technical) support on the local level must be provided.

**Building good governance and fostering harmonious social relations.** Strengthening the rule of law, particularly the coherence of rules that govern access to land, as well as strengthening the inclusivity of public institutions and social networks are important medium- to long-term measures in addressing conflict risks (PAC8). Considering that forced displacements are projected to rise, improving inter-communal relationships, particularly between refugees and local populations, can help reduce potential conflict (PAC7). The same also applies to farmer-herder relations: fostering cooperation and complementarity between these groups is an important step towards achieving the first strategic orientation for the Sahel to “promote inclusive governance for better community living”.

**Agricultural support is critical.** Given that climate projections for the agricultural sector is for the most part negative, and yet the sector contributes to a major part of Sahelian livelihoods and food security, there is a real need for more agricultural support in terms of climate adaptation and resilience. In particular, emphasis should be given in providing technical support at the national level for relevant ministries (e.g. ministries of environment or agriculture) to implement projects of the scale and ambition needed. This would help enhance regional capacities and a sense of ownership. Several specific recommendations include:

- Promoting resilient and sustainable agricultural production and irrigation techniques (including traditional techniques) and capitalising on the complementarity of agricultural and pastoral production systems (PAC1).
- Increasing the funding of national agricultural research systems so that they can respond to the challenges of the climate, land degradation and changes in consumer preferences by making suitable technologies available to smallholder farmers (PAC4).

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38 UNECA (2019)
Supporting the implementation of effective and sustainable agricultural advisory programs capable of providing smallholder agricultural producers with the skills necessary to be more productive, and to adapt to different environmental constraints (PAC4).

Ensuring adequate agricultural technical and vocational education and training systems, and building the skills of young people to seize the entrepreneurship opportunities offered by agriculture, to which African governments should make huge investments (PAC4).

**Adaptation in climate-sensitive sectors needs to be strengthened.** In addition to agriculture, and given the projections of rising GDP exposure to heatwaves, policymakers need to identify heat-sensitive economic production sites and activities, and integrate climate adaptation strategies in these areas as well (PAC6). This could include, for example, improved solar-powered cooling systems, “cool roof” isolation materials or switching the operating hours from day to night (PAC6). The projected decline in water availability also highlights the urgency to invest in water-saving measures and technologies for future water consumption after 2030 (PAC6). By addressing these issues in other sectors, economic diversification opportunities could be promoted which, together with broader regional economic integration and the free movement of people and goods across Sahel, would help strengthen resilience in the long-term (PAC1). And as with agricultural support, technical assistance should also be provided for relevant ministries to implement projects at the necessary scale and ambition at the national level.

**As conflict has been identified as a major impediment to human development in the Sahel,** it is essential to address the underlying risks of conflict which are largely related - but not limited - to socio-economic grievances, management of crucial resources such as water, and societal vulnerability to climate extremes (PAC12). A step in this direction would therefore involve addressing the recommendations set out above.

Indeed, armed conflict will continue to plague the region for years and possibly even decades ahead (as evident by the conflict forecasts), unless there is a radical change in the main drivers of violence (PAC12). Similarly, this calls for a shift in the way policies are formulated for the Sahel. While measures aimed at immediate conflict reduction may offer a temporary respite, any efforts to promote a sustainable peace must also address the structural challenges that the Sahel faces. It follows that more investments should be channeled towards capacity-building for societal resilience to climate extremes (PAC14).

Furthermore, the lessons from the Sahel do not stop there: we recommend utilising and adapting the methodologies of the Predictive Analytics Project in the Sahel to other vulnerable regions. This boils down to the fact that climate change knows no borders, and that being able to proactively address its impacts in all fragile contexts would help ensure that the people of the Sahel, along with the broader global community, can share a peaceful and sustainable future together.
Annex

List of Predictive Analytics Contributions (PACs)

- PAC1 - CASCADES (2021) Scenarios on possible future impacts of climate change in the Central Sahel (conducted by: (the Barcelona Centre for International Affairs (CIDOB), the European Centre for Development Policy Management (ECDPM) and adelphi).
- PAC2 - Climate Hazards Center (CHC) (2021) Agroclimatic analysis (in support of: Famine Early Warning Systems Network (FEWS NET)).
- PAC4 - Initiative Prospective Agricole et Rurale (IPAR) (2021) A West African Think Tank’s perspective on the future of agriculture in Sub-Saharan Africa.
- PAC6 - Potsdam Institute for Climate Impact Research (PIK) (2021) Climate Risk Profile for the Sahel.
- PAC7 - Potsdam Institute for Climate Impact Research (PIK) (2021) Predictive Analytics and Strategic Foresight in the Sahel.
- PAC8 - PREVIEW, German Federal Foreign Office (AA) (2021) Conflict Trends at Subnational Level for the Central Sahel Region in the Context of Climate-Change Induced Weather Events.
- PAC10 - UN DESA (2021) Input on the demographic situation and prospects in countries covered by the UN Integrated Strategy for the Sahel.
- PAC12 - ViEWS, Uppsala University (30 September 2021) Contribution to the Predictive Analytics project.

For more information on each PAC, including their data sources, methodologies, modelling approaches, and projection tools, please visit the UNISS subpage (forthcoming).
Guide on reading line graphs and maps from PAC6 and PAC7

How to read the line plots:

- historical best estimate
- RCP2.6 likely range
- RCP6.0 very likely range
- RCP8.5

Lines and shaded areas show multi-model percentiles of 31-year running mean values under RCP2.6 (blue) and RCP8.0 (red). In particular, lines represent the best estimate (multi-model median) and shaded areas the likely range (central 66%) and the very likely range (central 90%) of all model projections.

How to read the map plots:

Colours show multi-model medians of 31-year mean values under RCP2.6 (top row) and RCP8.0 (bottom row) for different 31-year periods (central year indicated above each column). Colours in the leftmost column show these values for a baseline period (colour bar on the left). Colours in the other columns show differences relative to this baseline period (colour bar on the right). The presence (absence) of a dot in the other columns indicates that at least (less than) 75% of all models agree on the sign of the difference. For further guidance and background information about the figures and analyses presented in this profile kindly refer to the supplemental information on how to read the climate risk profile.

External references

- Fondation pour les études et recherches sur le développement international (FERDI) Index of Physical Vulnerability to Climate Change (PVCCI). Retrieved on 20 October 2021 from [https://ferdi.fr/donnees](https://ferdi.fr/donnees)


• United Nations Secretary-General (May 2020). Data Strategy of the Secretary-General for Action by Everyone, Everywhere with Insight, Impact and Integrity (2020-22)

• United Nations System Chief Executives Board for Coordination (CEB) (CEB/2020/1/Add.1)