Climate Change and Indigenous Peoples' Knowledge in the Sahel

A Case Study on the Mbororo Fulani of Chad

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LOCAL & INDIGENOUS KNOWLEDGE - 2

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SHORT SUMMARY

Thriving in a changing environment: Indigenous weather and climate knowledge of Mbororo Fulani in Chad

The *Knowing our Changing Climate in Africa* project, initiated by UNESCO's Local and Indigenous Knowledge Systems (LINKS) Programme in 2012, supported a 6-year community-led research in the sub-Saharan African countries, including Burkina Faso, Chad, Ethiopia, Kenya, Tanzania, and Uganda, focusing on pastoral communities. The study delved into their weather and climate knowledge, forecasting skills, and observations of environmental changes, emphasizing sophisticated traditional indicators.

This publication highlights the results of the research from Mbororo Fulani in Chad, detailing the use of their traditional practices and weather forecasting rooted in environmental interactions in the arid Sahelian region. The study, combined with an innovative mapping initiative, showcases how this knowledge guides them across diverse landscapes, from the Sahel's climatic zones to the more tropical regions of Central Africa.

The Mbororo's decision-making process requires the use of **more than** **2,000** **indicators** over their seven distinct seasons.

The Mbororo decision-making process is influenced by various factors, such as the availability and quality of pasture, and the reliance on the seasonal calendar and star observations to predict rainfall trends and seasonal changes, employing over 2000 indicators across their seven distinct seasons.

This report also emphasizes the transdisciplinary dialogue between Indigenous knowledge and meteorologists to enhance climate forecasts, presenting a collaborative approach crucial for sustainable policies to enhance communities' resilience.

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"Since wars begin in the minds of men and women, it is in the minds of men and women that the defences of peace must be constructed"

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LOCAL & INDIGENOUS KNOWLEDGE - 2

Foreword

by Shaofeng Hu, Director of the Division of Science Policy and Basic Sciences

For over two decades, UNESCO's Natural Science Sector has been promoting the unique and complex understanding of different peoples about their environment and the changing climate. This effort aligns with global frameworks such as the Paris Agreement and the Global Framework on Biodiversity. UNESCO acknowledges the synergy between Indigenous and scientific knowledge systems, a principle firmly integrated into the International Decade on Indigenous Languages and the International Decade of Sciences for Sustainable Development, a commitment the Organization actively upholds.

This report, prepared by Mbororo herders and researchers, provides important insights into how policy making can be strengthened through the dialogue between traditional knowledge systems and formal sciences. It is part of a long-term UNESCO commitment to supporting African knowledge production which transcends geographical boundaries and cultural landscapes, immersing us in the intricate tapestry of the lives of the Mbororo Fulani cattle herding people in Chad.

The Mbororo People, steeped in deep-rooted traditions, offer us a glimpse into a world where resilience and harmony with nature take precedence. As we navigate the findings of community-led research, this report encourages exploration of the profound insights derived from their experiences, particularly in the face of the pressing challenges posed by climate change.

This work stands as a testament to the collaborative spirit that brought together researchers, elders, youth, traditional leaders and scientists to better understand the knowledge of weather and the changing climate in Africa. It emphasizes the significance of intertwining traditional practices and scientific knowledge for a holistic approach to addressing the complexities of our changing climate. This publication not only serves as an informational source but also as a catalyst for dialogue, understanding, and, most importantly, action. As we absorb the narratives and lessons within, we recognize the importance of preserving and transmitting these traditional pastoral practices conducive to sustainable coexistence with our planet.

Mbororo communities, alongside other Indigenous Peoples, are experiencing the accelerating impacts of climate change. The wealth of knowledge possessed by pastoralist populations in Africa empowers them to make decisions about managing natural resources and their way of life. Their experience, knowledge, and collective memory position them as crucial contributors to monitoring, mitigating and adapting to climate change, as well as assessing loss and damage. UNESCO is pleased to be a partner in the process, supporting knowledge production, the scientific dialogue and providing tools for informing effective policy making.

UNESCO supports global approaches to multiple evidence-based decision-making and the enhancement of transdisciplinary capacity, recognizing that Indigenous knowledge comprehends natural phenomena in their entirety, which complements conventional scientific knowledge. The transdisciplinary methodologies highlighted here showcase the co-production of scientific and Indigenous knowledge in assessing and adapting to climate change through dialogue. It underscores the importance of engaging Indigenous and local communities with decision-makers. This dialogue among pastoral communities, climate scientists, and policymakers is pivotal for integrating pastoral knowledge into national decision-making processes related to climate change assessment, adaptation, and mitigation.

Acknowledgements

This document is part of the UNESCO-LINKS project *Knowing our Changing Climate in Africa* and is accompanied by a PowerPoint presentation as well as a report of the Expert Meeting on *Indigenous Knowledge and Climate Change in Africa* held in June 2018, and a series of policy briefs produced in 2019. These can be viewed online: https://www.unesco.org/en/links/climate-africa

We thank the following colleagues for their coordination of the *Knowing our Changing Climate in Africa* project: Douglas Nakashima and Jennifer Rubis. We also thank the following individuals for their support in the research, feedback and review of the first version of this report: Louis Dorémus and Veronica Gonzalez-Gonzalez.

Our thanks also go to the colleagues who helped during the publication process of this report and its communication phase: Monia Adjiwanou, Kelly Dochy, Sunday Fadina, Ouissal Hmazzou, Yichen Liu, Enzo Panetta, Marie-Eugénie Papastavrou, Susan Schneegans, Natalia Tolochko, and François Wibaux.

We express profound gratitude to the author of this Chad case study, Ms. Hindou Oumarou Ibrahim, whose support and partnership were pivotal in initiating and guiding this research.

Our heartfelt appreciation goes to the Mbororo Fulani communities in Chad, as well as to the other Indigenous communities involved in the *Knowing our Changing Climate in Africa* project, including the Fulani in Burkina Faso, the Afar in Ethiopia, the Maasai and Samburu in Kenya, the Maasai in Tanzania, and the Bahima and Karamojong in Uganda. Their invaluable insights, knowledge sharing, and active participation have enriched our understanding of climate change adaptation, forming the cornerstone of this study.

We extend our thanks to the dedicated researchers, academics, meteorologists, climatologists and other scientific experts. Their expertise, rigorous methodologies, and commitment significantly contributed to the depth and quality of the research findings.

Acknowledgement is due to the government authorities and policymakers in Chad for their cooperation and support, and for their understanding of the critical importance of including Indigenous Peoples and their traditional practices into national environmental and climate change policies. Their commitment to preserving Indigenous knowledge is paramount.

We extend our sincere thanks to collaborative partners and funding organizations, especially the Swedish International Development Cooperation Agency (Sida) and the Japanese Funds-in-Trust, whose financial and logistical support ensured the success of this project.

Drafting team

This paper was commissioned by UNESCO's Local and Indigenous Knowledge Systems (LINKS) Programme, within the Science Policy and Capacity Building Division of the Natural Sciences Sector. The material is based on six years of research and cooperation with the Association des Femmes Peules & Peuples Autochtones du Tchad (AFPAT).

The author, Hindou Oumarou Ibrahim, is the Executive Director of AFPAT and a specialist in human rights, Indigenous Peoples' rights and climate and the environment.

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Background

The arid and semi-arid zones of sub-Saharan Africa are subject to variable weather conditions which are difficult to predict. The observed and expected changes related to climate change will worsen these conditions. Owing to their dependence on natural resources and rainfall, nomadic pastoralists in these regions are vulnerable to these changes. Nevertheless, their nomadic lifestyles and knowledge of their environment are key resources for adaptation.

In continuity with activities initiated since 2011, the project *Knowing our Changing Climate in Africa* (2014-2018), coordinated by UNESCO's Local and Indigenous Knowledge Systems (LINKS) programme, in partnership with the Association des Femmes Peules & Peuples Autochtones du Tchad (AFPAT), documented and respected the traditional knowledge systems of the nomadic Fulani Mbororo communities of Chad to establish a dialogue with science for the co-production of knowledge. This work aimed to strengthen the consideration of the needs of these communities and the knowledge they hold to adapt to climate change.

The project developed and implemented a research methodology with nomadic pastoralist communities to document their own knowledge systems, particularly in terms of weather and climate forecasting, and to share them with meteorologists. This participatory research has revealed a **detailed knowledge of the seasons and their variations**, as well as a **wide variety of abiotic factors** (observation of wind patterns, clouds, etc.) or **biological factors** (behaviour and phenology of fauna and flora) observed and analysed to predict the weather and support decision-making for adaptation at the community level. Their knowledge and transhumance practices allow these communities to anticipate and adapt to environmental changes while pursuing sustainable use of the ecosystems on which they depend.

The importance of this knowledge has significant potential for the adaptation of these communities. In this regard, the project has initiated a **transdisciplinary dialogue between the holders of this Indigenous knowledge and scientists representing many disciplines** (meteorologists, agrometeorologists, biologists, anthropologists, etc.).[1] Promising results have been obtained by the project and **avenues**

1 In this report, by 'science' we refer to formal knowledge systems (as defined by IPBES: https://www.ipbes.net/glossary/western-science). While formal science strives to be universal and replicable anywhere, Indigenous and local knowledge systems are specific, communal, and culturally transmitted (see UNESCO's definition: https://www.unesco.org/en/links/mission).

of collaboration have been identified for the co-production of knowledge. These collaborations would notably improve the access, quality and relevance of seasonal forecasts disseminated to nomadic communities, and even improve knowledge, assessment and monitoring of climate change based on the holistic vision of Indigenous knowledge.

Strengthening the consideration given to Indigenous knowledge and the dialogue between knowledge systems provides many perspectives and solutions for climate change adaptation and has major applications in sectoral policies, including (1) strategic planning for disaster prevention, (2) inter-community conflict management, (3) land and migration corridor management and (4) natural resources management.

The sustainability of the dialogue between knowledge systems and the inclusion of local and Indigenous knowledge in adaptation depends on their **adequate consideration in adaptation policies**. In this regard, the project has initiated work to raise awareness and mobilise national and international decision-makers on these issues. The continuation of the work initiated by the project appears necessary to further explore and implement knowledge co-production projects and strengthen the consideration of sustainable and adaptive knowledge and practices of local communities in adaptation policies.

Any initiative involving Indigenous knowledge requires consideration of intellectual property rights and respect for free, prior and informed consent (FPIC). The research conducted by the Indigenous Peoples' organization described here has generated new data and information, some of which has not yet been published and which is the collective knowledge of Mbororo pastoralists. Throughout the project, the researchers, themselves members of the community or long-term collaborators, discussed issues of intellectual property and FPIC. The agreement, which forms the basis of the cooperation with UNESCO, ensures that the work is published only with the consent of the individuals and communities involved in the research. As a result, we do not publish here the full content of the seasonal calendars or the results of the indicators, which have been returned to the communities in graphic form.

Chapter I
Introduction

1.1 Considering Indigenous Peoples' knowledge in climate change adaptation policies

In the face of the challenges and uncertainties of global change, it is essential that decision-makers develop policies based on the best available knowledge. In recent years, it has become increasingly clear that science alone will not be enough to solve the climate crisis. In this context, there is a pressing need to include the unique insights and contributions of Indigenous Peoples. These communities and their territories are expected to face powerful and immediate impacts due to their location in generally

> **Definition of Indigenous and local knowledge systems per the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES):**
>
> *"... dynamic bodies of integrated, holistic, social and ecological knowledge, practices and beliefs pertaining to the relationship of living beings, including people, with one another and with their environments. Indigenous and local knowledge is grounded in territory, is highly diverse and is continuously evolving through the interactions of experiences, innovations and various types of knowledge (written, oral, visual, tacit, gendered, practical, and scientific)..."*
>
> *(IPBES-5/1, Annex II).*

vulnerable environments such as small islands, arid or polar environments, and high mountains. However, these populations hold knowledge and solutions to strengthen their resilience to change. Indigenous, local or traditional knowledge has progressively been recognized as an important source of knowledge on climate and adaptation to environmental change.

In recent decades, international mechanisms and instruments on biodiversity or climate have increasingly recognized the value of diverse knowledge systems and the importance of Indigenous Peoples' participation in assessing issues and defining policies to address them. In 2015, the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC) resulted in the signing of the Paris Agreement for reducing greenhouse gas emissions and combating climate change. Article 7.5 of the Agreement recognizes the role of Indigenous Peoples' and local communities' knowledge systems in addressing climate change, the importance of taking them into account in understanding climate change and developing relevant actions for adaptation as follows: *"Parties acknowledge that adaptation action should (...) be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions, where appropriate."* (FCCC/CP/2015).[2] At COP21, the parties went further by additionally adopting paragraph 135 of 1/CP.21 which *"recognizes the need to strengthen knowledge, technologies, practices and efforts of local communities and indigenous peoples related to addressing and responding to climate change, and establishes a platform for the exchange of experiences and sharing of best practices on mitigation and adaptation in a holistic and integrated manner."*[3]

Although they are benefiting from increasing recognition, particularly at the international level, these knowledge systems and practices continue to occupy a limited place in adaptation policies. The appreciation and mobilization of Indigenous knowledge for adaptation thus represent a considerable challenge.

In the arid and semi-arid zones of sub-Saharan Africa, nomadic pastoralist communities are exposed to variable and unpredictable weather and climate conditions, which are exacerbated by climate change. The capacity of national authorities to forecast the weather, anticipate extreme climatic events, and transmit this information to remote areas requires constructive dialogue with rural populations and connections with the scientific community. This ensures that all relevant and available knowledge systems are considered in the development of adaptation strategies.

2 https://unfccc.int/sites/default/files/english_paris_agreement.pdf
3 https://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf

1.2 The Chadian context and the aim of the project

In 2011, the Association des Femmes Peules & Peuples Autochtones du Tchad (AFPAT) initiated community-based research in collaboration with several Indigenous Mbororo Fulani communities in Chad. This work was developed within the framework of the project *Knowing our Changing Climate in Africa*[4] (2014-2018), coordinated by UNESCO's LINKS program, which involved Indigenous communities from six sub-Saharan African countries, namely: Fulani from Burkina Faso; Afar from Ethiopia; Samburu, Maasai Laikipia and Maasai Liota from Kenya; Bahima and Karamojong from Uganda; Maasai Ilkisongo and Maasai Parakuiyo from Tanzania; and Fulani Mbororo from Chad.

The project aimed to **identify and mobilize existing Indigenous Peoples' knowledge and local knowledge related to weather and climate for adaptation** in Africa. It focused on nomadic or semi-nomadic pastoral populations and **explored how a constructive dialogue between local and Indigenous knowledge systems and science can facilitate the mobilization of the best available knowledge for the development of adaptation policies**. Discussions between knowledge systems can help fill gaps in climate science and build the capacity of national authorities to monitor, predict and respond to extreme climatic events such as drought.

This project aimed to conduct research and activities to better understand the knowledge of these communities about weather and climate to enhance their capacity for local resilience. It also aimed to identify opportunities for synergy between Indigenous knowledge systems and formal science to improve climate knowledge in Africa and seize opportunities created by national adaptation policies to strengthen them through the inclusion of Indigenous knowledge.

To achieve these objectives, the project relied on a **participatory research methodology based on nomadic pastoralist communities** to document their own knowledge systems, including weather and climate forecasting, and to share them with meteorologists. This methodology aimed to ensure the full participation of communities in the process and create a more equitable basis for dialogue between knowledge systems. The work to establish a dialogue between knowledge systems was based on a **transdisciplinary approach** that included both community knowledge holders and

4 The *Knowing our Changing Climate in Africa* project was supported between 2014 and 2018 by the Swedish International Development Cooperation Agency (Sida) grant "Transdisciplinary research on climate change adaptation for vulnerable Indigenous communities in sub-Saharan Africa : Fostering Indigenous – scientific knowledge co-production", and the Japanese Funds-in-Trust (JFIT) grant "Building capacities of pastoralists in LDCs in Africa : Reinforcing Indigenous knowledge in climate change adaptation planning", as well as the regular funds of UNESCO's LINKS programme.

representatives of meteorological and climate-related institutions and disciplines, as well as other scientific disciplines that are key to understanding local and Indigenous knowledge in its entirety.

Technical partnerships have been established with the World Meteorological Organization (WMO), the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC), and meteorological organizations at national, regional, and international levels, including the African Centre of Meteorological Applications for Development (ACMAD), the Regional Centre for Agriculture, Hydrology and Meteorology (AGRHYMET), the IGAC Climate Prediction and Applications Centre (ICPAC), and the national meteorological services of Burkina Faso, Ethiopia, Kenya, Uganda, Tanzania and Chad.

This report presents the different components of the work carried out with the Mbororo communities of Chad, including community-based research and the initiation of dialogue between knowledge systems, as well as the main results and perspectives for strengthening dialogue, the co-construction of knowledge and the stronger inclusion of local and Indigenous knowledge in climate change adaptation policies.

Chapter II
Research methodology

2.1 Work with the communities

2.1.1 Communities involved and regions concerned by the project

Participatory research was conducted with Mbororo Fulani communities in three regions of Chad:

1. **Lake Chad** (and part of the administrative territory of Hadjer-Lamis): The Mbororo Fulani communities in this region follow a nomadic pastoral lifestyle based entirely on transhumance. These communities do not practice other activities but share the space with farmers, herders and fishermen. This region is located in a Sahelian zone dominated by arid ecosystems, and communities move during the rainy season. During the dry season, communities move to the Lake Chad bed where they can access water points and pastures.

2. **Chari Baguirmi** (south of Lake Chad): This area is difficult to access and not highly developed. The climate is considered Sahelo-Saharan and the Mbororo Fulani communities involved in the project practice agriculture and livestock farming. In this region, movement in search of water and pasture is undertaken exclusively by young men. During the dry season, they may travel as far as the Central African Republic.

3. **Mayo Kebbi East and Mayo Kebbi West** (south of Chad): The Mbororo Fulani communities involved in the project occupy an agro-pastoral zone extending into the forest and encompassing wetland and Sahelian ecosystems. These communities lost their livestock during the great drought of the 1970s, leading them to adopt an agro-pastoral lifestyle. Transhumance is practiced by young men who own livestock, and they move to wetter areas during the dry season to wetter areas.

The involvement of these different communities belonging to the same ethnic and cultural group but following different lifestyles (nomadic/semi-nomadic, pastoral/agro-pastoral) enables the consideration of the diversity of knowledge and practices within the framework of this project. Furthermore, the distribution of the study areas over a significant north-south gradient allowed for the consideration of different climate and ecosystem types.

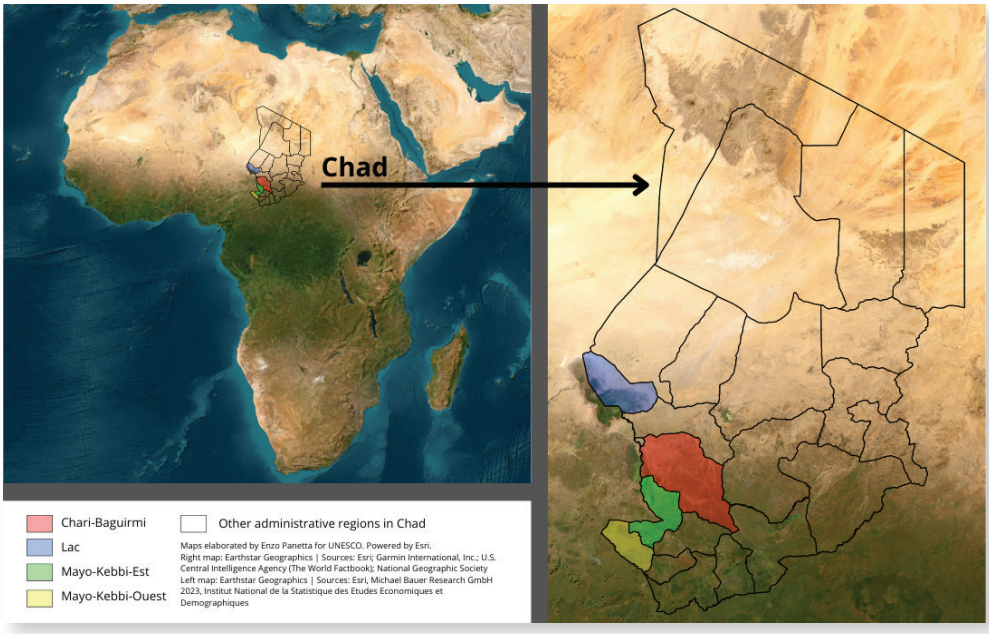

Figure 1: Chad's location in Africa, highlighting the specific administrative regions within Chad where community-based research was conducted in the framework of the *Knowing our Changing Climate in Africa* project (*Source data:* Google Earth, ICPAC, Famine Early Warning Systems Network - FEWS NET).

2.1.2 Community research methodology

The community-based research conducted within the project aimed, in the first instance, to document and highlight each community's knowledge of weather and climate.

Several group interviews were conducted in each community, organized in single-sex groups to respect the traditions of the group and to allow both men and women to express themselves. In each focus group, representation from community leaders, religious leaders and elders aimed to ensure a trusted environment and to facilitate discussion and knowledge sharing. AFPAT conducted two rounds of interviews with

the community in the Lake Chad region between 2016 and 2018 and one round of interviews with communities in Chari-Baguirmi, Mayo-Kebbi East, and Mayo-Kebbi West regions in 2018. Based on this work, various meetings organized by AFPAT and UNESCO-LINKS consolidated and validated the work of documentation and analysis of these knowledge systems.

Figure 2: Community-based research in the Lake Chad region (1) and Mayo-Kebbi East region (2) (©AFPAT).

We also note the organization of participatory mapping work carried out before or in parallel with the *Knowing our Changing Climate in Africa* project, which helped to enrich the process of initiating the valorization of traditional knowledge and the involvement of communities in the dialogue with the scientific community and political decision makers. In 2012, AFPAT, in collaboration with the secretariat of the Indigenous Peoples of Africa Coordinating Committee (IPACC), organized a participatory 3D mapping workshop with members of the Mbororo communities in southern Chad. In 2016 and 2017, mapping work was conducted to trace the transhumance routes of nomadic communities in the Lake Chad region.

2.2 Dialogue between knowledge systems

2.2.1 Main meteorological institutions in the region

The main regional and national meteorological institutions that offer products and services to rural communities in the areas involved in the research project include:

1. **ACMAD (African Centre of Meteorological Application for Development):** Created in 1987 by the Conference of Ministers of the Economic Commission for Africa (ECA) and the World Meteorological Organization (WMO), the centre brings together 53 African countries (see Figure 3). Its objective is to contribute to the sustainable development of the various socio-economic sectors of Africa through:

    - Preparation and transmission of weather and climate information to users, especially in rural areas.
    - Development and transfer of tools and technologies to national meteorological services.
    - Networking of national meteorological services and regional development assistance institutions.
    - Showcasing the development of technological partnerships.
    - Increasing the contributions of Member States and partners through a resource mobilization policy.
    - Strengthening the capacities of universities and research institutes in African States in the fields of climate prediction or technologies.

2. **The Agriculture, Hydrology, and Meteorology Research Centre (AGRHYMET):** This specialised institute of the Permanent Interstate Committee for Drought Control in Sahel (CILSS) brings together 13 West African States, including Chad (see Figure 3). Its objective is to contribute to food security and increase agricultural production in CILSS and ECOWAS member countries, as well as to help improve natural resource management in the Sahel region. Its missions include:

   - The training of managers from Sahelian countries.
   - Agrometeorological and hydrological monitoring at the regional level.
   - The development of agricultural statistics and crop monitoring.
   - The development of regional databases.
   - The management and dissemination of information on the monitoring of natural resources in the Sahel.
   - Documentation on agrometeorology, plant protection, environmental monitoring, desertification, natural resources management, etc.
   - Maintenance of meteorological instruments and electronic equipment.
   - Strengthening inter-state cooperation through the exchange of methodologies and technologies.

3. **The National Meteorological Agency of Chad (ANAM) (see Figure 3):** ANAM is a public institution that provides Chadians with weather forecasts and data. Its missions are varied and include, among others:

   - The delivery of meteorological data and services to public and private actors, as well as to citizens, to help them make decisions in the context of climate change.
   - The production of meteorological models through new technologies such as supercomputers.
   - The safety of goods and people: This mission implies the implementation of vigilance by informing citizens and public authorities in case of dangerous weather phenomena.
   - The safety of air transport on Chadian territory and contribution to national defence and environmental protection by monitoring air quality.
   - The study of climate, focusing on preserving climate memory, monitoring current trends, and forecasting future conditions.
   - Participation in the progress of research in meteorology and climate sciences.

In addition to the representatives of these three institutions, the various transdisciplinary exchange meetings also welcomed experts from other disciplines such as environmental and climate sciences, as well as social sciences. Additionally, representatives of international organizations also participated.

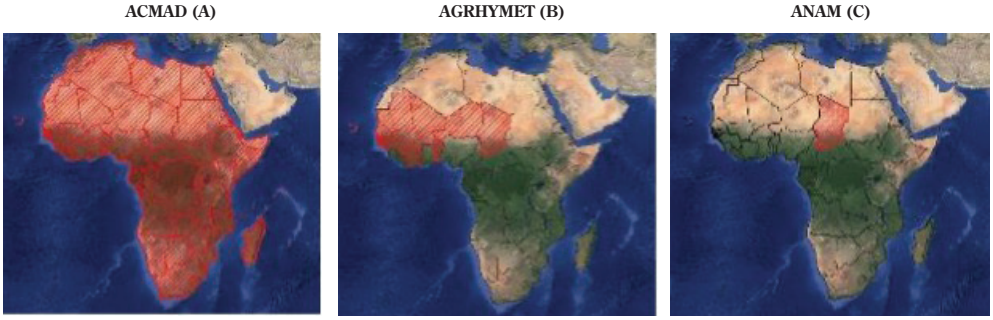

Figure 3: Area covered by ACMAD (A), AGRHYMET (B) and ANAM (C) (*Source data:* Google Earth, ICPAC).

Note: - The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
- Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.
- Final status of the Abyei area is not yet determined.

2.2.2 Methodology used to initiate discussions between knowledge systems

Within the framework of the research project, several workshops bringing together representatives of Indigenous communities and scientists were organized to initiate **transdisciplinary exchanges** and to explore perspectives for the co-production of knowledge for climate change adaptation.

Particular attention was paid to **ensuring the presence of communities or their representatives during any exchange with the scientific community** so that Indigenous Peoples themselves could share the knowledge they hold and actively participate in the exchanges and reflections on solutions for the co-production of knowledge and adaptation. These meetings included the participation of Indigenous men and women from several Mbororo Fulani herding communities. In addition, Indigenous knowledge holders from other pastoralist peoples of sub-Saharan Africa involved in the *Knowing our Changing Climate in Africa* project were also able to participate.

The **natural sciences** were represented by experts in climate sciences and meteorologists as well as agronomists, biologists and geographers. These different

specialists reflected on how the knowledge of Indigenous Peoples could be harnessed to improve weather forecasting and to develop products and services adapted to the needs of nomads. As for **social scientists**, their contribution made it possible to comprehend knowledge in its social and cultural dimensions, by considering the social and political organization of communities.

The discussion focused on **the way each knowledge system conceives, assesses and predicts weather and climate, and the challenges faced by Indigenous communities and scientists in predicting these phenomena**. These exchanges allowed the scientific community to become familiar with the results of community-based research and to recognize the wealth and potential of traditional knowledge systems for forecasting and adaptation. Based on these exchanges, **avenues of collaboration were identified** to improve the quality and relevance of weather and climate forecasts for nomadic communities and to integrate Indigenous knowledge into climate assessment and adaptation policies.

To raise awareness among decision-makers about this work and to strengthen the inclusion of the knowledge and practices of Indigenous nomadic populations in adaptation policies, **government representatives and international institutions dedicated to adaptation policies were invited to participate in these exchanges**. Bilateral meetings with representatives of UNESCO and AFPAT also provided an opportunity to present the project's results and identify perspectives for strengthening the inclusion of nomadic communities in adaptation policies.

The main UNESCO and AFPAT meetings held throughout this process were:

- **African regional workshop on pastoral peoples' Indigenous knowledge, meteorology and adaptation to climate change (N'Djamena, November 7-9, 2011)**, bringing together representatives of pastoral communities in sub-Saharan Africa and national and regional meteorological institutions, and the Chadian Minister of Urban and Rural Hydrology and Minister of Agriculture and Irrigation.

- **Workshop on pastoral peoples' knowledge of weather and climate: Dialogues around adaptation to climate change in Africa (N'Djamena, March 11-15, 2017),** bringing together representatives of Mbororo Fulani pastoral communities in Chad and agropastoral Fulani communities in Burkina Faso involved in the *Knowing our Changing Climate in Africa* project. National (Chad's National Meteorological Department) and regional

(AGRHYMET) institutions represented the scientific community. On the last day of the workshop, the conclusions of the exchanges between Indigenous communities and scientists were introduced to a panel of policy makers from several ministries.

- **Expert Meeting on Indigenous Knowledge and Climate Change in Africa (Nairobi, Kenya, June 27-28, 2018)**, bringing together representatives of Indigenous Peoples from all the countries covered by the project (Burkina Faso, Chad, Ethiopia, Kenya, Tanzania, and Uganda). The scientific community was also present through the participation of representatives from academia, national (Department of Meteorology of the Kenyan Ministry of Environment), regional (ACMAD, ICPAC), and global (IPBES, UNFCCC, World Bank) institutions. The Report of the Nairobi consultation is available here: https://unesdoc.unesco.org/ark:/48223/pf0000374999

- **Workshop on Seasonal Calendars and Transhumance of the Indigenous Mbororo Fulani Peoples of Chad (N'Djamena, October 5-6, 2018),** bringing together pastoral and agropastoral communities from the three regions of Chad considered in this project, as well as two representatives of the National Meteorological Agency of Chad (ANAM) who followed most of the workshop and were able to exchange with the communities.

The process of initiating dialogue between knowledge systems also included a field mission allowing national scientists from Chad to work directly with communities and their environment. On this occasion, exchanges on Indigenous methods of weather and climate forecasting were carried out.

Figure 4: Hindou Oumarou Ibrahim delivering a presentation during the UNESCO Expert Meeting on Indigenous Knowledge and Climate Change in Africa (Nairobi, 2018) (©UNESCO).

Figure 5: Workshop on traditional calendars (N'Djamena, 2018) (©Louis Dorémus/UNESCO).

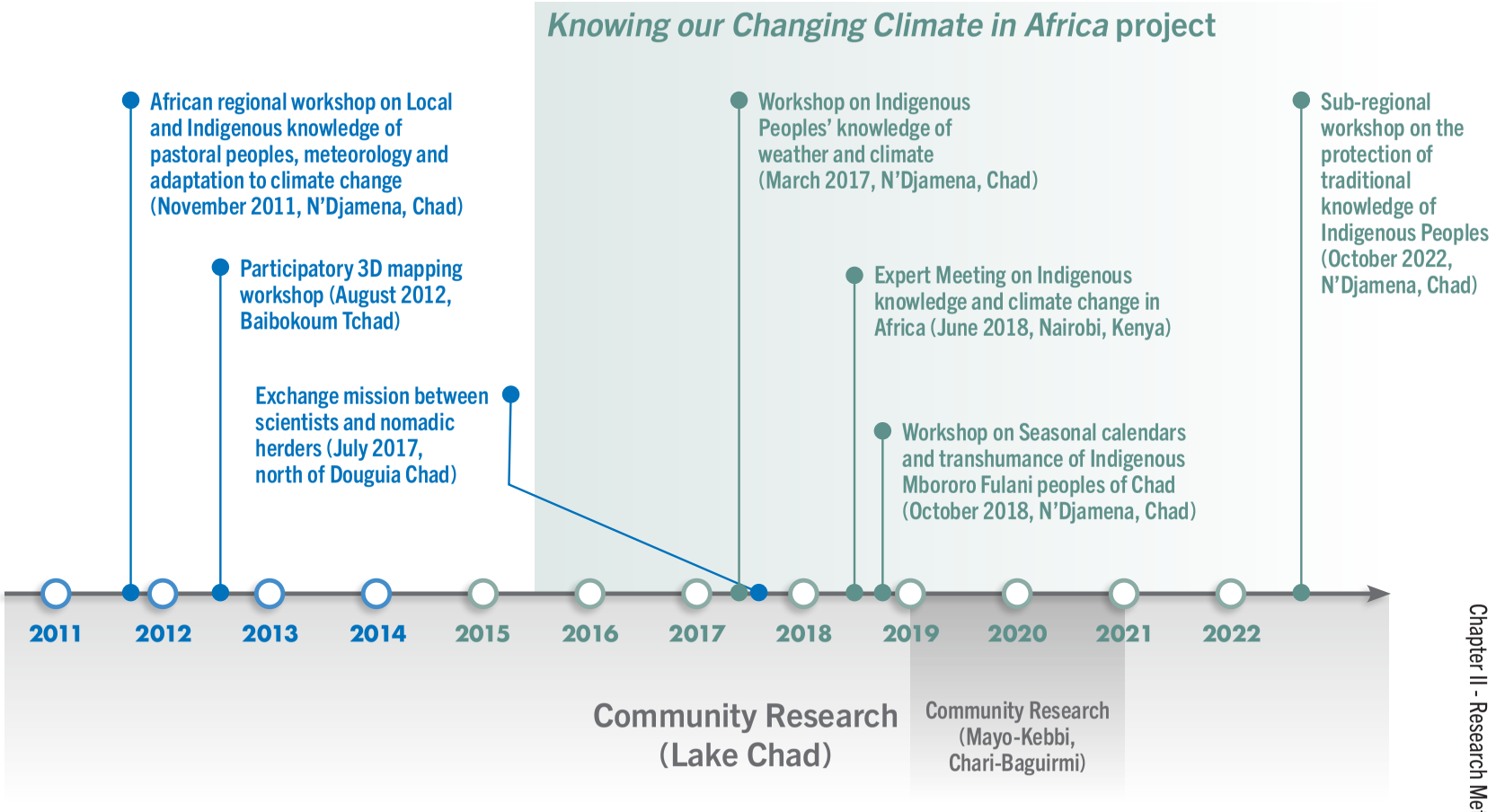

Figure 6: Timeline of the research project described in this report

Chapter III

Community research results

3.1 Seasonal calendars

Community-based research has revealed a wealth of knowledge in these communities about their surrounding environment, including biotic and abiotic factors and cycles.

These knowledge systems have their specific seasonal calendar frameworks employed to organize and understand the passage of time based on environmental cues. These calendars typically divide the year into different seasons, often influenced by factors such as rainfall, temperature, and natural phenomena specific to the local ecosystem. The calendars serve as a guide for various activities, including agriculture, hunting, and cultural events, aligning the community's practices with the cyclical patterns of nature. Indigenous seasonal calendars reflect a deep connection to the land and its rhythms, showcasing the communities' traditional knowledge and sustainable practices.

Typically, t**he seasonal calendars of these communities divide the year into three main periods**: a rainy season, a cold and relatively wet season (mists), and a dry season. **However, variations in seasonal calendars exist between communities**. For instance, communities in the Lake Chad region divide the year into five periods that can be considered seasons or inter-seasons, while communities in Chari-Baguirmi and Mayo-Kebbi East and West identify seven. The reasons for these differences may be linked to geographical situations and varying climates experienced by these communities, as well as to agricultural practices that serve as a reference point for the seasons.

Depending on the season, communities adopt different mobility strategies to access water and grazing resources for their livestock. While mobility is a common

characteristic of all Mbororo groups included in this project, there are significant differences in the transhumance strategies adopted. **The communities of Lake Chad make most of their movements during the wet season**, to take advantage of temporary pastures in the more arid areas. During the dry season, they remain mobile, but in a more localized manner, limiting themselves to the bed of Lake Chad where they have permanent access to water. **In contrast, communities further south practice most of their transhumance during the dry season**. Again, this strategy may be related to the agricultural practices of these communities, as well as to their geographic location and less arid climate.

It is also worth noting that **these communities follow the lunar calendar**, which is used in the Muslim world and which can vary considerably from year to year. These two calendars, lunar and seasonal, serve as different reference points depending on the activities considered. Particular attention must be paid to these differences to avoid misunderstandings and to better grasp the complexity of the communities' knowledge in their relationship to time.

3.2 Indicators for community weather forecast

The Mbororo Fulani know that changes in the seasons are accompanied by significant changes in all aspects of their environment. By observing these changes, n**omadic herders have developed indicators that allow them to diagnose weather conditions and make predictions**. Community-based research has collected several hundred of these indicators used by different groups of herders: 228 for communities in Lake Chad, 168 for those in Chari-Baguirmi, and 201 for those in Mayo-Kebbi East and West.

These indicators are used to **forecast the weather in the short term,** i.e. forecasting rainfall within a few days or **in the long term,** i.e. forecasting the duration or quality of future seasons. Other indicators are used **to determine the onset or end of seasons**, also constituting a projection of future weather.

The wide variety of indicators used reflects a holistic observation and understanding of the environment. Projections are thus made partly based on observations of meteorological elements such as cloud shape, wind speed and direction, or rainfall patterns. Nevertheless, most indicators – 60 to 80% of documented indicators depending on the community – are based on observations of biodiversity in all its components. These observations include bird migration, plant phenology,

appearance of insects, livestock behaviour. Several dozens of plants used for weather forecasting have been documented, and the corresponding Latin terms are necessary in many cases. The visibility and positioning of the Moon and stars is another important area of observation for the communities, the reading of which requires complex knowledge, generally held by experts.

Other groups of indicators, which do not fall into the above categories, were commonly mentioned by the communities in the three zones, such as the reactions of the human skin and body, and the change in the texture of the milk of cattle.

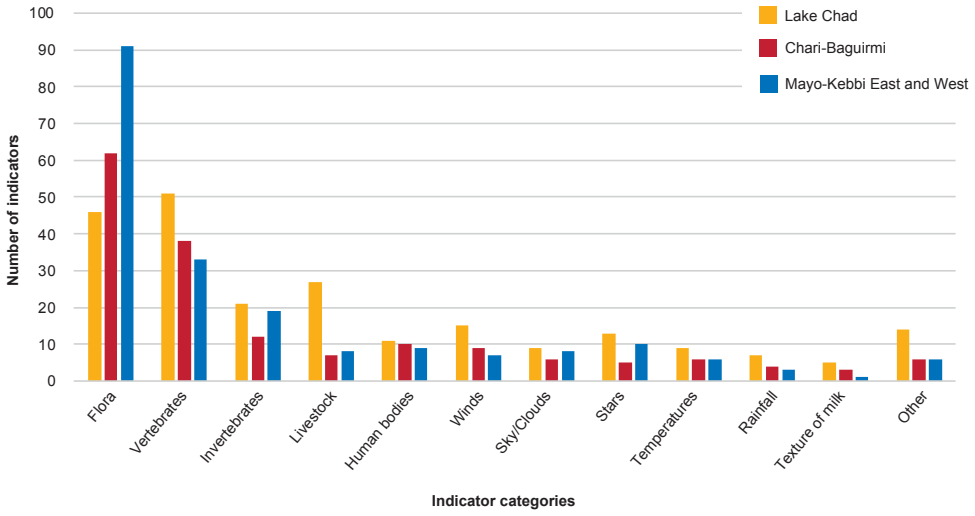

Figure 7: Comparison of the number of indicators used by communities in the three regions of Chad, sorted by category.

The distribution of roles for weather forecasting within the Mbororo Fulani community reflects a collective approach to environmental stewardship and survival, where each member's observations and knowledge contribute to the well-being of the entire community. Each member of the community (men, women, elders, youth, chiefs, spiritual leaders, herders, scouts, etc.) develops distinct knowledge about weather and climate, due to the role each person holds, particularly:

- **Elders** generally have more information and experience. Moreover, their observations, which are deployed over the long term and over large geographical areas, constitute a diagnosis of the evolution of climate and biodiversity on significant temporal and geographical scales.

- **Herders** pay attention to a multitude of elements in their environment to gather information that can be used to forecast and predict conditions for the movement of herds and communities.

- To move around, the Mbororo also rely on the knowledge of the **Modibo (religious expert)** about the stars and what they indicate about the changing seasons.

- **Women** develop knowledge and understanding of the seasons that complement those of the men. The security of the household relies on this knowledge, especially when the men go on transhumance. For example, women have extensive knowledge about the seasonal availability of certain foods and medicinal plants.

Particular attention must be paid to the participation of youth. In many communities, they are becoming detached from the traditional dynamics of knowledge transmission and engage themselves more outside the communities, showing little interest in Indigenous knowledge.

3.3 Information gathering, diffusion and decision making

The results of the research show a strongly collective dimension in traditional knowledge and decision making. Some institutions play a key role in the collection, interpretation and diffusion of weather forecasting information. Each movement represents an investment by the community, and environmental information is thus carefully analyzed by local experts (usually elders and chiefs) to ensure the success of transhumance movements.

At these meetings, available information is shared and interpreted according to many variables to decide how best to manage the livestock and the community, and how to reduce risk. These meetings allow for the anticipation of actions to be taken on a yearly or shorter-term basis. These exchanges play a central role in decision making, but also in the evolution of knowledge and innovation, which is fundamental in the context of accelerating climate change and increasing uncertainty.

Based on these elements, transhumance routes are identified. Before moving, a scout leaves the community a few days in advance to identify areas likely to meet the needs of the livestock. The aim is also to identify staging areas with sufficient water and good grazing for the rest of the season, and to ensure that conditions are conflict-free. This practice is a considerable source of information for forecasting and adapting strategies. These expeditions can take place throughout the year. The strategies and prospects for mobility are therefore the subject of constant attention on the part of the herders, even outside transhumance periods.

As in most nomadic pastoralist societies, these exploratory networks are a key element in the collection and diffusion of climate information. These networks for information collection and diffusion should be given special consideration as this Indigenous knowledge is critical to understanding and monitoring climate change and adaptation.

Participatory mapping was conducted with Lake Chad communities on transhumance periods during the 2015-2016 and 2016-2017 dry seasons. These initial results reveal the flexibility of the communities, depending on the quality of the seasons and the resulting availability of pasture. This work also allows for a spatialized representation of the areas covered and the regions visited during a year.

Figure 8: Mbororo Fulani herders in the Lake Chad region (©Louis Dorémus / UNESCO).

3.4 Adaptation and climate change

The results of this work demonstrate the intrinsically adaptive character of Mbororo nomadic and semi-nomadic communities. Through their understanding of seasonal cycles, their detailed knowledge of the territory and their mobility strategies, nomadic communities are able to reduce the risks associated with the high climatic variability of the arid and semi-arid environments they occupy. Drought is a significant risk among these. Their knowledge enables them to anticipate water scarcity, its duration and potential severity, and the geographical extent of its impact. Based on these forecasts, farmers develop strategies throughout the year to prepare for drought, such as storing feed or conducting exploratory missions. Utilizing their knowledge of different climates, microclimates, and ecosystems, these communities spatially distribute the use of pasture and water to ensure sustainable resource management and preserve the natural balances they depend on.

Due to these adaptive strategies through mobility, nomadic communities experience climate hazards differently from sedentary farming, fishing or urban populations. Community-based research reveals a perceived impact of climate change. Herders' observations include changes in season lengths, rainfall quality, and grazing. Climate and ecosystem changes also impact the knowledge of these communities. Some indicators once used by pastoralists have become less reliable, creating a global impression of environmental disruption.

> *"Our travels are seasonal and allow us to rationalize natural resource management on a seasonal and annual basis. Understanding the life and cycles of water, pasture, livestock, and the land of men and women, enables us to know exactly when and how much of the different types of water, pasture, livestock – goats, cows, camels – land and people need to be mobilized based on the expected weather. This decision depends on several factors, including the severity of weather. Like other pastoral peoples on the continent, we Mbororo have knowledge of biodiversity, climate resources and their cycles. This is linked to the implementation of diversification and management strategies at different temporal and spatial scales."* **Hindou Oumarou Ibrahim**

However, while communities recognize climate change as a challenge, they generally feel capable of adapting but they face obstacles that reduce their potential for resilience. Land grabbing, cultivated area expansions that force herders away during their passage, and the closure of transhumance corridors significantly reduce community mobility. Insecurity along transhumance routes and inter-community conflicts also pose major and growing threats.

Figure 9: Cattle around a waterhole in the Lake Chad region (©Louis Dorémus / UNESCO).

3.5 Conclusions from participatory research

The Mbororo Fulani communities' daily observations accumulated over generations, consider a wide range of environmental elements, including animal behaviour and migrations, plant phenology, wind and cloud characteristics, and star movements. Through this holistic view, these communities perceive the close interaction between all elements of their environment. This knowledge of natural cycles and signals is essential for these communities, as it directly impacts their way of life, transhumance routes, diet, activities, relationships with other communities, and other aspects.

An analysis of all documented knowledge was carried out within the project framework to present the knowledge of these seasonal cycles in a consolidated and visual manner. Seasonal calendars integrate most of the knowledge documented in the project and relate the seasons, indicators and transhumance strategies adopted. **Figure 10** presents an **overview of these visual representations**. These calendars were submitted to the communities for validation and ownership. This visual format for representing Indigenous knowledge has been a catalyst for community-based research, allowing for the completion and deepening of documented knowledge. The presentation

of knowledge in this format also provided a platform for exchanges between knowledge systems (see section 3.2.). While these visual documents are a key tool for participatory and transdisciplinary work, they remain a synthesized and simplified translation of complex, dynamic and collective knowledge systems.

Indeed, while community-based research reveals the considerable wealth of knowledge these communities possess about their environment, it also highlights **a complexity linked to their local, cultural, collective and evolving dimensions**. The research thus emphasizes the sometimes-significant differences in knowledge and practices from one community to another or within each community, notably through different seasonal subdivisions, the indicators used, transhumance strategies, the diversity of knowledge according to roles, and the processes of interpreting indicators and making decisions.

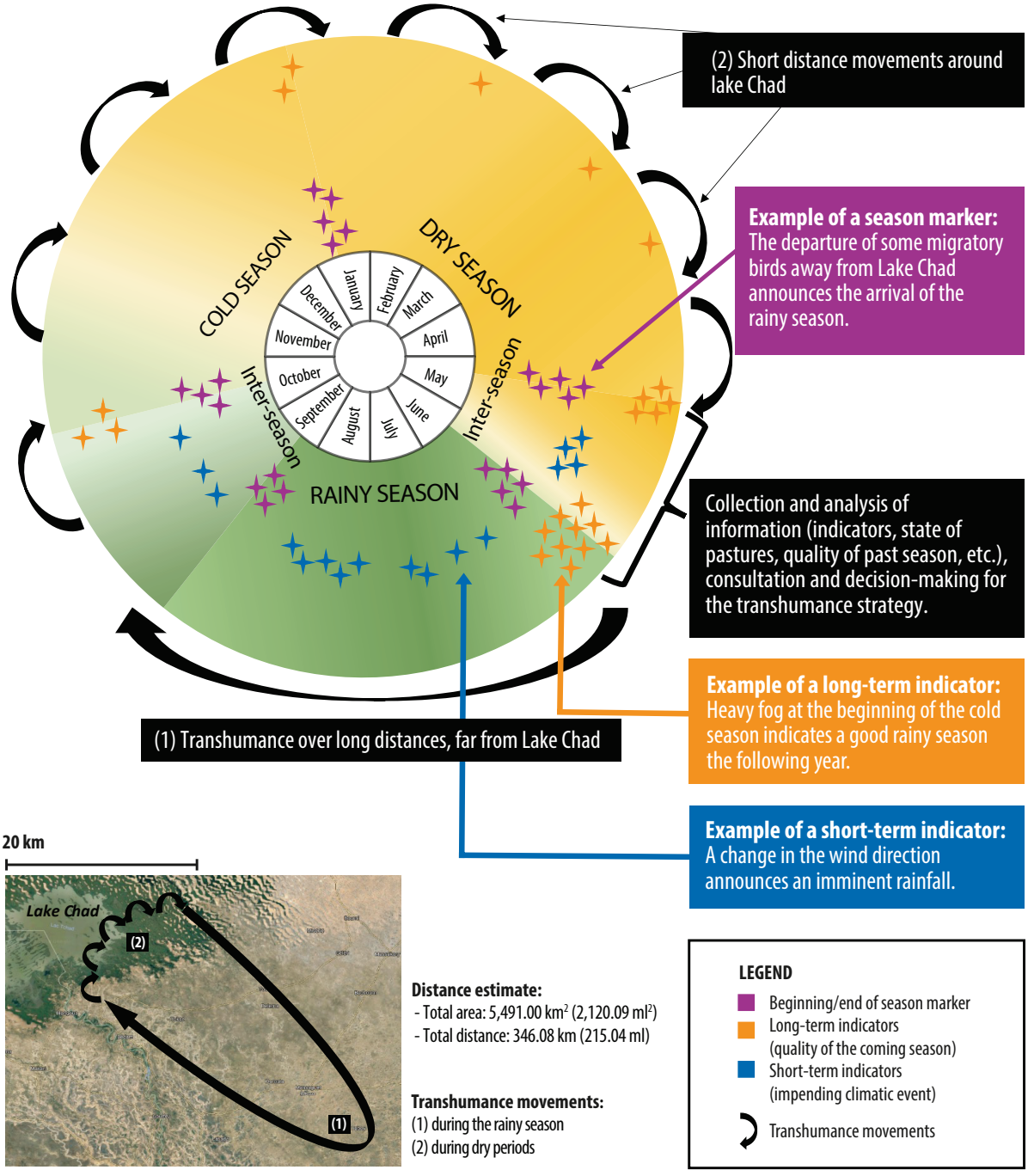

Figure 10: Overview of a visual and integrated representation of Indigenous seasonal calendars, indicators and transhumance strategies of Mbororo Fulani communities in the Lake Chad region.

Chapter IV
Initiating dialogue between knowledge systems

4.1 Early exchanges and inventory of similarities between knowledge systems

4.1.1 Comparison between scientific and Indigenous knowledge systems

The various transdisciplinary meetings organized by the project have facilitated exchanges between nomadic communities and the scientific community regarding their respective environmental knowledge and methods for forecasting weather and climate.

The preliminary results of the community-based research work were used to present seasonal calendars, indicators and practices for decision-making and community adaptation. In return, representatives of various meteorological institutions presented existing products and services, particularly for monitoring pastoral campaigns and supporting herders. These institutions and agencies (ACMAD, AGRHYMET, ANAM) provide numerous weather and climate services and monitoring, particularly for rural communities. These services concern short (1 day to one week), medium (monthly), or long term (seasonal) precipitation forecasts. Meteorological bulletins applied to different themes (health, pest development, risk of bushfires, etc.) are also produced. In addition to various seasonal forecasts, tools, primarily satellite-based, are available to inform farmers about water presence, forage production, and bushfire risks. Important issues of data management and meteorological station maintenance have been raised.

These exchanges have enabled the establishment of connections between the different methods of producing knowledge and the identification of many similarities, particularly through the consideration of parameters whose evolution provides indications of future climate events (e.g., ocean surface temperatures for scientists, biological or abiotic indicators for communities). Similarly, a parallel has been drawn between the procedures for consultation between experts to determine projections based on observations and in a collective manner. Similar processes of considering past observations to inform the interpretation of future events (scientific models, memory of elders) can also be noted.

Figure 11: Dialogue between scientists and Mbororo communities around seasonal calendars (N'Djamena, 2018) (©Louis Dorémus / UNESCO).

4.1.2 Community use of scientific forecasts

During the meetings organized by the project, part of the discussion between representatives of nomadic communities and meteorologists focused on the communities' use of various weather and seasonal forecasts and bulletins from meteorological agencies. Weather information is not necessarily unknown to communities and is considered in decision-making for mobility and adaptation strategies. **Nevertheless, several barriers to using this information have been identified**:

- **Access to information:** Nomadic communities are not always equipped to receive forecast bulletins, which require the use of radio, Internet, telephone, computer or other equipment. Identifying channels or the acquisition of appropriate means of communication appears necessary.

- **Comprehensibility of information:** Forecasts are not disseminated in the Fulani language, and even if the language used is sometimes understood, written form dissemination also poses a problem as community members are not always able to read or write. Additionally, the information is disseminated in a language that is sometimes too technical or scientific and difficult to understand.

- **Reliability of information:** Data disseminated often have a level of uncertainty, making it risky to take decisions based solely on this information. This uncertainty may result from limited resources (stations, instruments, computer tools, etc.) specific to the Sahel region, or it may be linked to the state of scientific knowledge and models related to the area's climate.

- **Accuracy of information:** Rainfall forecasts and seasonal quality projections are crucial for decision-making, but these predictions are frequently given at scales too large for farmers who require information on more localized sites. Furthermore, while satellite imagery is essential for identifying watering holes or grazing areas, the resolution of the observations is sometimes too broad for accurate and reliable identification.

- **Relevance of information:** Meteorological agencies primarily focus their projections on the rainy season as they mainly target farmers. In contrast, nomadic communities rely on forecasts made throughout the year, including dry periods. This issue of relevance was highlighted regarding rainfall forecasts based on average rainfall amounts over a given period. Mbororo communities need to know the "quality of rainfall", such as its distribution in time and space, the type of rain expected, etc. Another example is data on forage production and pasture conditions, derived from satellite observations, which can only identify the presence of vegetation. However, nomads need to ensure the presence of plant species that their livestock can feed on.

The causes of this restricted use of meteorological data by Indigenous communities can be grouped into three broad categories:

- **Lack of resources from meteorological services,** mainly affecting the reliability and accuracy of information;

- **Inadequate consideration of the specific needs of nomadic communities**, primarily impacting access, comprehensibility and relevance of information;

- **Limitations of current scientific knowledge about the atmospheric and climate functioning**, mainly affecting reliability, accuracy and relevance of information.

These barriers highlight the need for increased collaboration between meteorological agencies and nomadic communities to tailor scientific information to local needs and make this data more accessible and understandable for nomadic pastoralists. One goal of the dialogue between nomadic communities and scientists is to identify solutions to these problems. Community-based research has shown that communities can monitor and predict weather and climate changes and adapt accordingly. To fully appreciate Indigenous knowledge, **it is essential to view nomadic pastoralist communities not as mere users of meteorological services but as actors who produce relevant and reliable information crucial to their lifestyles and their adaptability**.

While the first exchanges allowed the development of knowledge and interest of Indigenous communities in meteorological products and their potential improvement, the scientific community's interest in the Indigenous knowledge's potential was not immediate. It was during these exchanges that collaboration perspectives for genuine co-production of knowledge emerged, notably through community research contributions and opening discussions to other countries involved in the project.

4.2 Opportunities for discussion between knowledge systems

Transdisciplinary exchanges between nomadic communities and scientists have identified numerous solutions and highlighted a strong potential for improving forecasts and strengthening nomadic communities' adaptation.

4.2.1 Development of accessible and usable services for communities

Exchanges between nomadic communities and scientists have identified the need for meteorological services to understand and consider communities' real needs for climate information.

The dialogue between communities and scientists is seen as an essential element for improving meteorological agencies' services, allowing for a better understanding of pastoral activity challenges and nomadic lifestyles.

The issue of accessibility and comprehensibility of climate information is central to ensuring information use. Identifying **the most appropriate communication channels is necessary for establishing an operational link between nomadic communities and meteorological agencies** and guaranteeing information dissemination and reception.

In particular, the project has enabled reflection on the **use of satellite technologies for remote sensing** of biomass, which can provide real added value to support local grazing management strategies and ecosystem management methods related to transhumance. Meteorologists and agrometeorologists are currently using these technologies to support herders in identifying potential grazing areas. The information generated by this type of technology is potentially useful for Mbororo communities, but there is still a need to better link this information to the specific criteria and logic of the herders in their choice of mobility. For the Mbororo, the choice of transhumance routes and locations is made based on the characteristics of different grazing areas, their food properties, their renewal capacity, the type of livestock they own, as well as

inter-community agreements for grazing management. All these elements are analyzed at length by Indigenous institutions, with the aim of ensuring comprehensive community management of these areas, according to annual and multi-year seasonal cycles. **Transdisciplinary work is therefore needed to enrich scientific information so that it can be more easily used by herders in their decision-making regarding grazing routes and locations**. The continued and active participation of Indigenous experts in processing this information is essential, to ensure that the technologies strengthen the future capacities of these peoples to manage their territories and the biodiversity they host, in the context of climate change.

4.2.2 Raising awareness in the scientific community and promoting Indigenous knowledge

The presentation of community-based research results at various meetings helped to raise the value of Indigenous knowledge in the eyes of the scientific community and revealed a relatively limited awareness of the extent of this knowledge and its potential for adaptation. This awareness-raising work is essential for dialogue and allows each party to better understand the potential and limitations of the other's knowledge. It also contributes to strengthening the links between scientists and Indigenous communities by eliminating preconceived ideas and potential power relations. The presentation of this work has made it possible to highlight a body of existing knowledge that is actively used and directly informs adaptation measures at the community level.

The development of visual approaches, using seasonal calendars that synthesize the results of community-based research, has played an important role. These graphic representations were particularly interesting for understanding the similarities and differences between knowledge systems and identifying phenomena that could generate discussion.

Particular attention must be paid to the fact that Indigenous knowledge is created in a specific environmental and social context and follows its own logic. There is a need to increase scientists' awareness of these other knowledge systems, their mode of subsistence and production as well as their potential to ensure that once shared, this Indigenous knowledge is correctly interpreted.

One example is the risk of misinterpretation of indicators used by Mbororo communities to project future weather conditions and adapt their movements and activities. The use by communities of indicators like those considered by meteorological sciences (temperature, wind, cloud cover, etc.), as well as other indicators (biodiversity, movement of stars, etc.), suggests interesting synergies between knowledge systems. Nevertheless, the **interpretation of indicators used by communities is complex and is a dynamic and collective process**. Work on these indicators that does not consider their original matrix could lead to an erroneous understanding of the information derived from them. This knowledge is also long-term and is related to environmental and climatic phenomena observed in the environment over the past years and sometimes over several generations. The flowering of a tree, for example, will be understood by the herders according to the way it took place last year.

In this sense, research has also demonstrated the **importance of social, cultural and linguistic anchoring of traditional knowledge in the Mbororo Fulani communities**. This knowledge is recorded and transmitted to new generations primarily orally through the local language with words – such as the names of seasons – linked to precise and operational concepts. The Mbororo communities' knowledge about their environment is also a constitutive part of the social relationships they maintain within their communities and with groups with whom they share the territory. This knowledge informs kinship ties, local loyalties, cultural values, beliefs, trust relationships and the configuration of reputation. Indigenous Peoples' knowledge is rooted in social interactions that rarely involve writing, but instead rely on observation, learning by doing, songs, rituals, dances and stories. This knowledge results from dynamic processes that ensure its accumulation, transmission and improvement, and opening the door to innovation. **Thus, Indigenous Peoples' knowledge of climate is not concentrated in one place or person but is embedded in the daily activities of the entire community**.

The various meetings organized have helped raise awareness of this complexity among scientists. The training of scientific personnel involved in transdisciplinary dialogue initiatives is a long-term and essential process to be implemented upstream throughout these activities. In turn, representatives of Indigenous communities involved in transdisciplinary dialogue also need training and understanding of the main principles and functions of modern science.

4.2.3 Co-production of knowledge

The project was able to demonstrate the benefits of dialogue and to explore avenues of collaboration for improving weather services for pastoral communities, as well as for enhancing existing Indigenous knowledge sets and practices actively used by communities for adaptation. However, the project also explored prospects for cross-system collaboration for the co-production of knowledge for a better understanding of climate change.

a. Improving climate assessments

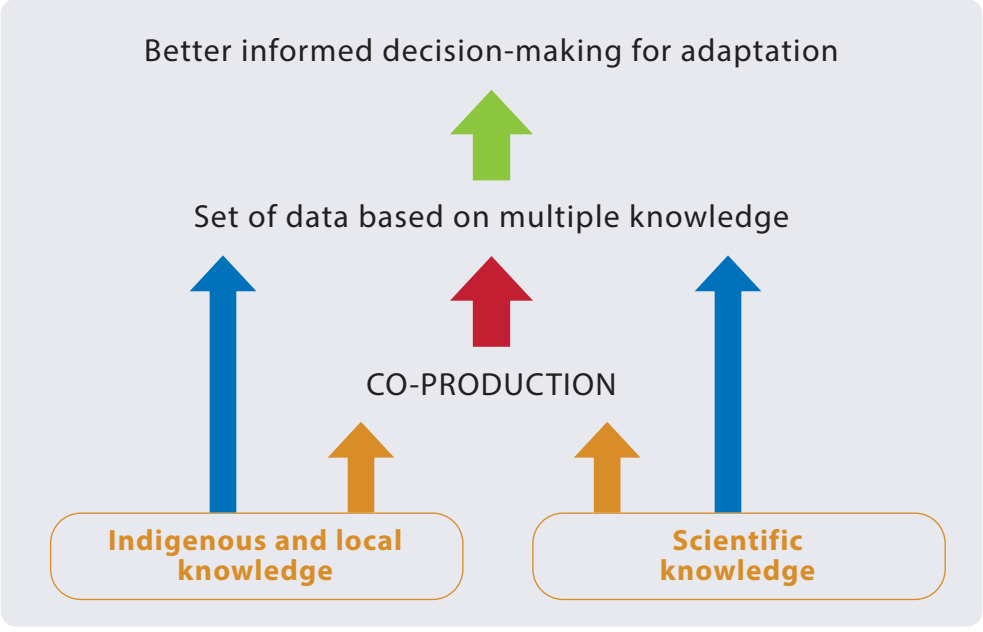

Figure 12: Coproduction process involving Indigenous, local and scientific knowledge systems (source: UNESCO).

Community-based research has revealed the vast wealth of traditional knowledge of the Mbororo Fulani nomads and their detailed knowledge of the environment in which they live. This knowledge constitutes a considerable reservoir of information on climate functioning at different scales and its evolution over several generations. The intersection of Indigenous and scientific knowledge could significantly improve assessments of climate change and its impacts.

The contribution of Indigenous knowledge to these assessments appears even more important as the Sahel zone has historically been, and remains today, poorly covered by scientific observations. The network of in situ scientific observation stations is small and scattered over a vast territory particularly affected by climate change. The contribution of traditional knowledge to these assessments is also relevant because the territories assessed are occupied by populations that contribute to their monitoring and management.

Finally, traditional knowledge is **operational knowledge that guides the adaptation strategies of communities every day**. Taking it into account in the assessment and in the definition of policy recommendations is a strong argument in favour of strengthening the joint work between science and traditional knowledge.

b. Increased understanding of the link between biodiversity and climate

The results of the community-based research highlighted the holistic approach of Mbororo communities in their observations and understanding of their environment. In particular, the use of indicators mostly related to the observation of biodiversity to predict weather and seasons appeared to be an especially interesting element during transdisciplinary exchanges.

The continuation of documenting Indigenous knowledge and exchanges with the scientific community will allow further exploration of this aspect. In this respect, strengthening the interdisciplinary aspect of science in the dialogue between knowledge systems appears necessary. This work would notably enable linking meteorologists, botanists, ecologists and ornithologists, as well as identifying complementarities between disciplines, filling certain current gaps in the sciences by improving knowledge on the links between climate change and biodiversity erosion.

c. Study of climate at the ecosystem and landscape scale

The knowledge of the Mbororo communities is developed based on observations of local events considering all the components of their environment. This local approach and the consideration of most elements from biodiversity (see previous paragraph) imply **an understanding of climate based on ecosystems**. Moreover, the work carried out in Chad as well as in other States involved in the *Knowing our Changing Climate in Africa* project, have highlighted the knowledge of Indigenous communities on **the influence of landscapes and landforms on climates and microclimates**. These approaches offer particularly interesting prospects for **developing knowledge of climate variability at a finer scale** than that generally adopted by weather and climate sciences, which focus on the study of land masses and the ocean at larger scales. Work in this area could lead to improved projections and the development of forecasts at an operational scale for nomadic herders.

It should also be noted that, because of their great mobility, nomadic herders apply a localized approach to seasonal forecasting over territories that sometimes extend over several hundred kilometres. For example, transhumance movements can take herders as far as the Democratic Republic of Congo, nearly one thousand kilometers from Lake Chad. On these routes, they cross a wide variety of ecosystems, landscapes and climates. As part of the UNESCO project *Knowing our Changing Climate in Africa*, exchanges at the regional platform level where Indigenous nomadic pastoralist peoples from West, Central and East Africa come together to share their knowledge of climate have also highlighted their ability to develop innovative information and approaches that can be applied on a large scale. Based on the experience of these platforms, knowledge related to the migration of certain birds, the behaviour of animals, or the shape of clouds in different territories was selected for its potential to develop knowledge that would allow the **production of climate information on a regional scale**.

d. Ecosystem-based resource management and climate change mitigation

Community-based research has shown that Mbororo herders have developed management methods that are concerned with the preservation of resources such as

water, pasture and the ecosystems on which they depend. The climatic projections that they can elaborate on are largely linked to the observation of the evolution of ecosystems. Additionally, the work also shows detailed knowledge of climate variations according to landscapes and ecosystems. The management model of the Mbororo Fulani thus seems to be based on a detailed knowledge of ecosystems and climate and their mutual interactions. By developing sustainable management strategies for the natural environments on which they depend, Mbororo pastoral communities are likely to guarantee the balance of ecosystems as well as the stability and mitigation of climate change.

> *The deepening of these links between ecosystems and climate, along with the potential role of pastoral communities in the maintenance of ecosystems and the mitigation of climate change, constitutes a transdisciplinary work area with high stakes for adaptation policies.*

Chapter V

Dialogue with policymakers

The work conducted by this project with Mbororo Fulani communities in Chad has contributed to a better understanding of Indigenous Peoples' knowledge of weather and climate, their evolution in the context of climate change, and the adaptation strategies put in place. This work has highlighted the importance of inclusive community-based approaches to building informed engagement of Indigenous Peoples and scientists on this shared problem. The community-based, participatory and transdisciplinary approach is a fundamental pillar for producing sound, timely and policy-relevant information on climate change adaptation.

Nevertheless, to ensure that Indigenous knowledge can feed into national and international efforts in this area, it is necessary that community-based research approaches and transdisciplinary exchanges find support and a relay in national policies. **It is from this perspective that during the various meetings organized by the project, government representatives and national or international agencies involved in climate change adaptation policies were invited to participate in the discussions and provide feedback**. As early as the 2011 regional workshop, the presence of the Minister of Urban and Rural Hydrology and the Minister of Agriculture and Irrigation allowed for political representation at the highest level of the N'Djamena Declaration formulated on that occasion and laid the foundation for the commitment of all actors, including political decision-makers in this process. During the N'Djamena meeting in 2016, the exchanges between scientists and communities also led to the identification of a first shared roadmap on solutions for strengthening transdisciplinary dialogue and adaptation. This roadmap was presented at the close of the meeting to a high-level panel bringing together representatives of several Chadian ministries.

In parallel to the transdisciplinary exchanges, the project facilitated several meetings with key actors of adaptation policies, both at the national and international levels. In particular, the project explored concrete possibilities for integrating the results of community-based research. In Chad, key documents

in the field of adaptation, especially the National Adaptation Program of Action (NAPA, 2010), reflect an emerging recognition of the relevance of certain pastoral practices such as transhumance, for climate change adaptation. In this perspective, the project has contributed to strengthening this recognition as well as the capacities of the various partners to implement concrete projects in this area.

To seize opportunities for collaboration at the policy level, the project partners organized meetings with Chadian government officials at both the local and ministerial levels. These exchanges helped to raise awareness among the national government and international agencies about the capacities of nomadic pastoralist communities to implement Indigenous knowledge-based initiatives for adaptation. The importance of the involvement of Indigenous communities and the dialogue between knowledge systems for adaptation was demonstrated to decision makers. Concrete applications were identified in policies related to:

1. Strategic planning for the prevention of disasters,
2. Management of inter-community conflicts,
3. Land and transhumance corridor management,
4. Sustainable natural resources management.

In addition, representatives of international organizations working in the field of Indigenous and local knowledge for adaptation have also collaborated in this project initiated and led by UNESCO, so that these advances can be coordinated with the agreements made by the international community in this area. Among the participants involved, we can mention the Adaptation Programme and the secretariat of the Platform of Local Communities and Indigenous Peoples of the UNFCCC, as well as the World Meteorological Organization, with whom this project was designed.

Figure 13: Movement of livestock in the Lake Chad region (©Louis Dorémus / UNESCO).

Chapter VI
Conclusions and recommendations

6.1 Project conclusions

Community-based research has highlighted the richness of the knowledge systems of the Mbororo Fulani communities on weather and climate. Through their observations and interactions with their environment, these nomadic communities have developed specific and operational taxonomies that reflect a holistic and integrated vision of the environment. This knowledge represents a considerable source of information for monitoring, understanding, and evaluating the evolution of climate and biodiversity at the ecosystem scale. Accumulated over several generations, this knowledge covers long periods of time, making it possible to study the evolution of climate over the long term in vast and difficult-to-access Sahelian zones. Deeply rooted in the culture and language of the communities and based on dynamic and collective processes, this knowledge and the practices that stem from it underpin the intrinsically adaptive nature of the nomadic and semi-nomadic lifestyles of these communities. The documentation and appreciation of this knowledge – long underestimated or undervalued – take on greater value as a result of community-based research which contributes to the community members' confidence in their ability to understand and adapt to their environment.

The community-based research conducted under this project has strongly supported efforts to initiate dialogue between Indigenous communities and scientists. Exchanges between knowledge systems have shown the importance of considering the specific problems and dynamics of nomadic pastoralist activities. As such, improving the relevance, quality and access of users to information for adaptation is a major incentive for maintaining dialogue between nomadic herders and scientists. Community-based research and the dialogue initiated between knowledge systems also show that Indigenous communities are not only consumers of meteorological

information but have their own knowledge and methodologies. The continuation and perpetuation of the dialogue could allow for a true co-production of knowledge in order to have the best available knowledge for adaptation. In particular, the dialogue between knowledge systems opens perspectives for improving our understanding of (1) climate and its evolution, (2) the link between climate and biodiversity, (3) the study of climate at ecologically or socially relevant scales such as landscapes and ecosystems, and (4) solutions for adaptation and ecosystem-based management of natural resources. Pursuing this dialogue and exploring its potential requires a sustained, interdisciplinary commitment and is an opportunity to break down barriers and strengthen complementarities between different scientific disciplines.

This research project demonstrated the value of a community-based participatory research approach to better understand the nature of these knowledge systems and ensure their inclusion in climate change adaptation initiatives. The transdisciplinary approach allowed for the active participation of knowledge holders at all stages of the research and exchanges with the scientific community. This approach has given Indigenous knowledge holders a more active role in the initiatives put in place. The participatory approach has made it possible to verify the relevance of the project for the communities and to better articulate the research with the problems and needs they have identified. In addition to climate change, many other interconnected issues were identified and taken into consideration, including biodiversity loss, land rights, food security, sustainability of livelihoods, and transmission of their knowledge.

By being part of a process that spans nearly a decade, this project demonstrates the importance of a sustained dialogue to establish links of trust and proximity between all actors involved – Indigenous and local communities, scientists, decision-makers and other partners. The results of the work initiated by this project in terms of community-based research and dialogue between knowledge systems open major perspectives for the development of adaptation policies. In particular, these results have concrete applications for policies on (1) strategic planning for natural disaster prevention, (2) management of inter-community conflicts, (3) management of land rights and transhumance corridors, and (4) sustainable management of natural resources. In this perspective, the continuation of the work initiated by this project, the perpetuation of the dialogue between knowledge systems, and their inclusion in adaptation policies depend on a significant political commitment.

6.2 Recommendations

Based on these conclusions and with a view to strengthening the valorization and consideration of Indigenous knowledge, the following recommendations have been identified:

- **Continue community-based research** on the knowledge of Indigenous Peoples in their diversity and ensure long-term follow-up, including year-to-year comparison of forecasts and strategies adopted.
- **Build the capacity of Indigenous communities** to conduct community-based research, improve their understanding of scientific knowledge, and bring their messages to scientific and political actors.
- **Train and educate scientists** to better understand Indigenous Peoples' knowledge and its potential for climate understanding, prediction, and adaptation, by, for instance, strengthening training of scientists on Indigenous Peoples' knowledge, such as through dedicated academic modules or by developing work on visual representation of seasonal calendars and other elements as part of the community free, prior, and informed consent (FPIC) process.
- **Strengthen the inclusion of Indigenous Peoples' knowledge** in climate change and impact assessments, as well as in the development of adaptation and mitigation policies.
- **Develop knowledge co-production initiatives and programmes**, for example through the development of transdisciplinary global change observatories and joint seasonal forecasting, and encourage collaboration between Indigenous Peoples' traditional knowledge and modern science.
- **Strengthen the representation of several scientific disciplines** in the dialogue between knowledge systems, such as, for example, biologists, ecologists, geographers, hydrologists, anthropologists, linguists.
- **Perpetuate the dialogue between knowledge systems**, through the institutionalization and mediation of relations between Indigenous communities and scientific agencies.
- **Strengthen the participation of Indigenous communities** at all levels in the processes of inter-system dialogue and in the definition of adaptation and mitigation policies by respecting the principle of free, prior and informed consent of communities.
- **Ensure that ethical principles**, Indigenous **community rights**, and **gender issues** are considered in the development of research programs, adaptation policies, and knowledge co-production initiatives.

Through the UNESCO project *Knowing Our Changing Climate in Africa*, Indigenous Peoples' organizations, such as the Association des Femmes Peules & Peuples Autochtones du Tchad (AFPAT), together with other national, regional and UN partners, have been actively engaged in a UNESCO-commissioned six-year community-led research project across Burkina Faso, Chad, Ethiopia, Kenya, Tanzania, and Uganda. The initiative aimed to harness the deep traditional knowledge of pastoralist communities regarding weather and climate to enrich the science-policy dialogue processes in Africa.

The research has unveiled a wealth of traditional forecasting capacity, including seasonal calendars and indicators for precipitation. Language-specific taxonomies provide Indigenous communities with frameworks for climate analysis, variability, and change over extended periods.

This publication features the Mbororo Fulani of Chad, showcasing how nomadic herders in the Lake Chad region successfully adapt to changing environmental conditions through traditional knowledge, particularly in predicting weather changes and adjusting their herds' movements. The collaborative study underscores the importance of including Indigenous knowledge systems and their sustainable practices into climate change strategies. It also advocates for collaborative efforts between Indigenous Peoples and scientific experts, including meteorologists, fostering a co-creation of knowledge to enhance understanding and inform environmental policies.

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