Council of Ministers

Higher Council for
Environment and Natural Resources.

Sudan's First Biennial Update Report

January 2022.

REPUBLIC OF THE SUDAN

Council of Ministers

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Khartoum

January 2022

Foreword

It is with great pleasure that I present the First Biennial Update Report (BUR) of Sudan to the United Nations Framework Convention on Climate Change (UNFCCC). The BUR contains updated information on progress made by Sudan in meeting its climate obligations. I am especially pleased to highlight the collective efforts of the many Sudanese experts, women and men, representing over 35 institutions in preparing this report.

Recent scientific findings published by the Intergovernmental Panel on Climate Change in its Sixth Assessment Report (2021), have validated the very climate impacts that Sudan has been increasingly witnessing, particularly over the past few years, including extreme heat waves, heavy rains and flooding events. The floods of the year 2020 were unprecedented in the more than 100 years of records of the River Nile, causing loss of lives and serious damage to properties - both settlements and agricultural assets - of thousands of people almost everywhere in Sudan.

Sudan strongly supports international efforts directed to reducing greenhouse gas emissions in pursuit of the objectives of the UNFCCC and 2015 Paris Agreements.

Prime Minister of Sudan
Chair of the Higher Council for Environment and Natural Resources

Preface

Climate change poses a significant threat to Sudan natural resources, economic development, and the health and livelihood of its people. Climate change is not merely an environmental issue defined by precipitation and temperature changes; it represents a serious sustainable development problem that affects everyone in our country, particularly those in rural communities who are the most vulnerable.

In fulfilment of its obligations as a Non-Annex I signatory Party to the United Nations Framework Convention on Climate Change (UNFCCC), Sudan has previously submitted National Communications in 2003 and 2013, following the Guidelines stipulated in Decision 2/CP.17. Sudan had also implemented various policies and measures to fulfil its obligations towards the international community and actively participates in international cooperation and regional climate change initiatives.

It is with great pleasure that I present Sudan's First Biennial Update Report. The report has been prepared in a highly participatory process involving more than 40 national experts affiliated with more than 15 institutions from government, academia, research centres, civil society institutions and the private sector. Sudan's First Biennial Update Report advances Sudan preparations for implementing the Enhanced Transparency Framework of the Paris Agreement where the Biennial Update Report will be replaced by a Biennial Transparency Report.

On behalf of the Government of Sudan, I would like to acknowledge the financial support of the Global Environmental Facility (GEF) though the implementing agency, the United Nations Development Program (UNDP); both are owed a special vote of thanks and sincere appreciation for their support throughout the duration of the project.

Secretary General,
Higher Council for Environment and Natural Resources

Acknowledgements

Motivation and commitment have always played a key role in the success of any venture. Successful completion of any type of project requires support from a number of persons and institutions. This report has been prepared through a collaborative process and has greatly benefitted from the contributions of numerous institutions, national and international experts, without whom it would not have been possible to complete this report.

I would like to acknowledge with much gratitude the crucial rule of the National Climate Change Committee for the wise guidance they provided in support of the implementation of the project.

My deep thanks and gratitude go to our national consultants and the members of the technical committee for the Greenhouse Gas Inventory for their enthusiasm, dedication, patience and commitment to the successful achievement of their assigned tasks and activities.

I am greatly indebted for the international consultants who provided the needed technical support and backstopping to the various themes of the report.

I am extremely grateful to Professor Rashid Makki Hassan, the Secretary General of the HCENR who provided his full support and guidance throughout the project.

I am also grateful to Mr. Nagmeldin Goutbi Elhassan, the government project coordinator for his valuable support and technical advice.

Special thanks to Mr. Khalid Ahmed Ali, the project accountant and Mrs. Mona Omer Alhadary, the project secretary, for their tremendous help and assistance with managing the project to its successful conclusion.

I would like to present my warmest thanks and gratitude to all colleagues and staff of HCENR for the support they provided to the various activities of the project, they really deserve special thanks and appreciation.

Last but not least, I would like to express my sincere gratitude and recognition of UNDP colleagues, for their continuous support and valuable guidance to the project implementation.

Rehab Ahmed Hassan
National Project Manager,
Higher Council for Environment and Natural Resources

Contributors

National Climate Change Committee

Prof. Rashid Makki Hassan	Secretary General, HCENR
Dr. Osman Omer Abdalla	Forests National Corporation
Mr. Khalid Mohieldeen Ibrahim	Ministry of Industry
Mr. Ali Mohamed Ali	Sudanese Environmental Conservation Society
Dr.EltaybDafalla Ahmed	Ministry of Energy and Petroleum
Dr.Yahya Ali Sabil	Ministry of Animal Resources.
Ms.HananMagzubRabbah	Sudanese Meteorological Authority
Amb.MohamedYosif Ibrahim	Ministry of Foreign Affairs
Prof. ZeinabAbdalrahim Osman	National Center for Research
Mrs.Ikhlas Mohamed Ali	Ministry of Finance and National Economy
Prof. MigdamElshaikhAbdelghani	HCENR
Dr.Elsiddig Mohamed Elobaid	Ministry of Finance &National Economy
Prof. Mona Mahjoub Mohamed	Institute for Environmental Studies
Dr.SawasanKhairelseedAbdelrahim	Ministry of Agriculture & Forestry
Dr.Sayeda Ali Ahmed Khalil	Forests National Corporation REDD+ Project
Dr.Bushra Hamid Ahmed	Higher Council for Environment, Urban and Rural Development.
Mrs. Sana Mahmoud Abdalla	Ministry of Energy and Petroleum
Dr.Nouralla Ahmed Yasin	United Nations Development Program

Project Management Team

Mrs. Rehab Ahmed Hassan	National Project Manager, HCENR
Mr.Nagmeldin Goutbi Elhassan	Government Project Coordinator, HCENR
Mr. Khalid Ahmed Ali	Finance Assistant
Mrs. Mona Omer Alhadary	Secretary

BUR National Consultants

Dr. Ismail Abdelrahim Elgizouli	Energy Consultant.
Dr. Mohamed Eljack Suliman	Industrial Research and Consultancy Center
Dr.Arig Jaafer M. A. Bakheit	National energy Research Center
Dr.Abdalla Gaafer Mohamed	ANSIAM Consultancy Group
Dr.Bushra Hamid Mohamed	Higher Council for Environment, Urban and Rural Promotion
Dr. Quosay Awad Ahmed	University of Khartoum Consultancy Corporation
Mr. Ammar Mokhtar Gomaha Gaber	Sudan Meteorological Authority
Ms. Asia Adlan Mohamed	Institute of Environmental Studies
Ms.TafaolEltayeb Osman	London School for Economics and Political Sciences

BUR Technical Team

Ms.Razaz Ibrahim Mohamed	The Higher Council for Environment, Urban and Rural Promotion
Mr. Ismail Elnadif Ibrahim	Khartoum State Sanitary Corporation
Ms.RashaAbdelmoniemBabiker	The Higher Council for Environment, Urban and Rural Promotion.
Ms.Hanadi Atta Elfadel	Ministry of Industry
Eng. TarigMukhtarMirghani	Industrial Research and Consultancy Center
Dr.Abubaker Ali Mahmoud	FAO Consultant
Mr.ShoroqSiddigElAmin	Khartoum University Consultancy Corporation
Dr.RatibaAbdelgadir Hag	National Energy Research Center
Ms.Safaa Ahmed Beraima	Forests National Corporation
Mr.KhaldaAbass Hassan	Forests National Corporation
Dr.Omema Ahmed Mohamed	Ministry of Animal Resources.
Mr.Alyas Ahmed Alyas	University of Khartoum-Faculty of Forestry
Ms. Sana Mahmoud Abdalla	Ministry Energy and Petroleum
Dr. Anwar Sidahmed Mohamed	Remote Sensing and Seismology Authority
Ms. Rana Mohammed Abdalla	Khartoum University Consultancy Corporation
Eng. Osama Salah Mohamed	Ministry of Energy and Petroleum
Dr.SawsanFouad Ahmed Salih	Ministry of Agriculture & Forestry

Technical Backstopping

K M Nazmul Islam	Mitigation Consultant on Energy and Waste. University of Queensland, Australia
William W Dougherty, PhD	Climate Change Research Group, Greater Boston Metropolitan Area, USA

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List of Acronyms

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BUR	Biennial Update Report
CBOS	Central Bank of Sudan
CBS	Central Bureau of Statistics
CFL	Compact Fluorescent Lighting
CH_4	methane
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
COP	Conference of Parties
DTU	Technical University of Denmark
FAO	Food and Agriculture Organization of the United Nations
FNC	Forest National corporation
FREL	Forest reference emission level
GDP	Gross Domestic Product
Gg	Gigagram, (billion grams)
GHG	Greenhouse gas
GIS	Geographic Information systems
GoS	Government of Sudan
HCENR	Higher council for Environmental and Natural Resources
HFC	hydrofluorocarbon
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on climate Change
IPPU	Industrial Processes and Product Use
IRENA	International Renewable Energy Agency
LPG	Liquified petroleum gas
LULUCF	Land use, land-use change, and forestry
MEA	Multilateral Environmental Agreement
MgO	magnesium oxide
MOU	Memorandum of Understanding
MRV	Monitoring, reporting, and Verification
MSW	Municipal solid waste
MW	Megawatts (million watts)
MWRE	Ministry of Water Resources and Electricity
N_2O	nitrous oxide
NAMA	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NASA	National Aeronautics and Space Administration
NDC	Nationally Determined contribution
NFI	National Forest Inventory
NFMA	National Forest Resources Monitoring and Assessment
NFMS	National Forest Monitoring Systems
PV	Photovoltaic
QC	Quality control

R&D	Research and development
REDD+	Reducing emissions from deforestation and forest degradation
RSSA	Remote Sensing and Seismology Authority
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TAP	Technology Action Plan
TNA	Technology Needs Assessment
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
USEIA	Energy Information Administration (US)
WB	World Bank

1. National Circumstances

Sudan (official name: Republic of Sudan) is located in between Sub-Saharan Africa and the Middle East. The country is bordered by Egypt to the north, Libya, Chad, and the Central African Republic to the west, a 1,937 km long border with South Sudan to the south, and Ethiopia, Eritrea, and the Red Sea to the east (Figure 1-1). The total land area is about 1.89 million square kilometers, making it the 3rd largest in Africa and Arab league, and 16th largest in the world. This corresponds to the land area following the separation in July 2011 into Sudan and South Sudan.

Figure 1-1:Map of Sudan. Source: Cartographic Section, Department of Field Support, UN Geospatial (Map Number: 4458)

1.1. Overview

Prior to the division of the country, Sudan was considered as the 17th fastest growing economy in the world due to rapid development from oil profits. Since then, Sudan has experienced adverse economic impacts due to the loss of oil revenue which had accounted for the largest share of exports and over 50% of governmental revenue. This has contributed to markedly less economic growth, double-digit consumer price inflation, increased fuel prices, and decreased fuel availability. In turn, this led to violent protests in 2013 and 2018/2019.

Nevertheless, Sudan is endowed with abundant natural resources including fertile lands, ample water resources, livestock, diverse forests, minerals (e.g., gold, copper), and energy resources (e.g., oil, and natural gas). Khartoum is the capital of Sudan, lies at the confluence of the White and Blue River Niles.

Sudan's population has been growing rapidly. Since 2008, the year of it last census, the estimated population has grown to 44.91 million in 2021, an average annual growth rate of about 3% over that period. Total estimatedGDP (based on purchasing power parity) in 2018 was USD 177.7 billion; USD 4,232on a per capita basis (IMF, 2021).

Sudan's integration with the world economy has improved in recent years. Comprehensive U.S. sanctions on Sudan, levied in 1997 and expanded in 2006, were lifted in October 2017. This allowed previously banned financial and trade transactions between global entities and their Sudanese counterparts. However, since December 2013, the start of the civil war in South Sudan, there has been drastically reduced cross-border oil flows which have harmed Sudan's economic prospects. Nevertheless, Sudan remains a highlyindebted country that has accumulated sizeable external debts and has been in non-accrual status with the World Bank Group since 1994, meaning loans are in default or arrears. As of the end of 2015, its external debt amounted to $50 billion (61% of its annual GDP) in nominal terms, about 84% of which was in arrears (WB, 2021).

Sudan's security situation remains fragile. More than 400,000 people have sought safety in Sudan because of the 2017 famine. Armed conflict in Sudan's westernmost region of Darfur has subsided but many parts of the region remain in a precarious security state because of the proliferation of arms and banditry. Efforts to settle other conflicts in South Kordofan and Blue Nile states are ongoing although progress is slow (WB, 2021).

The country continues to face severe environmental challenges. Primarily, these challenges are associated with an increasing variable climate has led to catastrophic floods and recurrent drought episodes. In many cases the environmental challenges are directly linked to governance issues. Agricultural expansion, for example, both in the public and private sector is taking place without adequate conservation measures, leading to deforestation, decreasing soil cover, and a drastic lowering of groundwater tables around the country.

1.2. Government structure

In 2019, worsening economic and other conditions sparked street protests that eventually led to the removal of the former regime in a military coup which occurred on April 11, 2019. The government of Sudan was then led by a "Transitional Military Council" until 20 August 2019 when it was dissolved its authority transferred to the Sovereignty Council of Sudan, which will govern for 39 months until 2022, as part of a process of transitioning Sudan from a totalitarian to a democratic state.

During the street protests that led to the change in government. it was estimated that over 70% of demonstrators were women. Due to persistent pressure, the transitional government includes two women on the 11-member Sovereignty Council overseeing the transition. Four female ministers were part of the cabinet out of 15, including the first female foreign minister. A Bill of Rights and Freedoms has codified in Sudan's new Constitution of 2019. Chapter 11 of the 2019 Constitutionstates that the armed forces are subject to the sovereign authority.

Sudan continues to be a federal republic with 18 states (see Figure 1-2) that enjoy a widerange of legislative and executive powers.Thecentral government role is represented by the federal ministry and is particularly focused on planning and approving general policies.Localgovernance is considered as one of the governances' pillars. Each state is composed of some local state organization to undertake, execute, and manage all educational, health, agricultural, handicraft, and service activities. The Abyeiarea in the southwest corner of South Kordofanwas given a special administrative status in the comprehensive Peace Agreement signed in 2005, it is considered as part of both Sudan and South Sudan in which there is joint control of the territory's affairs (i.e., a condominium).

1.3. Geography

Geographically, Sudan can be broadly classified as consisting of a northern, southern, and eastern region. The northern part of Sudanis the area between the Egyptian border and Khartoum.This area has two distinct geographic zones: the vast desert regions and the White and Blue Nile Valley regions. In the western region (Darfur and Kordufan states), there is an absence of perennial streamsand the topography is dominated by the volcanic mountain chain of JabalMarra an elevation of around 900 meters as part of the Nuba mountain range, a conglomerate of isolated dome-shaped, sugarloaf hills that ascend

#	Name
1	Al Bahr al Ahmar (Red Sea)
2	Al Jazira (Gezira)
3	Al Khartoum (Khartoum)
4	Al Qadarif (Gedaref)
5	An Nil al Abyad (White Nile)
6	An Nil al Azraq (Blue Nile)
7	Ash Shimaliyya (Northern)
8	Gharb Darfur (West Darfur)
9	Gharb Kurdufan (West Korodfan)
10	Janub Darfur (South Darfur)
11	Janub Kurdufan (South Kordofan)
12	Kassala
13	Nahr an Nil (River Nile)
14	Sharq Darfur (East Darfur)
15	Shimal Darfur (North Darfur)
16	Shimal Kurdufan (North Kordofan)
17	Sinnar
18	Wasat Darfur (Central Darfur)

Figure 1-2: States of Sudan (World Atlas, 2021)

steeply and abruptly from the plain (see Figure 1-2). In the northwest, there are excellent grazing lands *(jizzu)* while in the southwest there are extensive sanddunes*(qoz)*.

The southern part of Sudan is the area between Khartoum and the borders with the Central African Republic and South Sudan. This region is characterized by clay plains that stretch eastward from the Nuba Mountains to the Ethiopia border. These clay plains are the backbone of Sudan's economy due to their high agricultural productivity and good access to plentiful water resources. In the central area of the clay plains lies the Al Jazira state between the Blue and White Nile, known for its production of cotton, cereals, oilseeds, groundnuts, wheat, sesame, sorghum, millet, and vegetables much of which is destined for export, and accounting for more than half of Sudan's revenue and export earnings.

The eastern part of Sudan lies to the north and east of the central clay plains and covers the area east of Khartoum to the borders with Eritrea and Ethiopia, as well as the Red Sea. This region is divided between desert and semi desert areas, and includes the Butana, the Qash Delta, the Red Sea Hills, and the coastal plain. The Butana is located between Khartoum and Kassala states, and has good grazing lands for cattle, sheep, and goats. The Qash Delta is a depression filled with sand and silt due to flash floods of the Qash River. The whole area is watered by the Qash River and is a rich grassland and cultivation area. Trees and bushes provide grazing for camel herds, and the rich moist soil is suitable for agricultural production. Below the Red Sea Hills is a barren coastal plain while coral reefs are prevalent in the near shore waters of the Red Sea.

There are extensive areas of the country that have been experiencing significant desertification. This is manifested by a southward shift of the boundary between desert and semi desert, and it is most notable in North Darfur and North Kordofan. Due to declining precipitation, and continued loss of productive land,desertification is likely to continue to show southward progression of desert areas. These trends are closely linked with the loss of

tree cover due to land clearance and unsustainable biomass energy use which amount to about 277 hectares of land over the 2012 to 2020 period (Global Forest Watch, 2021).

1.4. Climate

The geographical location is a major determinant of the climate of any country. Sudan is located at the heart of the African continent. It is bordered by six countries and the Red Sea. From the north it is boarded by Egypt. From the east it is boarded by the Red Sea, Eritrea and Ethiopia. South Sudan and Central Africa from the south in addition to Tchad and Libya from the west. Although Sudan's land is almost flat (Figure 1-3), but there are some mountains and hills scattered across the country. The Red Sea Mountain chain is located in the eastern part and the Marrah Mountains mountain located in the western part of the country. The climate of these two areas is similar to the Mediterranean Sea's climate, which is hot and dry in summer and wet and warm in winter. From the north to the south, desert, semi-desert, Savanna and semi- humid climate zones are distributed

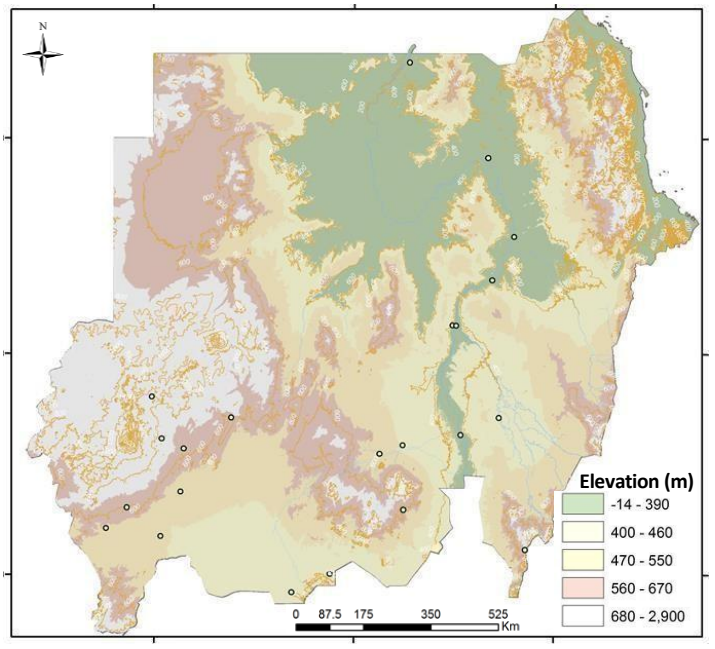


Figure 1-3: Sudan's topography (Sudan Remote Sensing and Seismology Authority, 2021)

1.4.1 Rainfall

Rainfall occurs in Summer in most parts of the country, except along the Red Sea coastal area it occurs in winter. It lasts for four months: June, July, August and September (JJAS). In the eastern parts (along the sea shore) of the Red Sea it commences in November and ends by February (NDJF).

Normally, July and August associated with heavy rainfall over the vast parts of the country. Heavy rainfall may cause flash floods and floods in many parts of Sudan. Rainfall diminished significantly outside JJAS period. The northward movement of the Inter-Tropical Conversion Zone (ITCZ) and the strengthening of the Easterly Winds (EW) determined the distribution and the intensity of the rainfall over Sudan. The local conditions affected the rainfall distribution and amounts in the early and late stages of the rainy season.

The El Niño Southern Oscillation (ENSO) phenomenon contributes significantly to seasonal climate fluctuations in Sudan. El Niña associated with heavy rainfall over Sudan. While normal to below normal rainfall associated with El Niño phenomena. During the Neutral phase of ENSO extreme event are likely to take place during the rainy season. This can be wet or dry conditions.

Distribution of the climatological Normal rainfall over the recent World Meteorological Organization (WMO) climatological period 1991-2020 for the rainy season (JJAS) is shown in Figure 4-4 below. Southern parts of the country normally receive more rainfall compared to the northern parts. June associated with less rainfall (0 – 15 mm) specially in the central parts. July and August are considered to be the peak of the rainy season (150 mm & 182 mm, respectively). The rainfall stared to decline by early to mid-October with the southward retreatment of ITCZ and weakening of the southwesterly winds over the country.

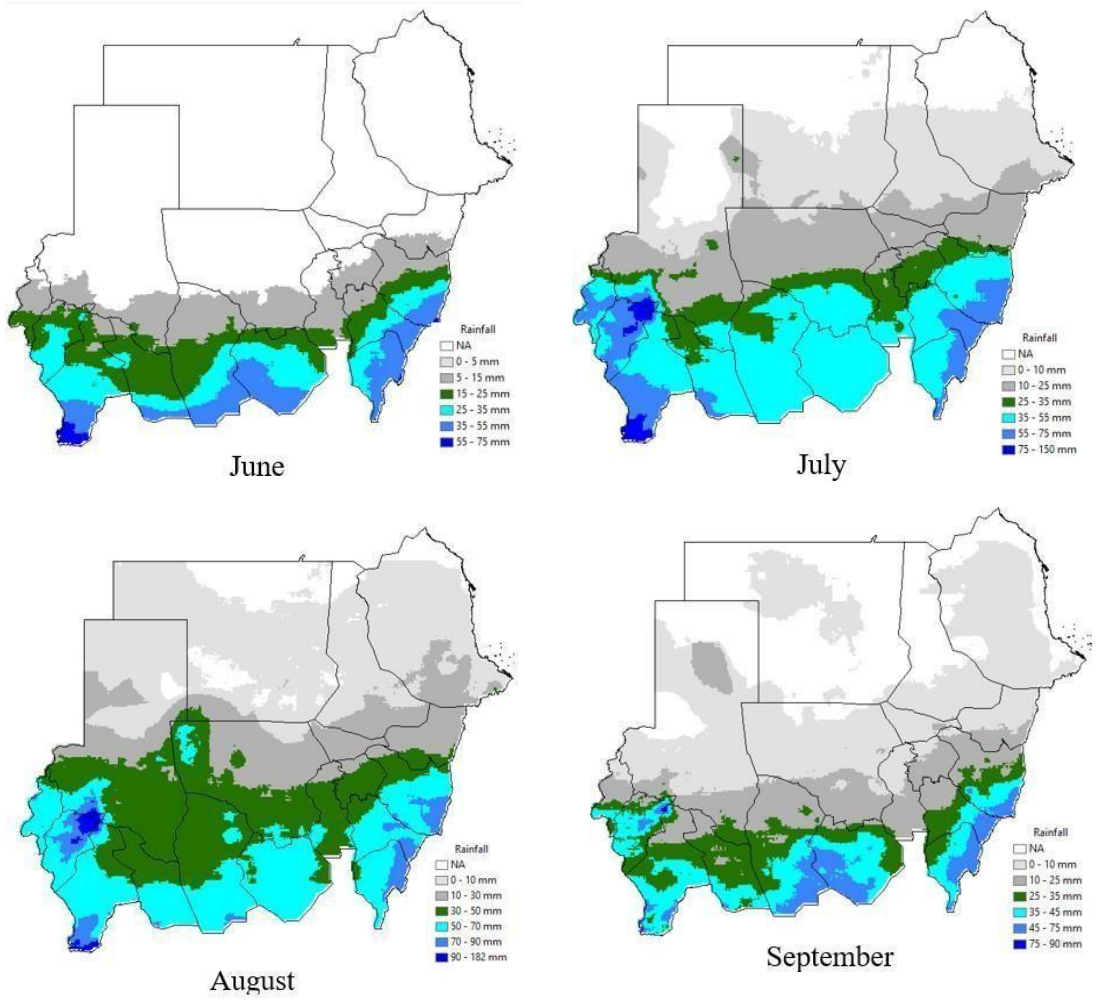


Figure 4-4: Distribution of the monthly rainfall (June, July, August and September) normal rainfall over the climatological period 1991-2020. Source: Climate Hazard Group InfraRed Precipitation with Satellite CHIRPS dataset (www.chc.ucsb.edu/products/CHIRPS-2.0/).

1.4.2. Temperature

The distribution of the monthly surface temperature over Sudan shown in Figure 1-5 below. Monthly mean maximum and minimum temperature patterns show the fluctuations of the surface temperature values across the country in each month.

March and April are considered as a transition period from winter to the summer season. These reflect slightly fluctuating weather and increasing temperatures. The effect of the northern wind confines in the most northern parts during this period. May is the hottest

month in the year. Maximum temperature exceeds 45°C in the northern parts and persists for days. June brings rainfall in the most southern parts that moderates the high temperature in the southern and central parts.

July through October normally associated with moderate temperature as a result of the domination of the south-westerly humid wind. The cloudy weather and rainfall moderate the maximum temperature and kept it under 40°C all over the country except the northern part.

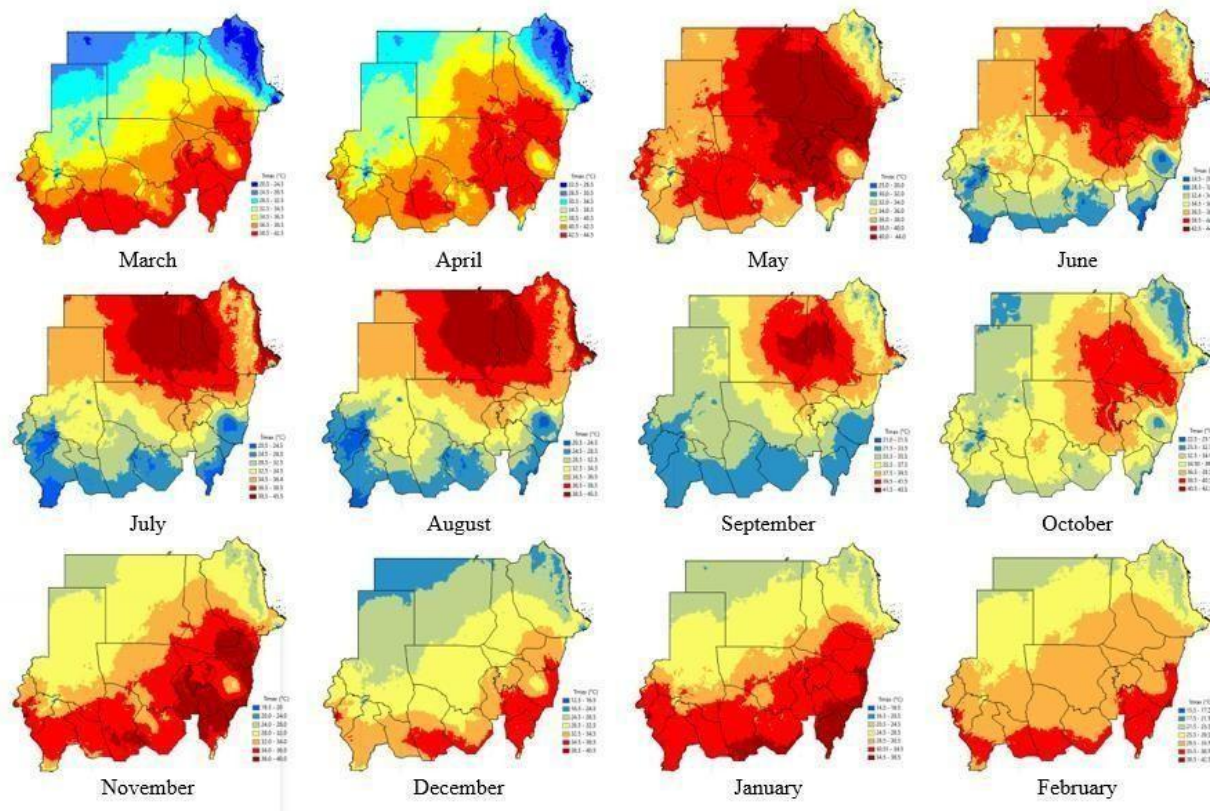


Figure 1-5 : Sudan Monthly Climatology of Maximum Temperature over the period 1970- 2000 in °C. Source: WorldClim v2.1 high resoloution (~1km) data set (https://www.worldclim.org/data/index.html).

In winter (November through February), the frontal systems affecting the temperature and winds over Sudan. Significant drop in temperature and increased winds speed that caused dust and sand storms are main features of the winter season. The frontal systems commence by mid-November and it propagates eastwards associated with cold front, warm front and warm sector. Sudan mostly affected by the cold fronts when they pass the Mediterranean Sea. Decrease in temperature, increase in wind speed and pressure are the main features of the frontal systems. Dust and sand storms associated with strong fronts that affecting not only the northern parts of the country but even the western and central parts. Temperature drops to its lowest limits in December and January.

In March, the northern winds begin to weakening and the transition period commences. During this period, a mixture of weather of extreme events takes places. Dust storms and sand storms occur frequently as well as the hot waves that last for many days.

Stationary low-pressure systems that developed in eastern Libya triggering the dust and sand storms episodes over the western and northern pats with moderate to strong wind speeds that cause poor horizontal visibility during the transition period.

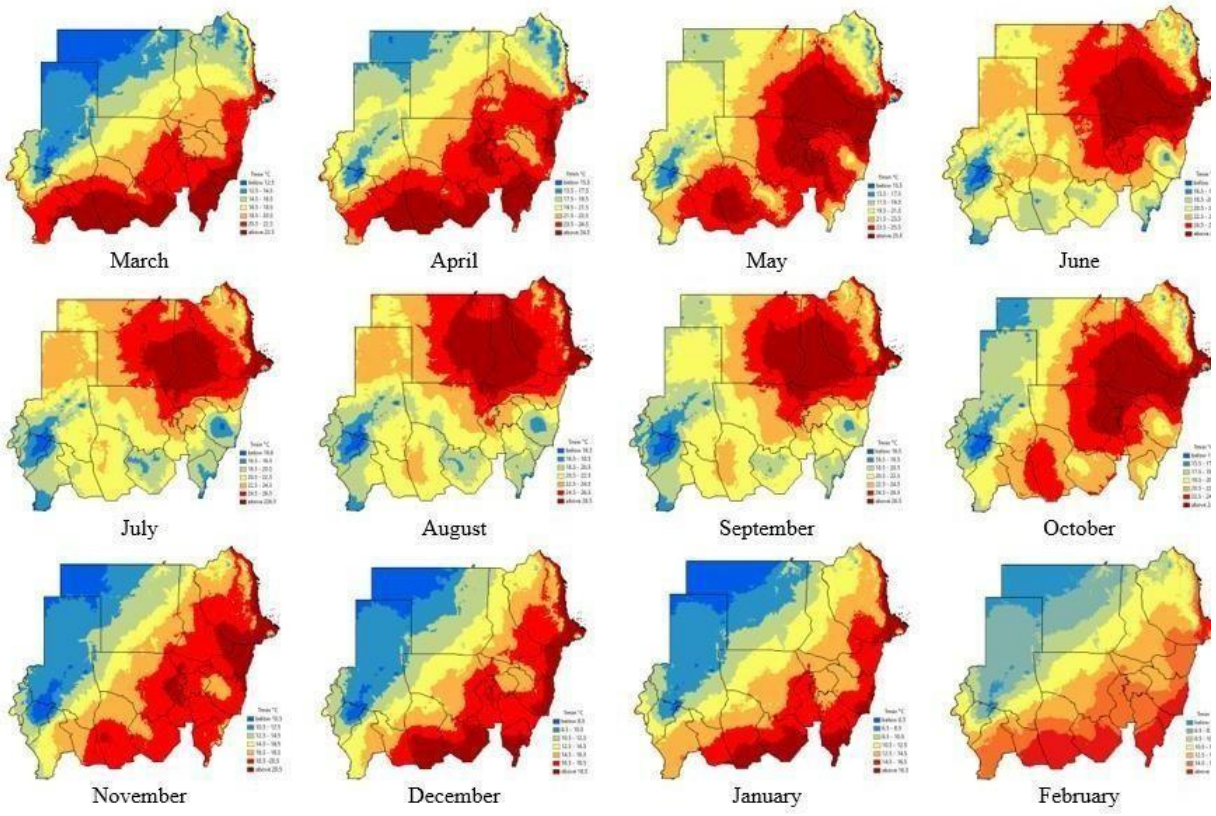


Figure 1-6: Sudan Monthly Climatology of Minimum Temperature over the period 1970- 2000 in °C. Source: WorldClim v2.1 high resoloution (~1km) data set (https://www.worldclim.org/data/index.html).

Figure 1-6 shows the monthly normal minimum temperature across the country. During the period March-June, lowest minimum temperature occurs in western and most northern part of the country. Central and southern parts remain relatively hot. By July, the situation inverses as the southwesterly humid wind dominate. Southern, central and western parts are relatively cold compared with northern and eastern parts. The north cold and dry wind commences by November and the temperature drops significantly in the northern and western parts. The central part also affected by the north wind and the minimum temperature decreased significantly.

1.4.3 Winds Speed and Direction:

Winds speed and direction fluctuate considerably across the different seasons. During the dry season, March through June, strong wind speed prevailing over the northern part and along the Red Sea coast. While moderate to light winds speed prevails over the eastern, southern and western parts. In the central parts, moderate wind speed prevails (Figure 1-7).

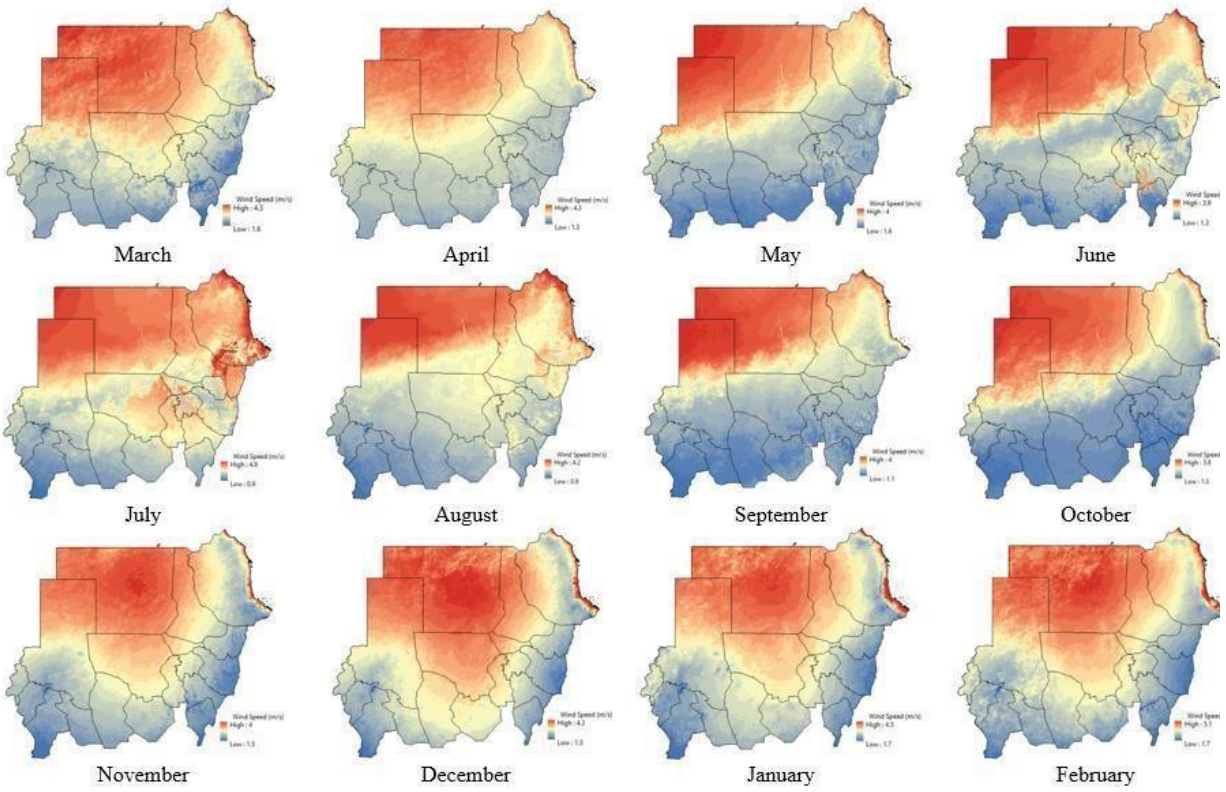


Figure 1-7: Sudan Monthly Mean Surface Wind Speed over the period 1970-2000. Source: WorldClim v2.1high resoloution (~1km) data set (https://www.worldclim.org/data/index.html).

During the rainy season (June – September), the southern and southern western humid wind prevailing in southern half of the country. Along the Red Sea coast and southern parts, the north wind is dominating. By the season progressing, moderate wind speed occurs in the eastern and central parts too. July exhibited high wind speed patterns and central parts. While August shows moderate wind in the same areas. It obvious that the location of the Inter-Tropical Conversion Zone (ITCZ) shows moderate wind speeds. During the summer season, the north wind confine in the most southern parts of the country. Moderate and relatively strong wind speed commences in June and July as the south westerly wind prevails.

The winter season (November-February) associated with significant strong wind speed that propagates to the nearly southern parts of the country. Wind speeds increase due to the high-pressure systems developed in the mid-latitude and Mediterranean. Drops in temperature and deterioration in horizontal visibility are caused by the increased wind speeds during December and January that resulted from the high pressure centered at the mid-latitude and Mediterranean.

1.4.4 Extreme events

The frequency of extreme climatic shocks is also increasing, particularly drought. Once a feared event that rarely occurred rarely prior to 1980, with the most devastating ones in 1913, 1940 and 1954 which covered many parts of the country. Since the 1980s, however,

drought has become now one of the most important and frequent challenges confronting Sudan. Droughts have recurred in 1984, 1987, 1989, 1990, 1991, 1993, and 1996, mainly in western Sudan in Kordofan and Darfur states, as well as in areas in central Sudan. This has had disastrous effects on rain-fed cultivation, livestock and forest sources on which the vast majority of rural communities depend. Moreover, massive displacements to urban areas have been taking place in those regions since the late 1960s contributing to unsustainable urbanization rates. Future drought threatens about 19 million hectares of rain-fed mechanized and traditional farms, as well as the livelihoods of many pastoral and nomadic groups.

Extreme flooding events have also exacted a heavy toll for Sudan in recent years. The most severe floods are associated with periods of exceptionally heavy rainfall that cause the overflow of the River Nile and its tributaries. While highly unpredictable, the frequency of floods has been noticeably increasing. In the 100-year period 1878-1977, there were only two severe floods; in the subsequent 25-year period 1977-2002, there have been three severe floods, one of the worst occurring in 1988. This corresponds to a 6-fold increase in the frequency of severe flooding events. Strong rains, such as those experienced in 2013 and 2018, caused massive destruction of houses of low-income groups and informal settlements where houses are usually built with mud and little attention to drainage. The most vulnerable groups are the thousands of communities who live in low lying lands along the riverbanks of the River Nile and its tributaries.

Finally, given its proximity to the Greater Sahara Desert, Sudan is prone to frequent dust storms. The frequency of intense dust storms has been increasing during the recent years, with two massive dust storms in May 2009 and June 2017. Such storms affect air traffic, destroy infrastructure and have adverse impacts on human health.

1.5. Demography

1.5.1. Population

Since the 2011 separation, Sudan's population has continued to steadily rise, reaching 43.9 million in 2020, equivalent to an average annual rate of about 2.4% over the 2012-2020 period (WB, 2021). The current population density is about 23.8 persons per km^2, with most of the population concentrated along the River Nile and its tributaries, as well as in the rich savannah lands. The three northern states (i.e., Red Sea State, Nile River state, and Northern state), large in area and with much of their populations concentrated on the banks of River Nile, have roughly a fifth of the national average population density. The population of Sudan is young, with about 42% of the population being under the age of 15. There are about 104 males for every 100 females.

1.5.2. Urbanization

Sudan's urban areas have been growing rapidly, with about 35% of the total population living in urban areas (WB, 2021).Over the 2012-2020 period, the urban population grew at an average rate of about 3.1% per year, considerably higher than the average rate for the entire population. Also, urbanized areas in Khartoum and Gezira states exhibit several-fold higher population densities due to the availability of basic services (e.g., health facilities, schools, employment opportunities).

Rapid and uncontrolled population influx into Khartoum and other cities and towns, and lack of facilities to manage solid waste and sewage represent major environmental concerns. In addition, the greater use of energy resources in urban areas for domestic, industrial, transportation, cooling, and air conditioning, is linked with greater air pollutant emission, intensifying heat island effects, and adverse public health impacts.

1.5.3. Labor force

The Economically Active Population (EAP) comprises all persons of either gender who furnish the supply of laborfor the production of goods or services within the production boundary, as defined by the System of National Accounts (SNA). The EAP is divided into both employed and unemployed categories. According to a Labour Force Survey conducted in 2011 that corresponded to the territory of Sudan after separation, the reported EAP for people aged 15 and older was 8.972 million people, with employed males accounting for the largest share of the EAP (see Figure 1-8).

The findings of the survey confirmed earlier studies which showed that labor force participation rate of women 15 and older is much lower than men and is one of lowest in Africa (IO, 2020), with about 24.5% participation in 2019, which compares poorly with neighboring countries such as Chad (64.8%), Eritrea (74.2%), and Ethiopia (74.4%).

This reflects demographic, social, legal, and cultural trends and norms in Sudan where women often work on farms or in other family enterprises without pay, and others work in or near their homes, mixing work and family activities during the day. However, access to good-paying occupations for women remains unequal in Sudan and is the focus of emerging policy initiatives to monitor and overcome gender disparities in employment and unemployment patterns.

1.5.4. Literacy

In 2018, the literacy rate of youth (ages 15-24) was 73.0% (73.5% for females; 72.5% for males) while the overall literacy rate for people aged 15 years and older was significantly lower at 60.7%, with males at 65.4% and females at 56.1% (WB, 2021). On the basis of the Gender Parity Index (GPI), the literacy rate of youth was 1.013, indicating that young Sudanese females exceed their male counterparts in the ability to both read and write.

1.5.5. Fertility

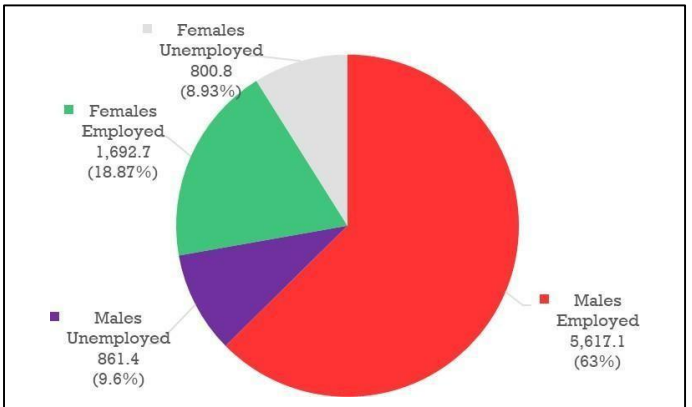


Figure 1-5: EAP by employment and genderinthousands, 2011 (CBS, 2011)

Fertility rates - as one of the major components of population change - have a relative impact on the general growth of the population. Fertility rates in Sudan have been in decline for several decades, driven largely by a massive increase in school enrolment, rural-urban migration, an increase of the mean age at first marriage, and the rise in the prevalence of contraceptives. Considering the foregoing, fertility is projected continue it declining trend through 2038 (see figure 1-9).

1.6. Economy

Despite the secession of South Sudan in 2011, the growth in Sudan's GDP growth has remained positive, rising from 66.08billion USD in 2012 to 85.07billion USD (constant 2010 USD) in 2020, an average annual growth rate of 3.2% (WB, 2021). On a per capita basis, the economic output per person increased from USD 1,825 to USD 1,940 (constant 2010 USD) over the period 2012-2020. According to the World Economic Outlook, Sudan ranked number 40th out of 54 countries in Africa in terms of per capita GDP as of 2018 (IMF, 2018). On a Purchasing Power Parity (PPP) basis, Sudan's ranking increases to 21st in Africa.

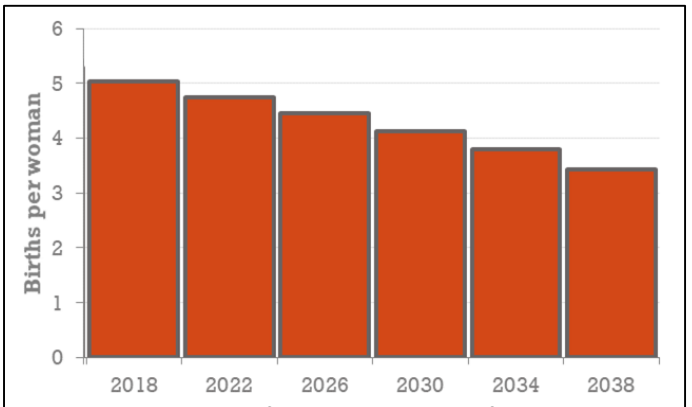


Figure 1-6: Projected fertility rate trend for the period 2018to 2038 (projected by the Central Bureau of Statistics)

1.6.1. Structure of GDP

The share of each sector to GDP has remained showed significant change for the period 2012 to 2020 (WB, 2021) as shown in Figure 1-10. The agricultural sector – comprising agriculture, forestry, animal resources, and fisheries – while representing the largest contributor to GDP in 2020 at 17.4 billion USD (constant 2010 USD) or 20.5% of GDP, dropped significantly compared to 2012 when it accounted for 33.5% of GDP (USD 22.14 billion at constant 2010 USD). Over the same 2012-2020 period, the industrial sector (including construction) grew from 20.3% to a 26.0% share of the economy, accounting for USD 13.44 billion and USD 22.15 billion, respectively (constant 2010$ USD). The individual shares of all other sectors (i.e., mining/quarrying; electricity. water and gas; trade, hotels, and restaurants; finance, insurance, and banking; transport and communications; government services; and other services) are small in comparison to the agriculture and industrial sectors, although taken together they accounted for over 50% of GDP in 2020.

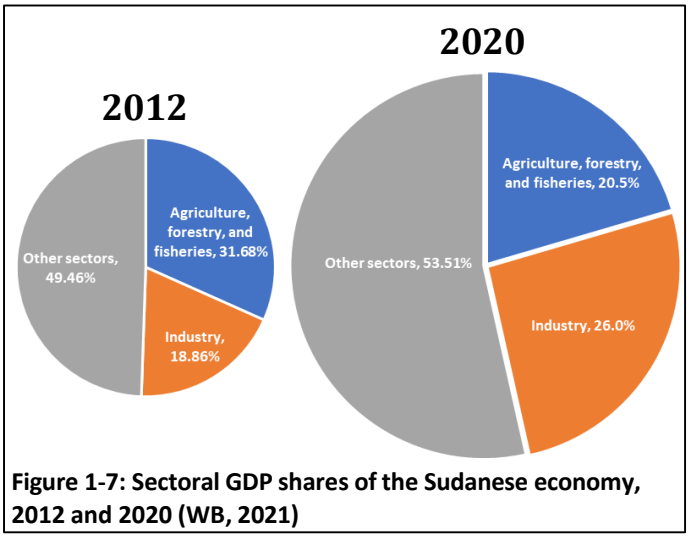


Figure 1-7: Sectoral GDP shares of the Sudanese economy, 2012 and 2020 (WB, 2021)

1.6.2. Balance of payments

Sudan's balance of payments (i.e., annual net payment) has shown mostly deficits over the period since the 2011 separation to 2018, except for2015 when there was a 38.4 million USD budget surplus. In 2011, the annual deficit was 688.3 million USD, the maximum deficit everrecorded in Sudan (see Figure 1-11, left). The current account balance (i.e., national debt comprisingtradebalance, services, income, and current transfers) has fluctuated considerably over the 2011-2018 period and reached nearly 14% of GDP in 2018 (see Figure 1-11, right).

1.6.3. Trade

Sudan exports goods to countries on all six continents. The main export destinations are non-Arab Asian countries and Arab countries. In the period 2008 – 2011, China represented the top export destination in Asia and worldwide, with an average share of 74.4% annually of total exports. In 2012, the United Arab Emirates surpassed China as the top export destination with a 52.3% share of total exports and has continued as the top export market

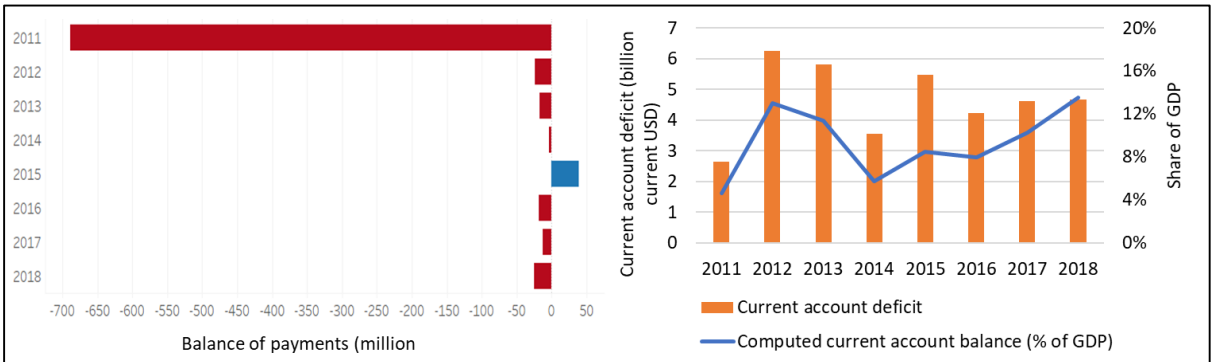


Figure 1-8: Left: Sudan balance of payments, 2011-2018 (Central Bank of Sudan); Right: Sudan current account balance, 2011-2018 (WB, 2021)

in the years since.

The July 2011 separation has had a significant impact on international trade in goods. Petroleum and petroleum products had been the main contributor to Sudan's exports, accounting for an average of about 86% of total export value over the 2008-2011 period. In the years since the separation, oil exports have dropped significantly ranging from 11% to 24%. This resulted in the year 2011 being the last year that Sudan's annual trade balance for goods has been positive. From 2012 through the end of 2019, the annual trade balance has been negative and its trade situation has become progressively worse, with 2019 registering the highest trade deficit reached as a percentage of GDP while the total trade in goods and services as a percentage of GDP (a measure of trade openness) has consistently been lower than the 2011 value (see Figure 1-12, left).

In response, economic policies were implemented to promote exports from the mining industry to compensate for the loss of oil revenues. Prior to the separation, gold accounted for less than 10% of all traded goods. In 2012, gold exports accounted for about 53% of total exports and have remained well over 20% of total traded goods in the years since. Trade in agricultural products and livestock has also shown significant increases in the post-2011 period, roughly tripling their share of exports when compared to the 2008-2011 pre-separation period (see Figure 1-12, right).

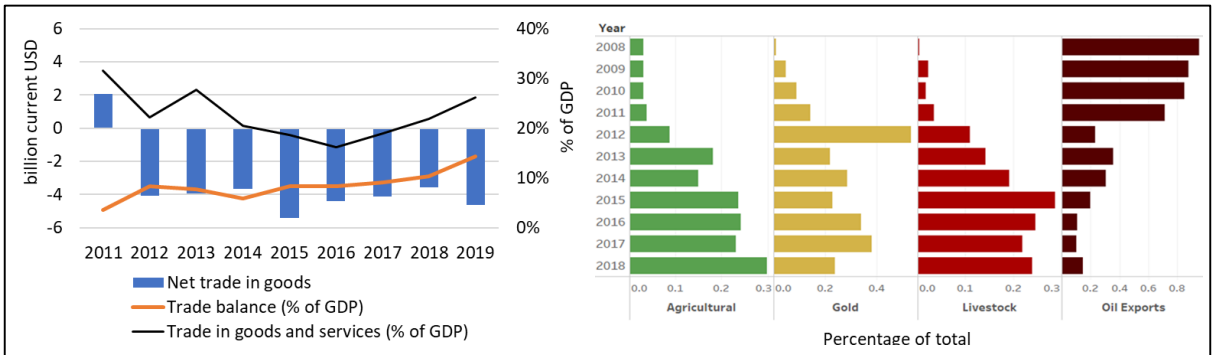


Figure 1-102: Left: Sudan's annual balance of trade in goods, 2011-2019(WB, 2021); Right: Change in the profile of exported goods, 2008-2018 (Central Bank of Sudan)

Inflation has been a persistent economic problem for Sudan. The steady rise of prices for goods and services has eroded the purchasing power of consumers. The inflation rate increased from 13% to 37% during the 2010–2013 period due to the implementation of economic reform measures that increased the foreign exchange rate for government transactions and a partial removal of subsidies on fuel which led to increases in transport costs. In addition, there has been a steady rise in prices of most food commodities and some imported services. In the 2014-2019 period, the annual inflation rate has continued to climb, reaching a high of 63% in 2018 (see Figure 1-13). The sole exception is 2015 where inflation was kept to a relatively low 17% as a result of coordinated policies adopted by the Central Bank of Sudan and the Ministry of Finance and Economic Planning to maintain price stability of some strategic goods such as wheat, edible oils, and medicines through the formation of finance consortiums. However, the effectiveness of these measures was short-lived, as subsequent years revealed.

1.6.4. External debt

Sudan's external debt obligations have averaged around USD 21.2 billion (current prices) over the period 2011-2019. As a share of GDP, total external debt by 2019 was over double the pre-separation shares of 2010, 67% and 33%, respectively (see Figure 1-14). Given the conventional threshold share of 30% for external debt sustainability, Sudan's external debt obligations are in a precarious condition.

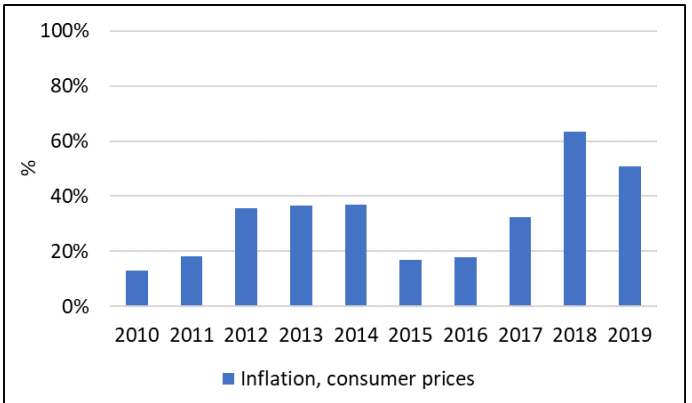


Figure 1-9: Inflation rate of consumer prices, 2010-2019 (WB, 2021)

1.6.5. Banking system

There are 37 operating banks in Sudan, of which 31 are commercial. The rest are specialized banks. After concluding the Comprehensive Peace Agreement (CPA), the Central Bank of Sudan Act 2002 was amended in 2006, wherein the nature of the banking system, the Bank and its branches, were specified in Section (5) from the Act as follows:

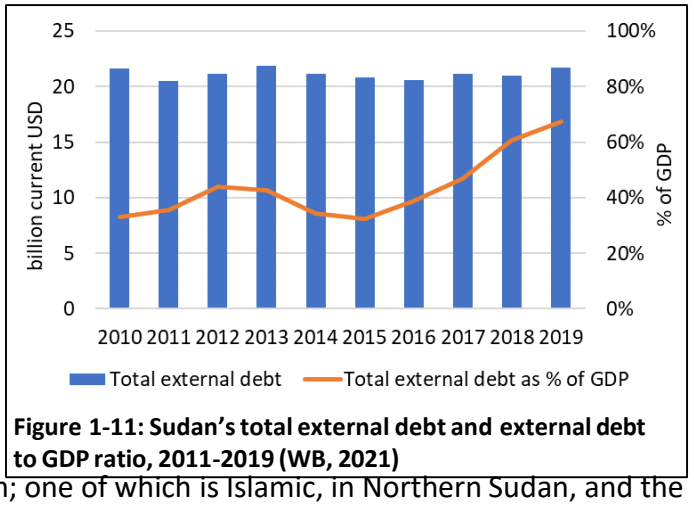


Figure 1-11: Sudan's total external debt and external debt to GDP ratio, 2011-2019 (WB, 2021)

- The Sudanese banking system shall consist of a dual banking system; one of which is Islamic, in Northern Sudan, and the other Conventional, in Southern Sudan.
- The headquarters of the Bank shall be in Khartoum and may establish branches, or agencies inside Sudan, and appoint correspondents outside Sudan.
- The Bank of Southern Sudan shall be established as a branch of the Bank to render, in addition to its other tasks, conventional banking services, in Southern Sudan, including the issue of license, as the Board may issue. There shall assume management of the conventional banking system, in Southern Sudan, as one of the windows of the Bank, and by its laws, policies, and safeguards.
- The Bank shall have an independent corporate personality, perpetual succession, a common seal, and the right to litigate, in its power name.

After the secession of Southern Sudan in 2011, the Bank of Southern Sudan (BOSS) became the central bank of the State of Southern Sudan on the 9th of July 2011. All branches of the Central Bank of Sudan in the previously southern states became affiliated with it. Agreements related to wealth sharing, monetary policy, banking, currency, and lending were frozen. In addition to this, policies of the traditional banking system in southern Sudan, and all circulars of the Central Bank of Sudan related to the dual system have been suspended, until the amendment of the law of the Central Bank of Sudan for the year 2002.

1.7. Agriculture

Sudan is known for its abundance of arable landsandfavorable soil characteristics, which have allowed the country to grow a wide variety of perennial crops in different regions. Agriculture has traditionally been a vital component of the country's GDP in the years prior to the separation, reaching a high of 47% of total GDP in 1997. Its contribution has declined substantially since then. Over the period 2011-2019, the share of the agriculture, forestry and fisheries sector in GDP declined by about 10% even as its total value added dropped in 2019 to less than 40% of its 2011 level (see Figure 1-15).

1.7.1. Cultivation systems

There are three major types of agricultural cultivation systems practiced in the roughly 0.71 million km^2 of arable lands, about 38% of the total land area. Along the Nile and its tributaries, large-scale irrigated agriculture is practiced in the El-Gezira (8,820 km^2), New-

Halfa (1,840 km^2), and Rahad (1,270 km^2) schemes. Mechanized rain-fed agriculture is practiced in central clay plain areas and non-mechanized traditional rain-fed agriculture is practiced in all other arable land areas.

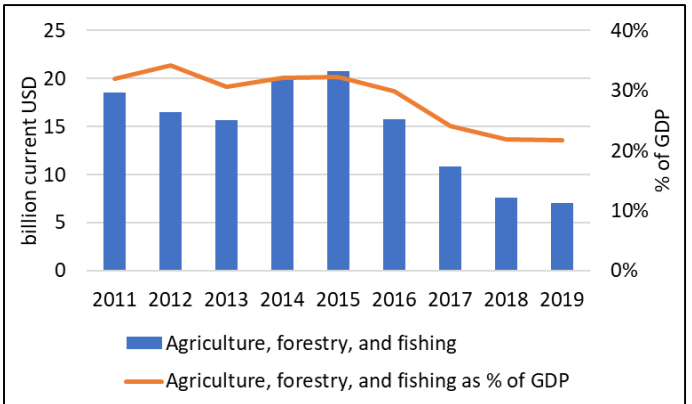


Figure 1-12: Total economic output of Sudan's agriculture, forestry and fisheries sector, and the share of the sector to GDP, 2011-2019 (WB, 2021)

Total cultivated area is currently around 0.18 million km^2. Traditional rain-fed agriculture accounts for the largest share of the land under cultivation, about 65%, followed by mechanized rain-fed systems comprising 30% and the share of irrigated systems at 5%. These shares have shifted considerably since 2002 when irrigated systems accounted for 25% of total cultivated land, and traditional systems accounted for only 42%. The share of mechanized rain-fed cultivation has held fairly steady.

Poorly planned and managed mechanized agricultural cultivation is a leading cause of land degradation and water pollution. Land degradation is also increased due to the sizeable growth livestock herds and the resulting overuse of rangelands.

1.7.2. Major soil types

There are several types of soil across the country (see Figure 1-16, left). The northern and west-central areas are characterized by sandy soils. These soils support vegetation and are used for livestock grazinginthe desert regions in northern Kurdufan and northern Darfur states. Livestock raising the major agricultural activity in this area, but crop cultivation is also practiced particularly pearl millet, peanuts, and sesame. Most of the country is moderately to highly suitable for agricultural production (see Figure 1-16, right).

The central region is characterized by clay soils. These soils support all type of agricultural cultivation in Sudan – irrigated, rainfed, and mechanized. They are found to the west of Kassala and southern Kurdufan. Irrigated cultivation is practiced in the areas of Al JazirahstateandKhashm al Qirbah in Kassala state because of the presence of significant clay

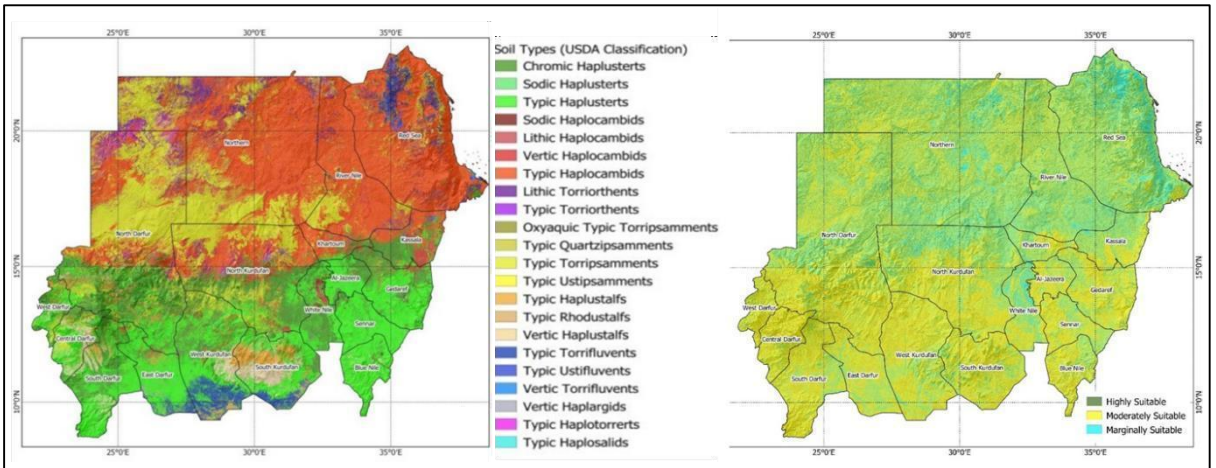


Figure 1-13: Left: Major soil types of Sudan; Right: Soil suitability for agriculture in Sudan(Sudan Soil Information System)

content in the soil.The region east of the Blue Nile River is used for mechanized rainfedcrops.Traditionalrainfed crop production is practiced in the area around the Nuba Mountains west of the White Nile River in South Kordofan where the primary crops are sorghum, sesame, peanuts, and cotton.

The southern regions of Sudan are characterized by laterite soils. These soils are highly important for agricultural production. They consistof alluvial soils found along the lower reaches of the White Nile and the Blue Nile rivers, along the main Nile to Lake Nubia, in the delta of the Qash River in the Kassala area, and in the Baraka Delta in the area ofTawkar near the Red Sea in the Ash SharqiAdministrative Division.

1.7.3. Major crop types

Sorghum, millet, wheat, cotton, sesame, groundnuts, and sunflowers are the major crops grown in Sudan. Annual production of these has been rising. During the 5-year period prior to the separation, average annual production for these crops together was about 5.5 million tonnes. By the 2014-2015 seasons, production levels had risen to 10.7 million tonnes and by the 2018-2019 seasons had reached 13.1 million tonnes in the last season. Sorghum dominates the total production of these crops, accounting for at least 60% of agricultural production (see Figure 1-17, left). Crop yields (in kg/acre) for the major crops has shown an overall increase across all seasons since 2005 except for sunflower which by 2018-2019 has decreased to about half of productivity levels in the 2005-2010 period (see Figure 1-17, right).

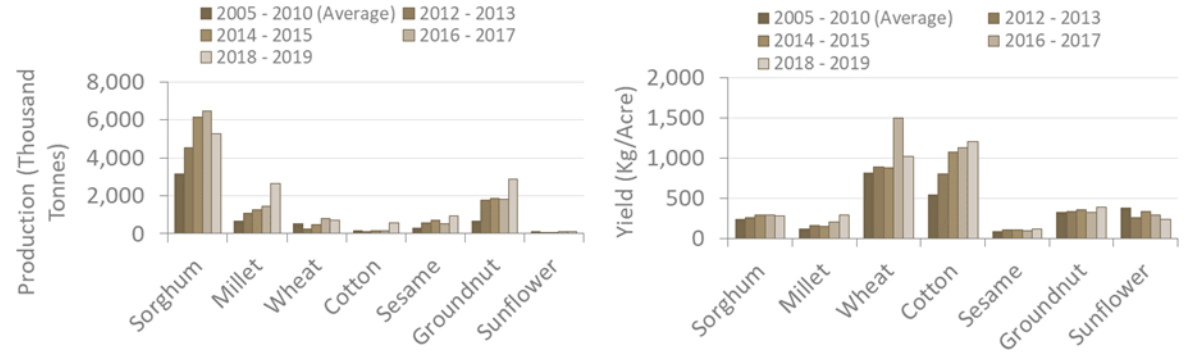


Figure 1-14: Left: Annual production of major crops, 2005-2019; Right:Productivity of major crops, 2005-2019 (Ministry of Agriculture and Forestry)

Sudan is the world's largest producer of Gum Arabic, a resin that is extracted from Acacia trees and used as an emulsifier in sodas, a thickener in candies, a binder in some inks as well as medicinal uses. Most is produced in the Kordofan region (49.3%), followed by Kassala and Darfur regions, representing 24.4% and 23.4% respectively (Gum Arabic in Sudan, Sudan Trade Point, 2013). Over the 5-uear period 2007-2012, Gum Arabic production increased nearly threefold, from 11.2to 30.4thousand tonnes. This trend has continued and in 2016 production reached about 87.7thousand tonnes, the highest level ever.

1.8. Energy

The energy sector has an essential role in Sudan's economy. It supports activities different public services such as health care, education, public transportation, and household electrification, as well as meeting the fuel and electricity needs of the agricultural and industrial sectors. The main sources of primary energy in Sudan are biomass, oil, and

hydroelectricity. Coal, natural gas, and uranium are non-existent in Sudan. Currently, Sudan's primary energy mix consists of biomass, hydroelectric power,oil products, and a small amount of solar photovoltaic power.

Installed electric generating capacity is comprised of renewable and thermal facilities. Over the period 2012-2017, total installed electricity capacity in Sudan increased from 3.05 GW to 3.59 GW, an average annual growth rate of 3.3% per year (see Figure 1-18, left). Renewable capacity is mostly made up of large hydro-based stations which account for around half of all installed capacity. Biomass is the form of bagasse is consumed in cogeneration units at industrial facilities and accounts for less than 10% of installed capacity. Solar PV capacity, while small, has been increasing steadily, roughly 7% per year. The remaining electric generating capacity consists of oil-fired thermal units which account for just under half of all installed capacity and has been growing at about 4.4% per year.

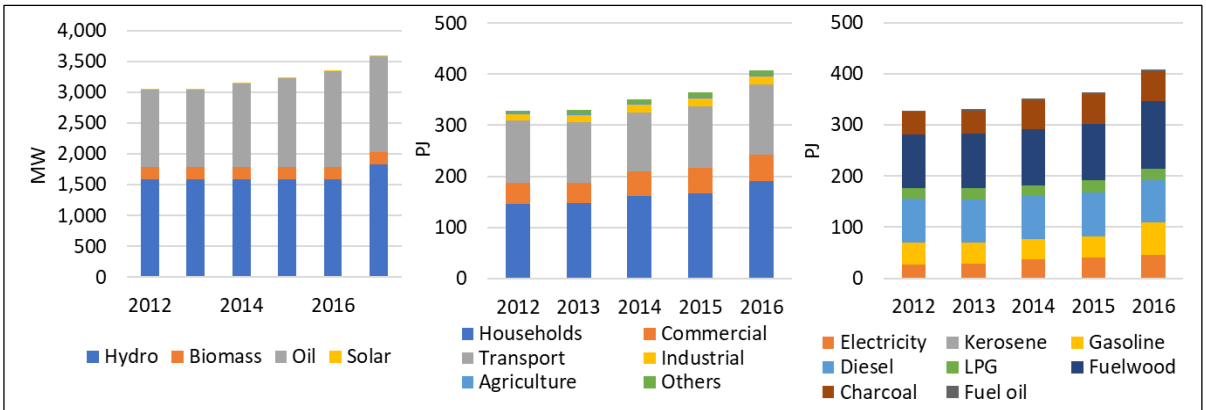


Figure 1-15: Left: Installed electric capacity, 2012-2017; Middle: Energy consumption by sector, 2012-2016; Right: Energy consumptionby fuel, 2012-2016 (UNDP, 2020)

Installed oil refining capacity is comprised of the AlJailifacility located about 70 km north of Khartoum. It was originally designed at a capacity of 50,000 bbl/day to refine low- sulfurcrude oil but was upgraded in 2006 to a capacity of 100,000 bbl per day for also refining heavier crudes.There is also a small refinery located in El-Obeid City in North Kordofan state that has a capacity of 15,000 bbl per dayandproduces naphtha, diesel, and fuel oil.Finally, there is a decommissioned refinery in Port Sudan that is under rehabilitation.

Energy consumption is dominated by the household and transport sectors (see Figure 1-18, middle). Household energy use in the form of electricity, LPG, and biomass accounts for about 45% of all energy use and has been growing rapidly at an average annual rate of nearly 7% per year. For the transport sector, gasoline and diesel use accounts for about 34% of all energy use and has been growing more slowly at an average annual rate of about 3.3% per year. Combined, all other sectors (commercial, industrial, agricultural, others) account for only 20% although they are experiencing average annual growth of nearly 7% per year. Sectoral energy consumption patterns over the period 2012-2016 are summarized in (see Figure 1-18, right).

1.9. Industry

There are several major activities that comprise the industry sector in Sudan. These include sugar, cement, pharmaceuticals, andother processing industries. These subsectors play an important role in creating gross value added to the economy, while also providing job

opportunities and improving the competitiveness of national products. An overview of each is provided in the subsections below.

1.9.1. Sugar

The factories engaged in sugar production include Kenana Sugar Company, White Nile Sugar Company, and four factories owned by Sudan Sugar Company (Hagar Assalaya, Gunied, Sennar, and New Halfa). From a peak sugar production peak in 2013 of about 702 thousand tonnes, sugar production has decreased at an average annual rate of 4.8%/year, reaching 606 thousand tonnes in 2016.

1.9.2. Cement

Sudan's cement industry has shown steady growth since 2011. In the 6-year period 2011-2017, cement production grew at an average annual rate of 6.2%, from 3 to 4.3 million tonnes. This has resulted in achieving self-sufficiency in cement production, while also contributing to cement exports. In 2017, of the 7 cement factories in Sudan, Atbara Cement and Al-Shamal Cement are the largest producers, accounting for 32.5% and 24.7% of total cement production, respectively (see Figure 1-19).

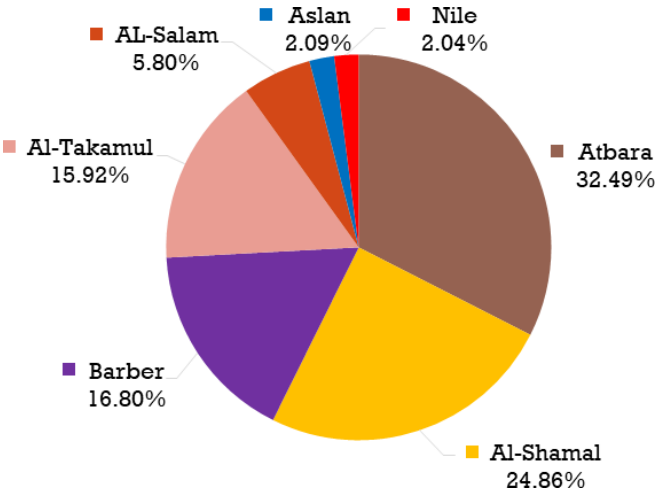


Figure 1-16: Shares of cement production by factory, 2017 (Central Bank of Sudan)

1.9.3. Mining

Sudan's economic policies have been encouraging the production of metals and minerals for export to compensate for the loss of foreign currency from oil exports due to the 2011 separation (see Section 1.6.3). In the 4-year period after the separation, 2012-2016, the contribution of the mining industry to GDP increased from 0.3 to 1.4 billion USD (current USD), equivalent to an average growth rate of 49% per year.

Mining occurs in several key locations throughout Sudan. The Hassai Gold Mine is an open pit mine located in the Red Sea Hills desert (Itbāyregion) in north-eastern Sudan where gold, iron ore, and base metals are mined. The Ingessana Hills Mining Area in Blue Nile State is another important mine from which chromite, gypsum, and salt are extracted. Phosphates, gold, and copper, among others, are found in Mount Kuoun and Mount Lauro in the eastern Nuba Mountain region of South Kordofan. Figure 1-20 identifies these and other locations where reserves of elements and minerals have been identified.

In the year 2010, Gold was the main contributing mineral to the GDP of the mining sector, accounting for 70%. The production of gold has more than doubled since the 2011 separation, from 44.5 tons in 2012 to 93.4 tons in 2016. The mining of feldspar, although accounting for only 3% of GDP in 2010, has also shown dramatic growth, increasing from 26.3 to 92.2 thousand tonnes between 2012 and 2016, a 3.5-fold increase (CBOS).

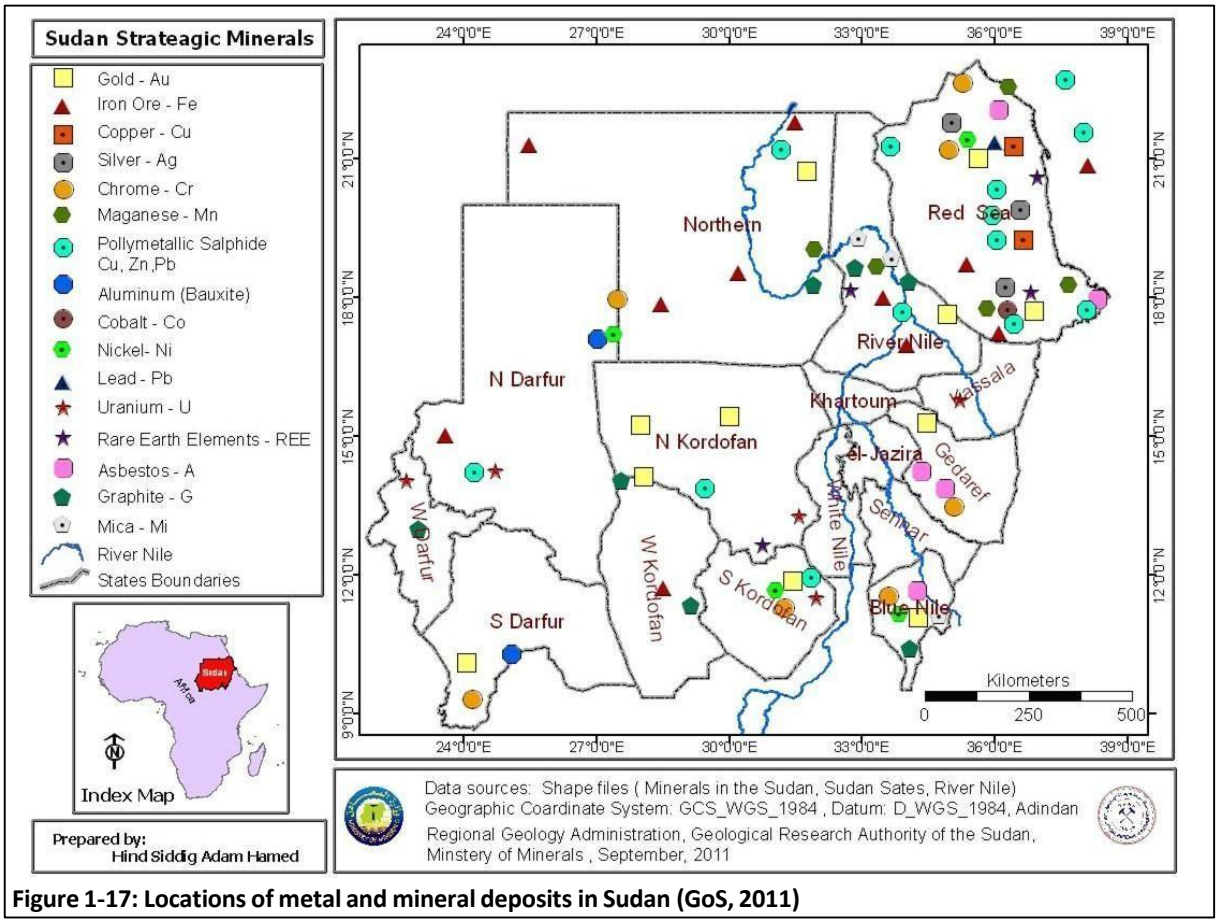


Figure 1-17: Locations of metal and mineral deposits in Sudan (GoS, 2011)

1.9.4. Other processing industries

There are several other notable industrial activities is Sudan. These include the production ethanol, cooking oil, beverages, wheat flour, steel bars, and water coolers & air conditioners (Thousand Units). Except for ethanol and carbonated beverages, each showed strong growth over the 2012-2016 period (see Table 1-1).

1.10. Transportation and Communication

Transportation and Communication. Transportation and communications in Sudan include a railway system, river and sea transportation, land roads in addition to air transportation. Transportation and communications are among the important elements of development, especially

Table 1-1: Annual production of different processing industries in Sudan (CBOS)

Other Processing Industries	2012	2013	2014	2015	2016	Growth rate (%/year)
Ethanol (Million Liters)	33	67	70	36	24	-8%
Edible Oil (Thousand Tonnes)	159	210	130	148	256	13%
Soft Drinks (Million Liters)	720	882	859	455	434	-12%
Wheat Flour (Thousand Tonnes)	1450	1694	1957	2000	2126	10%
Steel Bars						

economic	and	social	(Thousand	450	443	460	624	-	NA		

development, tourism development programs, exports	Tonnes) ~~Water Coolers &~~ Air Conditioners (Thousand Units)	18	17	18	280	189	80%

and investments, linking the internal regions with each other, as well as linking Sudan with the outside world. The ownership of vehicle is steadily increasing in Sudanese urban areas. The number of vehicles increased during the period 2010-2016 to 1,168,817 vehicles. For most people, private transportation is more convenient, reliable and cleaner when compared to public transportation. The lending programs launched by Sudanese banks during the past ten years have encouraged owning private cars. This process has inadvertently contributed to high levels of traffic congestion and air pollution in urban areas. These lending programs have recently been curtailed to ensure that sufficient banking resources are available to lend to productive economic sectors. Sudan has had a railway since 1875. The railway is 5,844 km long and connects urban and rural areas to transport passengers and goods. Air navigation began in Sudan in 1947 to connect Sudan with the outside world and to link the inner cities together. There are approximately 14 airports in Sudan. Maritime transport is an important source of transportation for Sudan, as it links Sudan with neighbouring countries and delivers Sudanese exports to all parts of the world. Sudan has about 7 sea ports.

1.11. Waste management

Waste management is among the most important environmental problems facing Sudan, given the increasing quantity of municipal solid waste (MSW) and its effects on public health and the economy. Challenges includerapidly increasing quantities that overwhelm the collection capacity of local authorities, the lack of environmental awareness, and the growing wastefulness of the society.

Sudan's average daily solid waste generation is estimated at 0.5kg per capita and is projected to remain at this level through 2030. Based on the population in 2018, a total of 7.66 million tonnes of municipal solid waste was generated. Of this amount, it is estimated that only 2.53 million tonnes, or 33%, are disposed of at waste disposal sites where they are burned causing air pollution. The remaining 5.13 million tonnes are not collected but rather disposed of within residential areas and vacant lands.

MSW collection coverage is less than 100% in all urban areas across Sudan's 18 states and is typically less than 30% in rural areas (see Table 1-2). Some of the uncollected waste is informally recycled, with little safety measures, exposing citizens and workers to health risks. Recycled waste includes newspapers, plant material, plastic, and scrap metal. Recycling rates are lower in areas outside towns due to logistics and costs associated with collection and transportation to recyclers.

Regarding wastewater, there is approximately 50.6 thousand m^3/day generated by industrial activities. The

Table 1-2: Waste collection system coverage (%) in urban and rural areas, 2017 (HCENR)

#	State	Urban Areas	Rural Areas
1	Al Bahr al Ahmar (Red Sea)	70	30
2	Al Jazira (Gezira)	NA	NA
3	Al Khartoum (Khartoum)	NA	NA
4	Al Qadarif (Gedaref)	25	10
5	An Nil al Abyad (White Nile)	50	-
6	An Nil al Azraq (Blue Nile)	40	16
7	Ash Shimaliyya (Northern)	38	-
8	Gharb Darfur (West Darfur)	NA	NA
9	GharbKurdufan (West Korodfan)	NA	NA
10	Janub Darfur (South Darfur)	NA	NA
11	JanubKurdufan (South Kordofan)	20	5
12	Kassala	NA	NA
13	Nahran Nil (River Nile)	35	1
14	Sharq Darfur (East Darfur)	NA	NA
15	Shimal Darfur (North Darfur)	25	-
16	ShimalKurdufan (North Kordofan)	64	14
17	Sinnar	NA	NA
18	Wasat Darfur (Central Darfur)	NA	NA

sugar industry alone accounts for nearly 98% of all wastewater generated, all of which is discharged into the Blue Nile River without any treatment. Tannery operations are the sole industrial activity where treatment is applied (i.e., partially activated sludge using aeration and a biological floc composed of bacteria and protozoa) before discharge into a water body.

1.12. Social fabric

Sudan's social fabric has been tested amidst a global COVID-19 pandemic that threatens to leave deep social, economic and political impacts for years to come, particularly in a country like Sudan that is already burdened by deep poverty and chronic conflict. The subsections below some of the ways the country is moving forward in addressing challenges to a more cohesive social fabric.

1.12.1. Women's empowerment

Although the Sudanese society can be considered a male-dominated one, notable strides have been made in recent years. The constitutional charter for the Transitional Period of Sudan called for the creation of the Women and Gender Equality Commission to ensure that women's empowerment and gender equality is prioritized going forward. This has been codified in Sudan's Constitution of 2019 (subsequently amended) that calls for gender considerations be accounted for within the fabric of future civil society. Specifically, Chapter 8 (Mandate of the Transitional Period), Article 7 calls on the transitional government to "Guarantee and promote women's rights in Sudan in all social, political, and economic fields, and combat all forms of discrimination against women, taking into account provisional preferential measures in both war and peace circumstances" (GoS, 2019).

1.12.2. Poverty

The country's poverty situation has been aggravated by prolonged years of conflict, a volatile security situation in the Darfur states, a political transition with the secession of South Sudan, an unsustainable national debt burden, international economic sanctions, and most recently, the overthrow of a political regime through peaceful protests in 2019. Many of these factors have severely constrained poverty reduction efforts and have entrenched Sudan within the "low human development" category, the lowest of the four categories that comprise the UNDP's Human Development Index (HDI). There has been negligible change in Sudan's HDI rank over the 2013-2020 period.

There are wide regional variations in poverty incidence across Sudan (AfDB, 2018). At the national level as of 2017, about 47% of the population (19.6 million people) lived below the national poverty line, with about 15% (6.3 million people) living on less than $1.90 per day on a purchasing power parity (PPP) basis. About 25.7% (10.7 million people) of the population can be classified as the "working

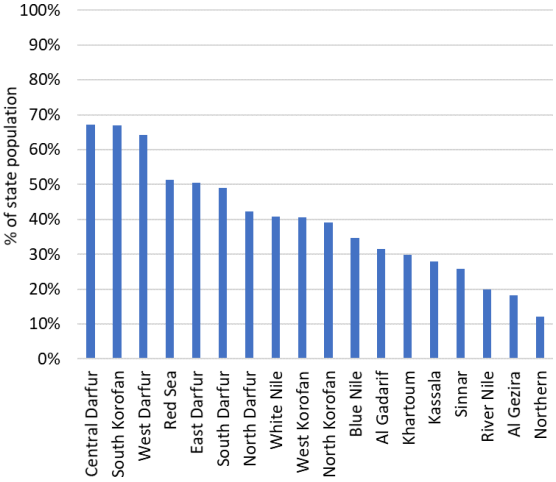


Figure 1-18: State-level poverty incidence levels in Sudan, 2014-2015 (AfDB, 2018)

poor" living on less than $3.20 per day on a PPP basis (UNDP, 2019). At the state level as of 2014-2015, those states with low poverty incidence - less than 20% of the state population - are the Northern, Al-Gezira, and River Nile states; the states with high poverty incidence – more than 50% of the state population - are the Red Sea and Central, South, and West Darfur states (AfDB, 2018).

The incidence of poverty ranges from a low of 12.2% of the state population in the Northern State to nearly 70% in Central Darfur (see Figure 1-21). Notably, Sudan's Ministry of Finance and Economic Planning estimates 65% of the population lives below the poverty line in 2020, largely due to the devaluation of the Sudanese pound which significantly reduced household purchasing power. The incidence of extreme poverty in rural areas is significantly higher than in urban areas (ESCWA, 2017; WB/MFEPA, 2013). In 2014, rural households in Sudan were 2.5 times more likely to be acutely poor than people in urban areas.

Extreme poverty in rural areas is also reflected in measures of food insecurity, with just over 10% of the rural population unable to satisfy basic nutritional needs and suffering from severe food insecurity. In contrast, only about 6% of Sudan's urban population faces similar food insecurity conditions (ESCWA, 2017).

1.13. Natural Resources

Sudan is rich in natural resources. In addition to the metals and minerals discussed previously, Sudan enjoys a bounty of water, land and renewable energy resources, as briefly described in the subsections that follow.

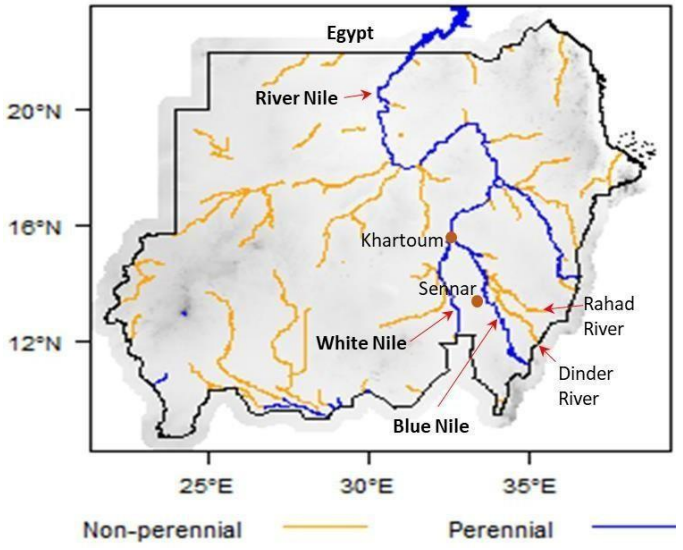


Figure 1-19: Major surface water features of Sudan (World Wildlife Fund HydroSHEDS; Digital Chart of the World drainage; and FAO Inland Water Bodies)

1.13.1. Surface water

There are numerous perennial and non-perennial rivers in Sudan (see Figure 1-22). Combined, these rivers represent a renewable surface water resource of about 35.8 billion m^3/year (FAO, 2011).

The River Nile is the major perennial river in the country. It consists of the Blue Nile which originates at Lake Tana in Ethiopia and flows northward. It is joined by two tributaries, the Dinder and RahadRivers between Sennar and Khartoum. It also consists of the White Nile which originates at Lake Victoria bordered by Uganda, Kenya and Tanzania. The two tributaries join at Khartoum to form the River Nile which flows northward through Egypt into the Mediterranean Sea.

1.13.2. Groundwater

Major groundwater aquifers in Sudan cover about 50% of the surface area of the country (see Figure 1-23) shows the distribution of these aquifers over Sudan. These aquifers fall under the following four categories: Nubian sandstone aquifers, Um Rawaba formation,

Alluvial aquifers (Wadi-filled) and Basement complex (Salama, 1976, Salih and Khadam, 1994; Salih 1994).

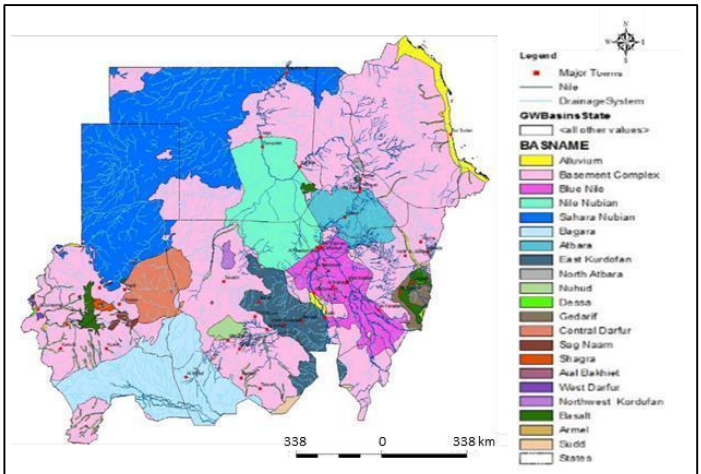


Figure 1-20: Groundwater basins in Sudan (source: Integrated Groundwater Resources Management within Reverbasins Workshop; Integrated Groundwater Resources Management in Sudan; Country paper Sudan; 15-17January 2019; Nairobi Kenya

The Nubian Sandstone Aquifers are the most extensive and largest aquifers in Sudan. They cover about 28% of the surface area of the country. They are preserved in nine major basins which are: Sahara Basin, Nile Basin, Atbara Basin, Central Darfur Basin, Blue Nile Basin, Nuhud Basin, Gadarif Basin, Sag El Naam Basin and Shagara Basin. The productive strata of these aquifers vary in thickness ranging from 100 to 2,000 meters. The sustainable well yield ranges from 100 to 400 m^3 per hour (2,400 – 9,600 m^3 per day). The depth to the groundwater table varies between 5 and 100 meters.

The Um Rawaba aquifers cover about 7% of the surface area of Sudan. They are preserved in three major basins which are: Bara Basin, Atshan Basin, and Baggara Basin. The aquifer thickness is very large, approximately 3,000 meters. Sustainable well yields are much lower than that of the Nubian Sandstone aquifers, ranging from 5 to 20 m^3 per hour (120 – 480 m^3 per day). The depth to the groundwater table varies from 10 to 150 meters below ground level.

The Alluvial aquifers are relatively small but numerous, rich and of high local importance. They are preserved in several water catchment areas, the most important of which are Gash, Wadi Azoum, Wadi Eldain, Wadi Nyala, KhorAbuhabil, Arbaat, Wadi Dordaib, and other minor catchment areas Alluvial basins are seasonal streams (known locally as Khors). They are typically located away from perennial rivers, as well as in areas where groundwater aquifers are unavailable. The runoff in these streams does not exceed three months per year. The runoff during this period is substantial and the aquifers are annually fully recharged through bed transmission from seasonal streams and wadis and represent a renewable groundwater source. The depth to the water table is shallow and usually varies between 2 to 15 meters. Well yields range between 50 and 100 m^3 per hour (1,200 – 2,400 m^3 per day).

For the Basement complex, groundwater is very scarce and is not replenished. However, water can be found in alluvial basins that are formed by seasonal streams in the basement complex. The recharge rate in alluvial aquifer is similar to those of other alluvial aquifers.

1.13.3. Fossil fuels

Sudan has significant amounts of proven oil reserves. Prior to the separation from South Sudan in 2011, Sudan had proven oil reserves of 5 billion barrels of crude oil including lease condensate reserves (USEIA, 2019). Due to the separation, the ownership and control of about 75% of its oil reserves were transferred to South Sudan. The result has been a

decrease in oil and other liquids production from 455,000 BBL/day in 2011 to 95,000 BBL/day in 2012 - the year after separation - to 82,000 BBL/day in 2019 (USEIA, 2019). While the lifting of US economic and trade sanctions on 13 January 2017 has been a positive development regarding the potential for foreign investment, there is as yet little progress toward developing new oil fields (USEIA, 2019).

In addition,Sudan has proven natural gas reserves of 3 trillion cubic meters as of January 2019 (USEIA, 2019). Despite these proved reserves - roughly double those of Kuwait and on par with those of Iraq - Sudan does not produce natural gas either for commercial use or for domestic consumption. All of it is either flared during oil extraction operations - about 383 million cubic feet in 2017 (NOAA, 2019) – or re-injected into associated oil fields. Regarding other resources, Sudan does not possess any other fossil fuels such as coal, oil shales, or tar sands.

1.13.4. Renewable energy

Sudan is endowed with a significant amount of renewable energy resources such as solar, hydro, wind, geothermal, and biomass. At present, except for large hydro and biomass, renewable resources remain largely untapped.

There are several hydroelectric dams on the Blue and White Niles, including the Sennar and Roseiresdams on the Blue Nile, and the Jebel Aulia Dam on the White Nile and Meroe Dam at the River Nile. There is also Lake Nubia on the Sudanese-Egyptian border. The total electric power potential from hydro dams is estimated at about 4,860 MW, with about 2,200 MW technically feasible through 2030 (Lahmeyer International, 2012; UNEP, 2017). Of this potential, Sudan's installed hydro capacity was 1,928 MW as of 2017 and consisted of six large reservoir dams (IRENA, 2019).Nevertheless, the current ambitious program of large hydroelectric dam construction on the Nile and its tributaries is expected to lead to riverbank erosion and loss of fertilizing silt.

The solar energy resource potential of Sudan is very high throughout the year and across the entire country (El Zein, 2017; Omer, 2015). Sudan is one of the 148 Sunbelt countries located close to the equator where the metrics used to quantify solar energy potential are very high for electricity generation via by photovoltaic (PV) or concentrating solar power (CSP) systems. Sudan's country-wide solar atlas for Global Horizontal Irradiance (i.e., the total amount of shortwave radiation received from above by a surface horizontal to the ground) shows values between 2,000 and 2,500 kWh/m^2 indicating very good solar potential for the use of PV technology (see Figure 1-24, left).

For wind, the highest average wind speeds are generally found in the areas close to the Red Sea as well as on ridgelines/plains in the central and northern parts of the country. At a height of 50 meters, there is a substantial wind resource in Sudan that could be tapped to generate electricity. At this height, the average wind power density ranges from about 250 to 664 watts (W) per m^2. The top 10% of land in the northern and north-eastern regionsof the country have an average wind power density of 500 W/m^2 which is at the lower bound of Wind Power Class 5, signifying good potential (see Figure 1-24, right).

Biomass (wood, agricultural residues, charcoal) availability is largely associated with use in rural communities across Sudan who rely on this resource for cooking (Omer, 2005; Omer, 2018). In rural areas of Sudan, most households do not have access to clean cooking fuels or modern technology and are reliant on inefficient cookstoves to burn biomass. In the case of

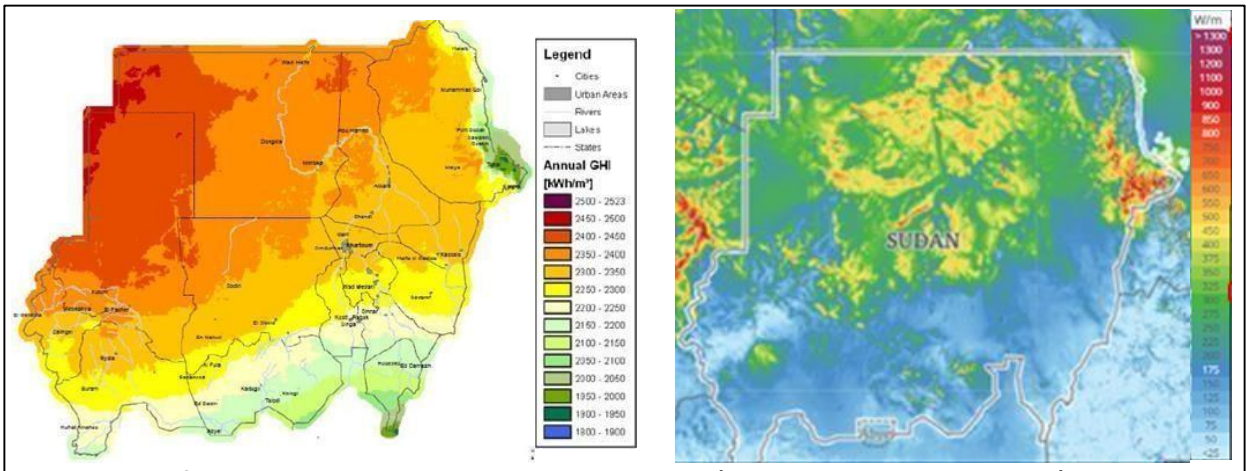


Figure 1-21: Left: Solar Global Horizontal Irradiance in Sudan (Lahmeyer International, 2012); Right: Wind resource potential of Sudan at 50 meters (DTU, 2019)

firewood and charcoal, this has led to environmental degradation as supplies of dead firewood are used up and communities rely on cutting down live trees in an unsustainable manner.

There is about 400 MW of potential geothermal energy in Sudan (REEEP, 2012). Geothermal potential is located in different regions around the country. For instance, in the Darfur region the JabelMarra volcano and the Tagbo and Beidob hills have registered good measurements, while further north towards the Red Sea there is geothermal activity near the Bayud volcano. Although there is currently no electricity from geothermal sources, the government is looking to neighbouring Kenya which has much experience in exploiting geothermal energy for guidance in this area (REEEP, 2012).

1.14. Institutional Arrangements

Sudan ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1993, the Kyoto Protocol in 2005, and Paris Agreement in 2017. Sudan is committed to international cooperation and the fight against the adverse effects of climate change.

In 1998, Sudan established a Climate Change Unit within the Higher Council for Environment and Natural Resources (HCENR) to coordinate with different national institutions, including government, research, academia, the private sector, and civil society institutions and organization to deal effectively with the challenge concerning climate change actions and responsibilities. The HCENR is chaired by the Minister of Environment and Natural Resources and Physical Development and its membership comprises all line ministries, state governments, academia, NGOs, and the private sector that work in the areas related to environment and natural resources.

The HCENR mandate includes, among others, coordination of Sudan's efforts to join and implement the multilateral environmental agreements. This includes climate change and the HCENR is the lead federal agency charged withaddressing and coordinating action on climate change issues. In addition, some states such as Khartoum state have setup Councils for Environment to deal with climate change issues at the state level. Under the leadership of the HCENR, Sudan has prepared its First and Second National Communications, its First Biennial Update Report, a National Adaptation Programme of Action (NAPA), a National

Adaptation Plan (NAP), a Technology Needs Assessment (TNA), a Technology Action Plan (TAP), and a Nationally Appropriate Mitigation Actions (NAMA) framework.

Based on the NAPA and NAP, several projects have been or are in the process of being implemented across 15 states in Sudan. Consistent with its mandate as a coordinating body, the HCENR convenes multidisciplinary teams representing its relevant member institutions and relevant national institutions (i.e., ministries, universities, private sector, NGOs, and other governmental bodies) is capacity building, awareness-raising, and programme/project development.

1.15. Financial, Technology, and Capacity Needs

While Sudan has advanced significantly in capacity for GHG inventory development, mitigation analysis, vulnerability assessment, adaptation strategy formulation, and other information relating to climate change, there remain important technical, institutional, and financial barriers and limitations for achieving the transparency obligations under the Paris Agreement. A Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis has identified the following areas of need for meeting the transparency requirements under the Paris Agreement.

- *Commitment.* To improve policies and legal arrangements for planning and fulfilling Sudan's obligations towards the Paris Agreement, the proposed institutional arrangements need to have national long-term commitments and procedural arrangements on transparency, including adopting proper policies and legal arrangements to support the implementation of the country transparency obligations under the Paris Agreement in a regular and improved manner, without being affected by future institutional changes.
- *Capacity.* The climate change unit of the HCENR needs to be strengthened to enhance its role in coordinating transparency under climate change, including measurement, reporting and verification (MRV), monitoring and evaluation (M&E) for climate change actions and support and tracking of NDCs, as well as the current requirements, including national GHG inventories, communication reports, and biennial update reports and adaptation actions.
- *Coordination.* A national inter-institutional mechanism is needed for better coordination between national institutions in which policy/decision-makers and technical experts from relevant institutions. Key institutions include representatives from government institutions, research, academia, the private sector, and civil society, coordinated and supported by the HCENR.
- *Knowledge.* Gender-relevant knowledge-generating and sharing mechanisms need to be developed that are suitable for relevant stakeholders at different sectors (both public and private) and levels (including policy and decision-makers, technical and administrative personnel, new graduates, and students). This should also include accessing media and to support public awareness through designing and publishing of press materials and perform public awareness sessions.

2. Greenhouse Gas Inventory

This chapter presents an inventory of greenhouse gases (GHG) for the years 2012, 2013, 2014, and 2015. It has been prepared to comply with the obligation under Article 4, paragraph 1(a), and Article 12, paragraph 1(a) of the United Nations Framework Convention on Climate Change (UNFCCC) for all parties have to communicate to the Conference of the Parties (COP) a national inventory of anthropogenic emissions by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies and following the provisions of Decision 17/CP.8.

The inventory addresses sources of GHGs, and removals by sinks, resulting from anthropogenic activities for the major greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and hydrofluorocarbons (HFCs). The gases are reported at the Tier 1 level for four sectors: Energy; Industrial Processes and Product Use (IPPU); Agriculture, Forestry and Other Land Use (AFOLU) and Waste. It represents the second update to the initial national inventory submitted as part of Sudan's Initial National Communication in 2003.

The rest of this chapter summarizes the results of Sudan's GHG inventory for the Base Year of 2017, as well as for the years 2012-2017. A complete and detailed reporting of GHG emissions by activity and gas, as well as details concerning data collection and validation processes, is available from the National Greenhouse Gases Inventory Report(HCENR, 2021).

2.1. Methodology

The methodology used in the development of the updated inventory is based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC, 2006). In addition, the Good Practice Guidance 2000 (IPCC, 2000) were consulted. Unless otherwise noted, central estimates of the default IPCC emission factors have been used. The calculation of carbon dioxide-equivalent values was based on Global Warming Potentials from the IPCC's Fourth Assessment Report. Version 1.3.2 of the 2006 GHG Software was used to derive the estimates and tabulate emissions from different sources and sinks.

The updated GHG inventory was prepared by a national team coordinated by the Climate Change Unit of the HCENR (Sudan national GHG Inventory team, 2021). About 50 experts from 19 relevant institutions including government, research, academia and civil society were trained in the methodologies and software and contributed to the preparation of the inventory (see Box 2-1). The overall team was organized into expert-led sector- based technical groups. Some of the participants had been involved in previous national GHG inventory processes.

Box 2-1: Participating Sudanese organizations in the development of the GHG inventory

1. Ministry of Energy and Petroleum
2. Ministry of Infrastructure and Transportation
3. Ministry of Agriculture and Forestry
4. Ministry of Industry
5. Ministry of Health
6. Ministry of Animal Resources
7. Forests National Corporation
8. Agricultural Research Corporation
9. Khartoum State Sanitary Corporation
10. University of Khartoum
11. Sudan University of Science and Technology
12. Ahfad University for Women
13. Remote Sensing and Seismology Authority
14. Higher Council for Environment, Rural and Urban Development
15. National Energy Research Center
16. Industrial Research and Consultancy Centre
17. Khartoum State Cleaning Corporation
18. Sudanese Environmental Conservation Society
19. Haggar Group

Data was collected for the 7-year period, 2011-2017. Because of its uniqueness as the year in which South Sudan seceded, the year 2011 is not typically included in the results reported in this Chapter.

Activity data was collected from a variety of sources including official governmental reports and statistics published scientific and technical research, survey/census data, and publications from international agencies such as the FAO and IEA. The IPCC's default emissions factors were used except for a few cases where local values and/or expert judgment were used (i.e., land use change and forestry, waste management, and industrial sectors).

2.2. Total GHG emissions

Table 2-1 presents total GHG emissions and sinks for the Base Year of 2017. Total GHG emissions in 2017 were 241,028Gg CO_2-equivalent (CO_2e), which includes 206,311Gg from agriculture, Forestry, and Other Land Use; 25,886Gg from energy; 6,647Gg from waste, and only 2,184Gg from industrial processes and product use.

Table 2-1: Total GHG emissions in Sudan, 2017

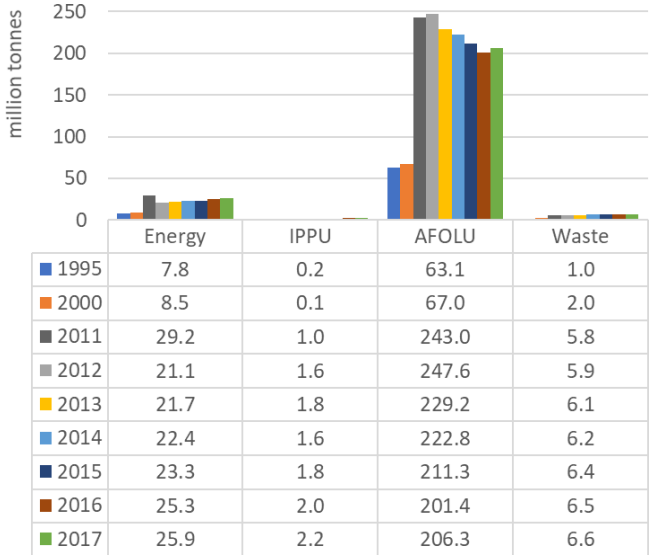
	CO_2e	Net CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
	(Gg CO_2e)	(Gg)			(Gg CO_2e)		
Total national emissions	**241,028**	31,676	8,342	3	20	0	0
1 Energy	**25,886**	18,133	295	1	0	0	0
2 IndustrialProcessesand Product Use	**2,184**	2,164	0	0	20	0	0
3 Agriculture, Forestry, and Other Land Use	**206,311**	11,353	7,796	0	0	0	0
4 Waste	**6,647**	27	251	1	0	0	0

Agriculture-related activities accounted for the dominant portion of GHG emissions in 2017. Approximately 86% of all CO_2e emissions are associated with enteric fermentation, manure management, and land use change. The combustion of fossil fuels in the energy sector accounts for only 11% of total national emissions. The remaining emissions are mostly associated with solid and wastewater management activities as industrial processes account for less than 1% of all emissions.

2.3. GHG emission trends

Figure 2-1 presents the trend in total GHG emissions for 1995 (Base Year of the initial GHG inventory), 2000 (Base Year for the SNC), and 2012 through 2017. Between 1995 and 2000, GHG emissions increased by about 8%; from 72.0 to 77.7 million tonnes of CO_2e. The 1995 and 2000 emission levels correspond to the combined emissions of Sudan and (now) South Sudan and are shown for reference purposes only.

Between 2000 and 2011 (the year of the secession of South Sudan in July



	Energy	IPPU	AFOLU	Waste
1995	7.8	0.2	63.1	1.0
2000	8.5	0.1	67.0	2.0
2011	29.2	1.0	243.0	5.8
2012	21.1	1.6	247.6	5.9
2013	21.7	1.8	229.2	6.1
2014	22.4	1.6	222.8	6.2
2015	23.3	1.8	211.3	6.4
2016	25.3	2.0	201.4	6.5
2017	25.9	2.2	206.3	6.6

Figure 2-1: CO_2e emission trends by sector, 1995, 2000, 2011-2017

of that year), GHG emissions increased by a factor of 2.6; from 77.7 to 278.9 million tonnes of CO_2e. Between 2012 and 2017, total GHG emissions have been decreasing at an average annual rate of 2.7%. The major drivers for changes in GHG emission levels over the 2012- 2017 period are briefly described in the bullets below.

- *Energy:* GHG emissions from energy use increased at an average annual rate of 4.2% per year. Increased fossil fuel consuming activities in electricity production, transport, and manufacturing are the primary reasons.
- *Industrial processes and product use:* GHG emissions from the industrial sector increased at an average annual rate of 6.4% per year. Increased emissions from cement and lime production are the primary reasons.
- *Agriculture, forestry and other land use:* GHG emissions from AFOLU decreased at an average annual rate of 3.6% per year. Reductions in biomass burning and improved forest management practices are the primary reasons for this declining trend.
- *Waste:* GHG emissions from the waste management sector increased at an average annual rate of 2.4% per year. An increase in methane emissions from municipal solid waste disposal is the primary reason.

Figure 2-2 (left) shows trends in emissions of the major GHGs, expressed in CO_2e. The overwhelming majority of emissions over the 2012-2017 period were in the form of methane, with emissions from biomass burning and livestock enteric fermentation accounting for the largest shares, about 74% and 20%, respectively (see Figure 2-2, right).

2.4. Energy

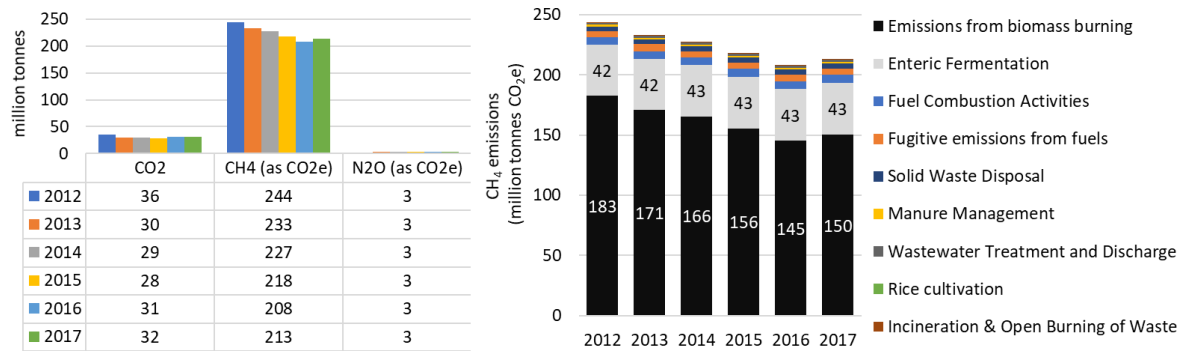


Figure 2-2: Left: CO_2e emission trends by GHG type, 2012-2017; Right: CH_4 emissions by activity (expressed as CO_2e), 2012-2017

Energy use across the major GHG-emitting activity is shown in Figure 2-3 (left). Energy use in the residential and transport sectors dominate fuel use, accounting on average for 70% of total fuel consumed over the period 2012-2017. The commercial and industrial sectors account for the next largest shares at 12% and 10%, respectively, over this period. Energy use across fuels is shown in Figure 2-3 (right). Biomass accounts for the largest share of fuel use, 58% on average, while gas/diesel and motor gasoline account on average for about 22% and 9%, respectively, of total fuel consumed over the period 2012-2017.

2.4.1. Overview

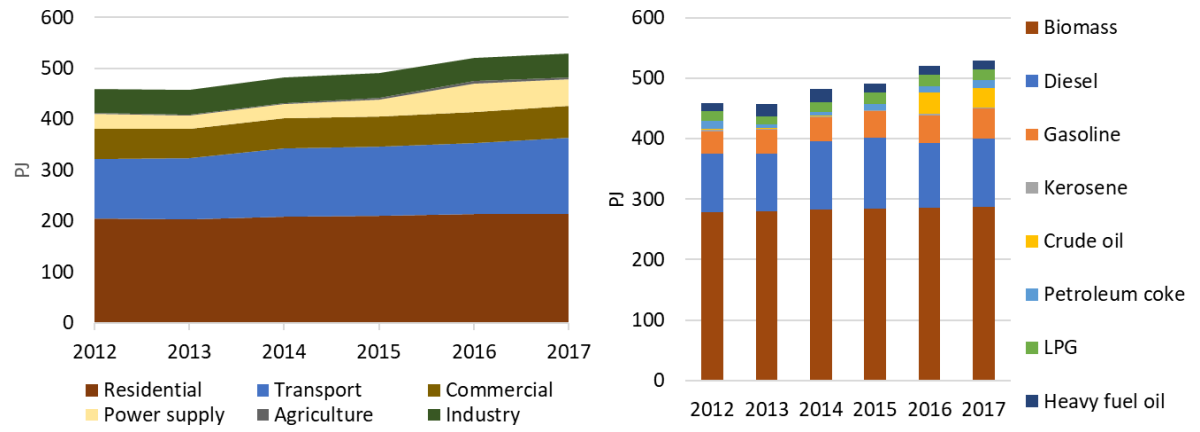


Figure 2-3: Left: Energy use by sector, 2012-2017; Right: Energy use by fuel type, 2012-2017

Energy use across the major GHG-emitting activity is shown in Figure 2-3 (left). Energy use in the residential and transport sectors dominate fuel use, accounting on average for 70% of total fuel consumed over the period 2012-2017. The commercial and industrial sectors account for the next largest shares at 12% and 10%, respectively, over this period. Energy use across fuels is shown in Figure 2-3 (right). Biomass accounts for the largest share of fuel use, 58% on average, while gas/diesel and motor gasoline account on average for about 22% and 9%, respectively, of total fuel consumed over the period 2012-2017.

2.4.2. Data sources

Activity and other data were obtained from several national sources. The Ministry of Water Resources and Electricity (MWRE) provided data regarding electricity and heat production. The administrative office of the Khartoum and El-Obied oil refineries provided activity data related to fuel used in refineries and the Ministry of Energy and Petroleum provided data for all other categories. Data regarding domestic and international aviation and water-borne navigation transport were obtained from Sudan Civil Aviation Authority and Ministry of Transport and Infrastructure, respectively.

Unless otherwise noted, central estimates of default emission factors were used to estimate the annual levels of GHG emissions based on default values from the 2006 IPCC Guidelines except in the case of net calorific values for certain fuels. The MWRE provided Sudan- specific net calorific values related to fuel used in electricity generation (heavy fuel oil, diesel oil, gas oil, crude oil, heavy Coker gasoil, sponge coke, and liquid petroleum gas (LPG).

2.4.3. Results

The energy sector is the second largest contributor to Sudan's total emissions. Relative to Sudan's overall anthropogenic GHG emissions, the energy sector represented shares of 7.6% in 2017 to 10.7% in 2017. Table 2-2 summarizes GHG emissions associated with energy sector for the years 2012 and 2017.

Energy sector emissions increased from 21,116 Gg CO_2e in 2012 to 25,886 Gg CO_2e, equivalent to an average annual rate of 4.2%. The highest GHG-emitting category is fuel combustion which accounted for between 75% and 79% of energy sector emissions. These emissions grew at an average annual rate of 5.3% and accounted for about 97% of the increase of 4,769 Gg CO_2e between 2012 and 2017. Similarly, fugitive emissions from the energy sector increased during this period at a much lower rate of about 0.5% per year.

Table 2-2: GHG emissions from Sudan's energy sector; 2012, 2017

		CO_2e (Gg)		CO_2 (Gg)		CH_4 (Gg)		N_2O (Gg)	
		2012	2017	2012	2017	2012	2017	2012	2017
Category	**Activity\Total**	**21,117**	**25,886**	**13,602**	**18,133**	**286**	**295**	**1**	**1**
Fuel combustion	Electricity Generation	2,483	3,956	2,475	3,943	0	0	0	0
	Petroleum Refining	0	0	0	0	0	0	0	0
	Manufacturing Industries and Construction	1,446	1,596	1,172	1,323	9	9	0	0
	Domestic Aviation	177	118	176	118	0	0	0	0
	Road Transportation	8,371	10,785	8,342	10,747	0	0	0	0
	Railways	0	0	0	0	0	0	0	0
	Domestic Water-borne Navigation	1	1	1	1	0	0	0	0
	Commercial/Institutional	505	752	0	227	17	18	0	0
	Residential	2,623	2,865	980	1,167	57	59	1	1
	Agriculture / Forestry / Fishing / Fish Farms	153	308	152	307	0	0	0	0
Fugitive emissions	Venting	129	128	1	1	5.1	5.1	0	0
	Flaring	297	294	291	288	0.2	0.2	0	0
	Production and Upgrading	4,513	4,466	12	12	180.0	178.2	0	0
	Transport	1	1	0	0	0.0	0.0	0	0
	Refining	3	2	0	0	0.1	0.1	0	0
	Distribution of oil products	415	615	0	0	16.6	24.6	0	0

At the activity level, the highest GHG-emitting activities are associated with fuel combustion from electric generation and road transportation, as well as fugitive emissions from oil production. Taken together, these activities account for 89% of energy sector emissions on average (see Figure 2-4, left). Carbon dioxide dominates emissions from the energy sector, accounting for nearly 71% on average during the 2012-2017 period (see Figure 2-4, right).

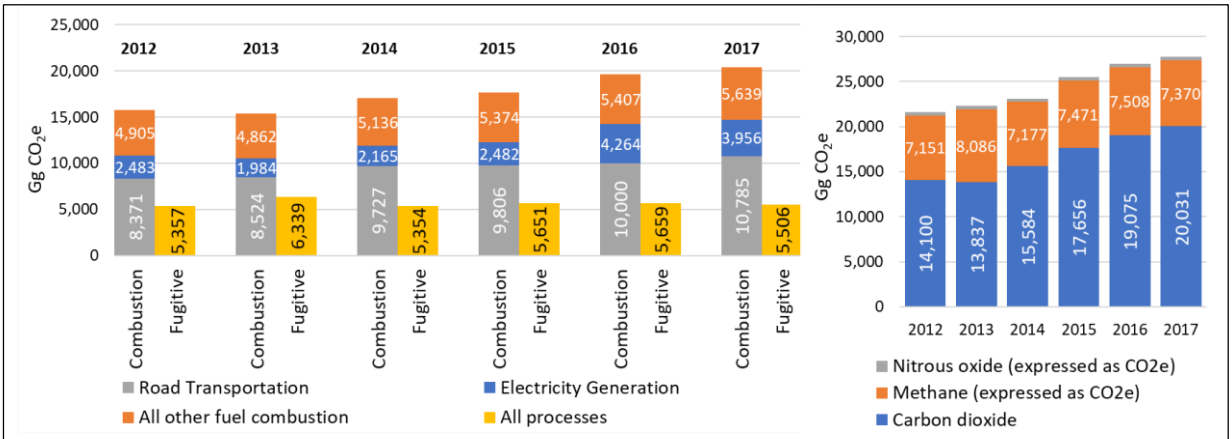


Figure 2-4: Left: Energy sector GHG emissions, by emission category and activity; 2012-2017; Right: Energy sector GHG emissions, by GHG type;2012-2017

The increase of 4,769Gg CO_2e is dominated by growth in electric generation and road transportation. Emissions from these activities grew at an average annual rate of 9.8% and 5.2%, respectively. Taken together, these activities accounted for 3,887Gg CO_2e of the increase, or about 82%. Notably, fugitive emissions from oil production account for only about 3% of the increase in emission levels, in contrast to about 24% on average of annual totals. Emissions from agriculture, forestry, fishing, and fish farm activities, while accounting for a small share of overall emissions (i.e., less than 1%) grew at the fastest annual rate, about 15.1% per year.

2.5. Industrial Processes and Product Use

Sudanese industry accounted for nearly 19% of GDP in 2012, with most of industrial operations being privately-owned. Main industries include tannery and leather production, weaving mills, spinning mills, gum arabic production, paper mills, minerals, ores, and raw materials extraction. Emissions from Sudan's industrial sector due to industrial processes; there are no emissions associated with product use of lubricants, paraffin wax, or solvents.

2.5.1. Overview

The only industries in Sudan that produce Industrial Processes and Product Use (IPPU) emissions are associated with cement and lime production, as well as the use of substitutes in refrigeration and air conditioning for ozone depleting substances. While there are several agriculturally based industries in Sudan that account for a significant share of annual GDP (e.g., sugar, flour milling, confectionary biscuits, textiles, edible oils, ethanol, animal and leather products, dairy products, animal fodder, and packing/canning activities), emissions associated with productive activities in these industries have been captured in the energy sector inventory; no process and product use emissions are produced by such industrial activities.

Other industries that produce process emissions such as chemical production, metals production, electronic production, and pulp/paper production are not found in Sudan. There are no process or product use GHG emissions associated with food and beverage production facilities.

2.5.2. Data sources

Activity and other data were obtained from several national sources. These includedstatistics from the Ministry of Industry, Central bank of Sudan reports, and published annual reports of various factories. Central estimates of default emission factors were used to estimate the annual levels of GHG emissions based on default values from the 2006 IPCC Guidelines. This introduced uncertainty in estimating emissions from clinker production as the raw material used in cement clinker likely contains amounts of magnesium oxide (MgO), which warrants the use of local emission factors. This is also the situation for dolomite lime processingaslocal dolomite lime may contain up to 20% or more of MgO.

2.5.3. Results

The IPPU category is the smallest contributor to Sudan's total GHG emissions maintaining a trend evident of earlier inventories. Relative to Sudan's overall anthropogenic GHG emissions, the industrial sector represented shares of 0.6% in 2012 to 0.9% in 2017. Table 2- 3 summarizes GHG emissions associated with the industrial sector for the years 2012 and 2017.

IPPU sector emissions increased from 1,600 Gg CO_2e in 2012 to 2,184 Gg CO_2e, equivalent to

Table 2-3: GHG emissions from Sudan's IPPU activities; 2012, 2017

	CO_2e (Gg)		CO_2 (Gg)		CH_4 (Gg)		N_2O (Gg)		HFCs (Gg CO_2e)	
	2012	2017	2012	2017	2012	2017	2012	2017	2012	2017
Activity \ Total	**1,600**	**1,798**	**1,580**	**1,775**	**0**	**0**	**0**	**0**	**21**	**23**
Cement production	1,563	1,748	1,563	1,748	0	0	0	0	0	0
Lime production	16	27	16	27	0	0	0	0	0	0
Refrigeration and Air Conditioning	21	23	0	0	0	0	0	0	21	23

an average annual rate of 6.4%. The highest GHG-emitting activity is cement production which accounted for more than 98% of IPPU emissions on average (see Figure 2-5, left). These emissions grew at an average annual rate of 6.5% and accounted for about 98% of the increase of 583 Gg CO_2e between 2012 and 2017.

Much of this growth in emissions from cement production is due to the expansion of the industry from the two factories represented in previous inventories to a total of five factories that were in operation during the 2012-2017 period. Notably, cement production grew at a much slower rate that lime production which grew at an average annual rate of 10.8%. The very high growth rate for lime production is due to an expansion in the number of lime kilns. HFC-134a emissions from refrigeration and air conditioning declined over the 2012-2017 period by an average rate of about 1.1% per year. Carbon dioxide dominates IPPU emissions, accounting for about 99% on average during the 2012-2017 period (see

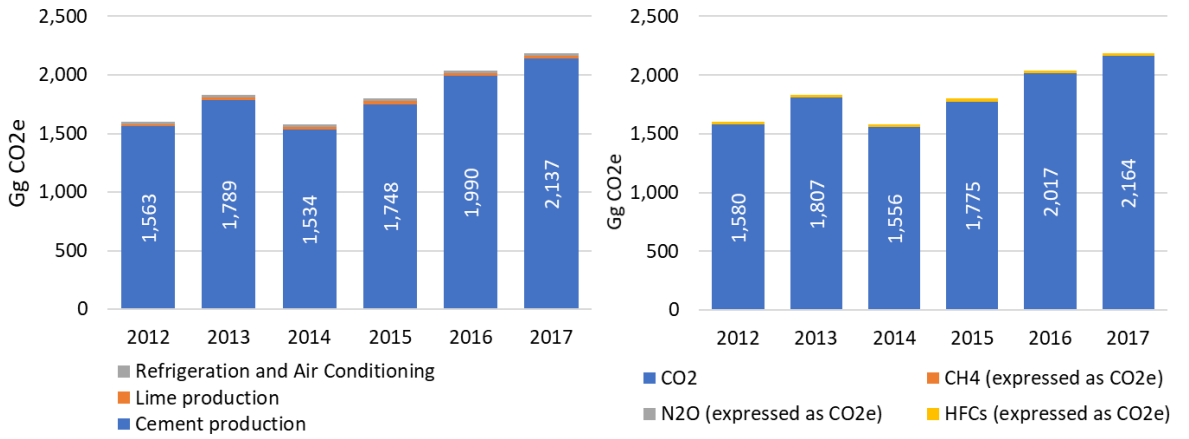


Figure 2-5: Left: IPPU GHG emissions, by activity, 2012-2017; Right: IPPU GHG emissions, by GHG type,2012-2017

Figure 2-5, right).

2.6. Agriculture, Forestry and Land Use

The agriculture, forestry and fisheries sector accounted for about 30.4% of GDP in 2012 (Bank of Sudan, 2012) and is responsible for most of the laborforce.Agricultural practices comprise into three major farming systems: irrigated, mechanized rain fed and traditional rain fed. About 70% of the population are agro-pastoralists depending on traditional subsistence crop production and livestock husbandry for their livelihoods.

2.6.1. Overview

Agricultural activity is dominated by small-scale farmers who employ largely rain-fed traditional and rain-fed mechanized practices, accounting for about 93% of the land under cultivation during the 2012-2017 period. Sudan's diverse agroecological zones (i.e., desert, low rainfall savannah, semi-desert, and high rainfall savannah) offer good potential to produce a range of crops (cotton, cereals, oilseeds, groundnuts, wheat, sesame, sorghum, millet, and assorted vegetables), as well as to sustain large livestock herds (camels, sheep, goats). Figure 2-6 (left) shows the extent of land area converted to cropland by agroecological zone over 2012-2017 and Figure 2-6 (middle) shows the composition and magnitude of livestock over this period.

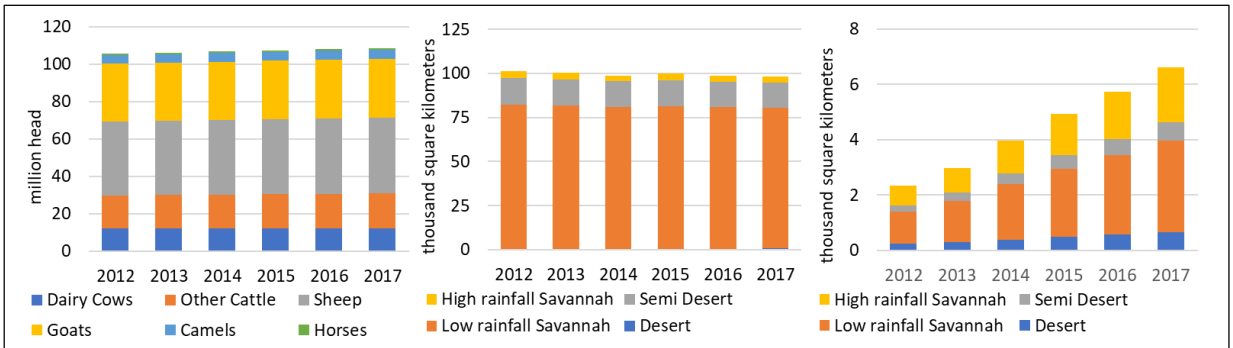


Figure 2-6: Left: Number of livestock, by animal type; 2012-2017; Middle: Land converted to cropland, by agroecological zone, 2012-2017; Right: Land converted to forest, by agroecological zone, 2012-2017

Forested areas are defined in Sudan as areas of more than 0.5 ha with trees that are at least 2meters tall and a minimum tree canopy cover of 10%. Such areas have steadily increased in Sudan, from 2.5 thousand km^2in the 1960s to roughly 12 thousand km^2 at present. Forested areas are managed by the Forest National Corporation whose mandate is to improve forest management practices and increase forest reserves and protected areas. Sudan's forests and species composition closely follow rainfall trends, with forests taking the form of bush land and scattered trees and shrubs in the north and in the form of dense forests with large acacia and broad-leaved trees in the southern end of the savanna and montane region. Figure 2-6 (right) shows the extent of land area converted to forest by agroecological zone over the 2012-2017 period.

2.6.2. Data sources

Activity and other data were obtained from several national sources. Animal and manure management statistics were obtained from the Ministry of Livestock Information Centre. Annual volumes of wood and fuelwood removal were obtained from statistics maintained by the Forest National Corporation. Forested areas affected by disturbance (i.e., burned areas) were extracted from NASA's publicly available Moderate Resolution Imaging Spectroradiometer data products (MCD45, 2015).

2.6.3. Results

Emissions from AFOLU activities are the largest contributor to Sudan's total emissions. Relative to Sudan's overall anthropogenic GHG emissions, AFOLU represented shares of 89.5% in 2012 to 85.0% in 2017. Table 2-4 summarizes GHG emissions associated with AFOLU activities for the years 2012 and 2017.

AFOLU emissions decreased from 247,585 Gg CO_2e in 2012 to 206,320 Gg CO_2e, equivalent to an average annual rate of -3.6%. The highest GHG-emitting category is aggregate sources and non-CO_2 emissions sources on land which accounted for nearly 74% of AFOLU emissions. These emissions declined at an average annual rate of 3.9% and accounted for about 79% of the decrease of 41,265 Gg CO_2e between 2012 and 2017. In contrast, emissions associated with livestock increased during this period at a rate of about 0.4% per year, while emissions associated with land management declined at an average annual rate of 14.7%, over thirty times faster.

At the activity level, the highest GHG-emitting activities are associated with emissions from biomass burning and enteric fermentation. Taken together, these activities account for 92%

Table 2-4: GHG emissions from Sudan's AFOLU activities; 2012, 2017

		CO_2e (Gg)		CO_2 (Gg)		CH_4 (Gg)		N_2O (Gg)	
		2012	2017	2012	2017	2012	2017	2012	2017
Category	**Activity\Total**	**247,585**	**206,320**	**20,873**	**11,362**	**9,063**	**7,796**	**0.5**	**0.2**
Livestock	Enteric Fermentation	42,209	43,168	0.00	0.00	1,688	1,727	0.0	0.0
	Manure Management	1,483	1,483	0.00	0.00	59	59	0.0	0.0
Land	Forest land	16,278	4,856	16,278	4,856	0.0	0.0	0.0	0.0
	Cropland	4,599	4,599	4,599	4,599	0.0	0.0	0.0	0.0
	Grassland	-4	-47	-4	-47	0.0	0.0	0.0	0.0
Non-CO_2 emissions sources on land	Emissions from biomass burning	182,715	150,122	0.0	0.0	7,309	6,005	0.0	0.0
	Urea application	0.12	1,953	0.12	1,953	0.0	0.0	0.0	0.0
	Indirect N_2O Emissions, managed soils	143	54	0.0	0.0	0.0	0.0	0.5	0.2
	Rice cultivation	161	132	0.0	0.0	6.4	5.3	0.0	0.0

of AFOLU emissions on average over the 2012-2017 period (see Figure 2-7, left). Methane dominates AFOLU emissions, accounting for around 93% on average during the 2012-2017 period (see Figure 2-7, right).

The decrease of 41,265 Gg CO_2e is dominated by a reduction in emissions from biomass burning and reduction in emissions from forested lands. Emissions from these activities declined at an average annual rate of 3.9% and 21.5%, respectively. Taken together, these activities offset by over 15 times the 2,911 Gg CO_2e increase in emissions associated with enteric fermentation, manure management, and urea application which only grew at an average annual rate of 1.3%.

2.7. Waste

The majority of Sudan's population is rural, with an urban population of just 34%. The largest metropolitan area is the capital Khartoum with around 7 million people and growing rapidly. Khartoum is also home to approximately 2 million displaced people from the southern war zone and the drought-affected areas in the west and east. In both settings, urban and rural, waste management is not well advanced and is typically addressed in traditional ways regardless of whether the waste is solid, liquid, industrial or domestic in nature. This has led to health hazards in both rural and urban areas as well as a source of environmental degradation in both urban and rural areas.

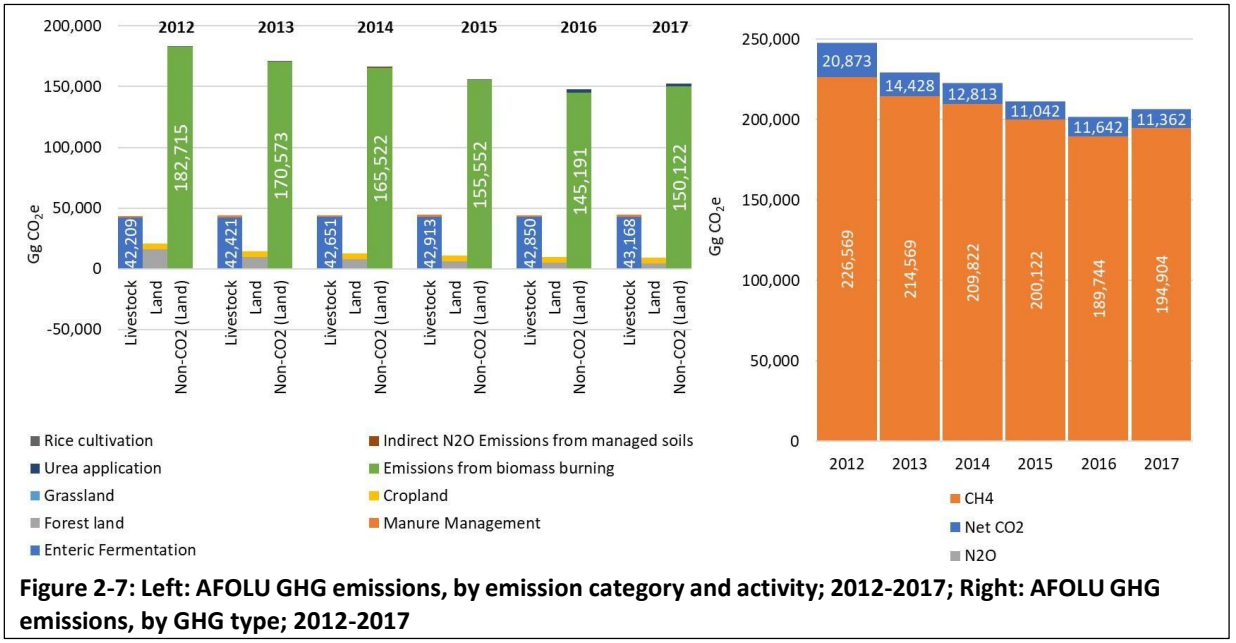


Figure 2-7: Left: AFOLU GHG emissions, by emission category and activity; 2012-2017; Right: AFOLU GHG emissions, by GHG type; 2012-2017

2.7.1. Overview

Currently, MSW management is inadequate in Sudan. Waste streams are unsegregated, waste collection is not systematic, and solid waste disposal sites are shallow, poorly designed and mostly unmanaged. Less than a third of estimated five thousand tons per day of municipal solid waste generated in Khartoum is collected. Most of this collected waste is dumped in shallow, unmanaged landfills with little engineering integrity, with a significant portion either openly burned or uncollected leaving a large proportion of the population without access to proper MSW disposal alternatives (see Figure 2-8, left).

Wastewater management is also inadequate. There are only two wastewater treatment plants, both located in Khartoum state and serving only 5% of the population. However, there are other wastewater treatment systems that are available and which are used widely across the country, including septic tanks, latrines and pits. Plans are process to build two new wastewater treatment facilities. Overall, nearly 70% of the population only have access to outdoor latrines and only 10% have access to wastewater treatment in anaerobic shallow lagoons (see Figure 2-8, right).

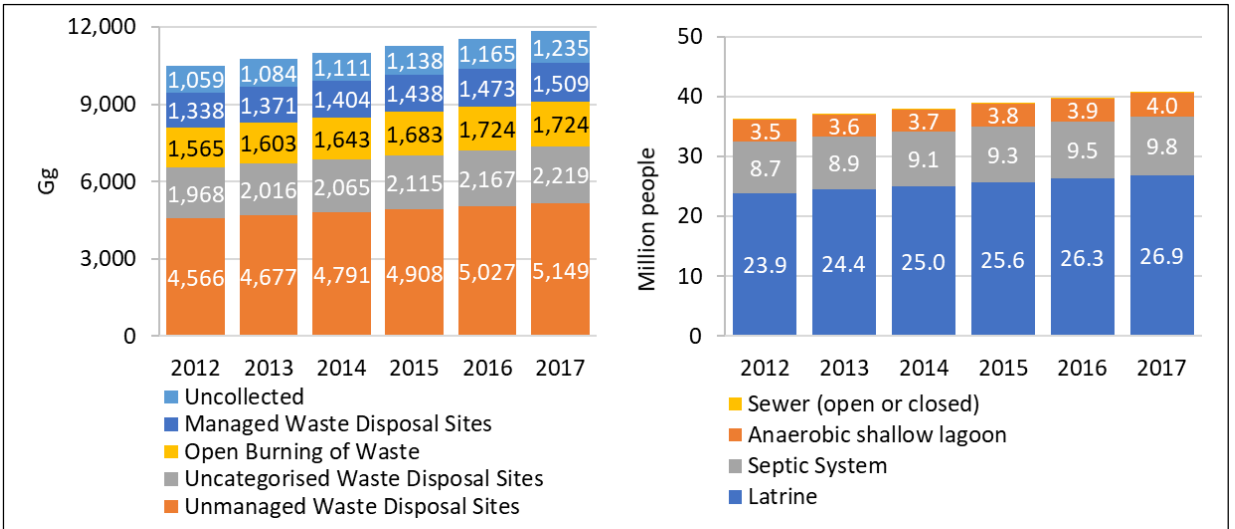


Figure 2-8: Left: MSW generation, by disposal method, 2012-2017; Right: Access of the population to wastewater treatment options, 2012-2017

2.7.2. Data sources

Activity and other data were based on assumptions validated by consultations with local experts. Estimates of Sudan-specific values of MSW composition going to solid waste disposal sites and methane correction factors for different type of MSW management systems were obtained from the Khartoum State Clean Corporation.

2.7.3. Results

The waste category is the third largest contributor to Sudan's total GHG emissions maintaining a trend evident of earlier inventories. Relative to Sudan's overall anthropogenic GHG emissions, the waste management activities represented shares of 2.1% in 2012 to 2.7% in 2017. Table 2-5 summarizes GHG emissions associated with waste management activities for the years 2012 and 2017.

Table 2-5: GHG emissions from Sudan's waste management activities; 2012, 2017

		CO_2e (Gg)		CO_2 (Gg)		CH_4 (Gg)		N_2O (Gg)	
		2012	2017	2012	2017	2012	2017	2012	2017
Category	**Activity\Total**	**5,916**	**6,647**	**24**	**27**	**223**	**251**	**1.1**	**1.2**
Solid waste disposal	Managed Waste Disposal Sites	647	735	0.00	0.00	26	29	0.0	0.0
	Unmanaged Waste Disposal Sites	2,207	2,507	0.00	0.00	88	100	0.0	0.0
	Uncategorized Waste Disposal Sites	951	1,081	0	0	38	43	0.0	0.0
Incineration	Open Burning of Waste	319	351	24	27	10	11	0.1	0.1
Wastewater Treatment and Discharge	CH_4 Emissions from Domestic Wastewater Treatment/Discharge	1,506	1,658	0	0	60	66	0.0	0.0
	N_2O Emissions from Domestic Wastewater Treatment/Discharge	279	307	0	0	0	0	0.9	1.0
	CH_4 Emissions from Industrial Wastewater Treatment/Discharge	8.9	9.2	0	0	0.4	0.4	0.0	0.0

Waste management emissions increased from 5,916 Gg CO_2e in 2012 to 6,647 Gg CO_2e, equivalent to an average annual rate of 2.4%. The highest GHG-emitting category is solid waste disposal which accounted for about 65% of waste emissions. These emissions increased at an average annual rate of 2.6% and accounted for about 71% of the increase of 731 Gg CO_2e between 2012 and 2017. Emissions associated with incineration and open burning of waste and wastewater treatment and discharge increased during this period at about 1.9% per year.

At the activity level, the highest GHG-emitting activities are associated with emissions from unmanaged waste disposal sites and methane emissions from domestic wastewater treatment and discharge. Taken together, these activities account for 63% of waste-related emissions on average over the 2012-2017 period (see Figure 2-9). Methane dominates waste emissions, accounting for around 94% on average during the 2012-2017 period.

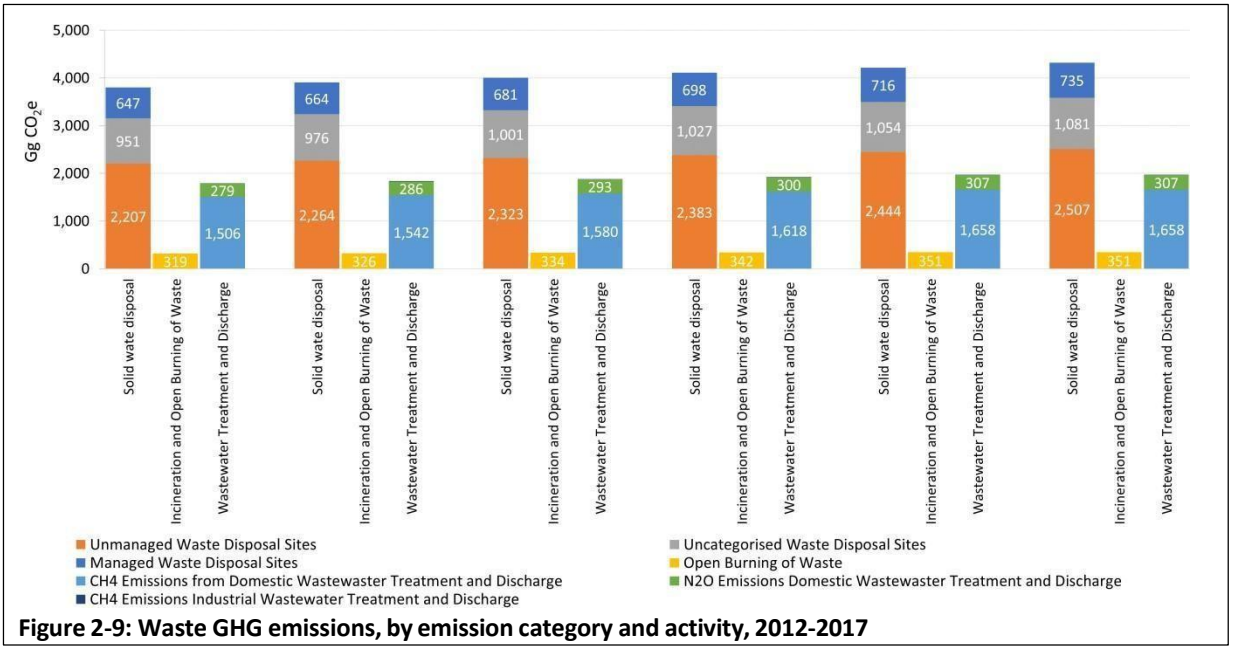


Figure 2-9: Waste GHG emissions, by emission category and activity, 2012-2017

2.8. Uncertainty Assessment

A quantitative uncertainty assessment was carried out for the energy and IPPU emission

categories. This involved applying the 2006 IPCC Guidelines to quantify the uncertainties at

the activity level. Approach 1 was used to combine uncertainties in activity data and

emission factors for each category and greenhouse gas. Quantitative estimates of uncertainty for activity data by fuel type were based on 2013; quantitative estimates of uncertainty for emission factors by emission and fuel type were based on 2013. These uncertainties where then aggregated for all categories and GHG components to obtain the total uncertainty for the energy and IPPU portions of the inventory (see Table 2-6).

Table 2-6: Results of uncertainty assessment

		Quantitative		Qualitative		
Category	Activity	Percentage uncertainty in total inventory	Trend uncertainty	Emission factor	Data quality	Confidence in results
Energy	All	72.0%	70.2%	Not applicable	Not applicable	Not applicable
Industrial process and product use	All			Not applicable	Not applicable	Not applicable
Agriculture, Forestry, and Land Use	Enteric fermentation	Not available	Not available	Medium uncertainty	Good quality	Medium
	Manure management			Medium uncertainty	Poor quality	Low
	land			High uncertainty	Medium quality	Medium
	Aggregate sources and non-CO_2 emissions on land			Medium uncertainty	Medium quality	Medium
Waste	Solid Waste Disposal	Not available	Not available	Not available	Not available	Not available
	Open Burning of Waste			Not available	Not available	Not available
	Domestic Wastewater Treatment and Discharge			Not available	Not available	Not available
Total		Not available	Not available	Not applicable	Not applicable	Not applicable

For the AFOLU category, an analysis applying the 2006 IPCC Guidelines to quantify the uncertainties at the activity level was not undertaken. This is due to the fact that the uncertainty assessment required a lot of detailed activity data which wasn't available for the forestry sector. Nevertheless, a qualitative estimate is provided in Table 2-6. For the waste category, an analysis applying the 2006 IPCC Guidelines to quantify the uncertainties at the activity level was also not undertaken. This is due to the fact that the uncertainty assessment required detailed data which is currently not available.

2.9. Quality Assurance, Quality Control and Verification

Quality control (QC) activities were carried out in accordance with 2006 IPCC Guidelines. QC

activities took place during activity data collection, data validation and data entry in the IPCC's inventory software. Numerous meetings and workshops were organized to review the collected activity data, emission calculations and collective results from each emission category. A detailed checklist was assembled and systematically addressed over the course of

the inventory development process. This ensured the avoidance of double-counting, the use of correct emission factors, the elimination of transcription errors, etc. External reviews by outside experts were also commissioned to undertaken independent checking of results. Emission and activity data were verified by comparing them with other available data that had been compiled independently of the GHG inventory development process. These included secondary data, research projects and programs initiated to support the inventory system, or while for other purposes were relevant to inventory preparation.

2.10. Recommendations

The process of addressing problems and overcoming challenges in the development of the inventory involved keeping a detailed log of recommendation for improving the process for subsequent inventories. The subsections below section summarize recommendation for future inventories.

2.10.1. Energy

For all activities, it is recommended that the Monitoring, Reporting, and Verification (MRV) system in the process of being developed include a data sharing agreement and a set of quality control procedures. This should lead to improved and more detailed data collection for fuel consumption (especially for road transport and aviation); improved collection of activity data; improved identification of fuel specifications including producing national calorific values; improved file management and inter-agency communication; and better data on auto producers of electricity and process heat. Regarding military and fugitive emission- related activities, it is recommended that a suitable data sharing agreement be established that accounts for the need for confidentiality.

2.10.2. Industrial Processes and Product Use

The following recommendations are offered for improving the quality of the IPPU portion of the future inventories:

- *Develop a systematic database system:* There is no regularly updated survey and hence reliable data, since the comprehensive industrial survey is carried out only once every 10 years, and the last one was completed in 1989. It is therefore recommended that an industrial database be developed and regularly maintained;
- *Conduct surveys:* These should be carried out to better represent the production for currently unaddressed industrial sub-sectors such as foundry industry, ceramic and pottery, concrete products, lubricant oil, asphalt roofing and paving, fugitive emission of HFCs/PFCs and the plastics industry; and
- *Strengthen local technical capacity:* There is an overall need for greater local capacity building in the industrial process area of GHG inventory development. Therefore, a training strategy should be developed and implemented prior to the next update to inventory.

2.10.3. Agriculture, Forestry and Land Use

The following recommendations are offered for improving the quality of the agriculture portion of the future AFOLU inventories:

- *Obtain suitable software:* There is need for development of country specific software as the use of the 2006 Software was quite challenging for the computation of the inventory results as it is not able to account for the diverse climatic conditions of Sudan which affects the results;
- *Conduct livestock surveys:* These should be carried out to better represent the number of livestock. The last livestock inventory was in 1976 and as a result the current inventory relied on available estimates rather than actual recent census numbers for

each animal type. Accurate estimates of animal number will increase the accuracy of the inventory;

- *Conduct manure management surveys:* There is need for increase of accuracy of the amount of manure used for determination of emission from manure management. The amount of manure used in the current inventory was based on estimation techniques, with little in the way of a solid evidentiary basis; and
- *Re-examine earlier inventories:* Recalculation of emissions for the year 2000 will benefit agriculture sector particularly as relate to manure management and agriculture soils. The use of 2006 IPCC guidelines showed a large difference (between 2000 and 2013) in the amount of emissions from these subcategories. The variation could be an outcome of the difference in the methodologies, as in 2000 the Revised 1996 IPCC guidelines were applied.

The following recommendations are offered for improving the quality of the forestry portion of the future AFOLU inventories:

- Develop a template for data recording for each sub-category;
- Prepare a guide for the use of the guidelines of the IPCC and explain clear procedures for vetting;
- Reconfigure data templates relative to ecological zones because the data are required by ecological zones while presently data are provided at the state level;
- Carry out studies to calculate emission factors for Sudan because all the emission factors used were default, or develop local emissions based on peer reviewed literature;
- Carry out studies to calculate the land converted to forest, crop, grass, settlement and other land;
- Promote institutional cooperation to enhance the quality and timely preparation of the GHG inventory;
- Strengthen national capacity through additional in-depth training of national experts on inventory methodologies.

2.10.4. Waste

The following recommendations are offered for improving the quality of future waste inventories:

- *Enhance municipal capacity:* Currently, the capacity of municipalities and the amount of resources they are able to invest in solid waste management is very limited. Additional staffing and the allocation of resources will be necessary to improve solid waste management and the quality of data collection; and
- *Strengthen institutional cooperation:* There should be a designated focal institution, which acts in support of other national agencies and ministries to collect and update waste generation and waste treatment data on a regional basis.

3. Mitigation actions and their effects

This chapter presents information about Sudan's intended actions from 2016 onwards to reduce the growth of future GHG emissions and increase GHG removals by sinks. All actions are aligned with the government's plans to implement low carbon development interventions in the energy, forestry, and waste sectors, consistent with Sudan's national development priorities, objectives, and circumstances. Sudan's proposed mitigation actions are briefly described below in accordance with the BUR guidelines established by UNFCCC as adopted in Decision 2/CP.17.

3.1. Background

Sudan's First and Second National Communications to the UNFCCC provided an overview of the direction envisioned regarding policies and measures to achieve future GHG emission reductions. The focus was on the energy sector to avoid emissions, and on the forestry sector to sequester emissions. There were also several cross-cutting initiatives to improve the enabling environment for GHG mitigation initiatives. At the time of these earlier communications, waste management had not yet been identified as an area of focus. Table 3-1 summarizes the range of GHG mitigation strategies that were identified as promising at the time.

Subsequently, the HCENR coordinated a Technology Needs Assessment for Climate Change. The carbon footprint of technologies in the energy and non-energy (i.e., agriculture, forestry) sectors was evaluated relative to their mitigation potential. Several priority technologies focusing on renewable energy and energy efficiency were identified from this effort, as briefly summarized below:

- *Energy efficiency:* Priority technologies identified were compact Florescent lighting for the residential sector and Mass Transport/Buses technology for the transport sector;
- *Cooking efficiency:* Improved stoves was a priority technology for the forestry sector in reducing the potential for unsustainable firewood consumption; and
- *Biogas digesters:* Anaerobic fermentation technology in biogas units

Table 3-1: Sudan's previously proposed GHG mitigation strategies

Area	GHG mitigation strategy
Energy	Increase and invest in electricity generation from geothermal resources in Sudan.
	Apply and enforce the Environment Protection Act in Petroleum Industry to minimize pollution and reduce GHG emissions.
	Conserve energy and encourage the use of highly efficient appliances and equipment.
	Switch from the use of traditional fuels (firewood & charcoal) in the household, industry, and commercial sectors to more efficient fuels.
	Reform the energy pricing policy and fuel subsidies in such a way as it encourages the use of more efficient technology.
	Encourage the introduction of more efficient means of transport, especially mass transport.
	Redesign the construction of roads and rehabilitation of the existing roads to reduce annual vehicle miles travelled.
	Reduce waste in production, transportation, and consumption of energy (petroleum products & electricity)
Forestry	Afforestation in irrigated and rainfed agricultural areas
	Afforestation in degraded areas of national forest reserves
Cross-cutting	Promote awareness of climate change and its potential impacts within government ministries, in schools and universities, and at the local community level.
	Strengthen energy research in the fields of M&E and R&D i.e., increase, rehabilitate, and upgrade the meteorological stations that provide the required data particularly in the most vulnerable areas.
	Invest and mobilize resources on education, training, and public awareness programs, climate change research, and systematic observation networks.

were identified as the highest priority technology option applicable to the livestock subsector of the agriculture sector.

3.2. GHG mitigation potential

In the intervening years since its earlier assessment of GHG mitigation options, there has been considerable progress is refining the estimates of renewable resource and energy efficiency potential.

- *Geothermal:* Sudan has geothermal resources in different parts of the country (Beoda desert, Red Sea, Jabal Mara in western Sudan). Approximately 100 MW could be readily exploited at reasonable cost;
- *On-Shore wind:* A global wind atlas has been developed that includes detailed information on Sudan. There are large areas in the Northern and Red Sea states that are characterized by wind speeds in excess of 8 meters per second (Power Class 6; excellent wind resource). The Ministry of Energy and Mining is exploiting this potential with the installation of a 100 MW windfarm in Dongola locality with another 180 MW under study in the Red Sea state.
- *Efficient lighting:* Most residential and commercial lighting in Sudan uses low efficiency Tungsten filament light bulb (60-100W). Replacing this technology with Compact Fluorescent Lighting (CFL) are at least 5 times as efficient and can lead to substantial electricity savings depending on the penetration level;
- *Alternative fuels for mass transport:* The use of Compressed Natural Gas (CNG), biodiesel fuel, and/or and electric motors for the bus mass transit fleet in Khartoum and other large urban areas as a replacement for diesel fuel can not only provide GHG reduction benefits but also air pollution reduction co-benefits;
- *Improved Cook Stoves:* These improved stoves are typically 35 % more efficient than the traditional three-stone open-fire stoves which is the traditional method used by rural households. These stoves reduce the rate of desertification as it uses a small amount of fuelwood compared to traditional stoves;
- *Biogas digestors:* The livestock subsector is quite large in Sudan will millions of head of cattle whose dung when decomposing produces methane. Anaerobic fermentation in biogas digestors process dung anaerobically to produce flammable gas that can be used for different energy purposes. The difference between the carbon dioxide emissions from combustion of the digestor gas and methane can be substantial;
- *Livestock ration modification:* Ration modification can take place either through replacing foraged sources with alternative feeds which in turn can reduce the quantity of methane gas emitted by animals;
- *High efficiency boilers:* Sudan's industrial sector, while still comparatively small, relies exclusively on diesel fuel. The introduction of efficient boilers as well as fuel switching to LPG instead of diesel can lead to significant GHG reductions;
- *Alternative fuels in cement production:* This involves the use of scrapped tires as an alternative fuel in cement kilns with its high calorific value compared to other wastes, it provides the potential to address both waste management and GHG mitigation objectives;

- *Compressed Stabilized Earth Blocks:* This is a product made of soil and stabilizer and reduces pollution and GHG emissions compared to fired bricks. GHG emission rates are 2.4 times lower than wire cut bricks and 7.9 times lower than fired bricks; energy consumption is 4.9 times lower than wire cut bricks and 15.1 lower than fired bricks; and
- *Cement extenders:* This involves the use of use of pozzolans in Sudan's cement industry as an additive to Portland cement concrete mixture to increase the long-term strength and reduce the material cost of concrete. Generally, cement with pozzolans do not require pre-processing and therefore can save very significant quantities of energy and corresponding lower CO_2 emissions as a substitute for regular cement.

3.3. National policy context for GHG mitigation

The development of a set of priority GHG mitigation is taking place against a background of national plans, programmes and vision documents that have been developed on the basis of supporting legislation. Table 3-2 provides a summary of the national policy/legislative context currently in placefor promoting sustainable development.

Table 3-2: Sudan's programme and legislative context for GHG mitigation strategy development

Agriculture	The Agricultural Revival Program	• Quarter Centennial Strategy Plan (2007-2032) • The Second Five Year Plan (2012 -2016)
Energy	Sudan Energy Efficiency Plan (2013-2016) Renewable Energy Master Plan (REMP) National Strategic Plan for Sudan (2007-2011) Intended Nationally Determined Contributions (INDCs) (2015) The MWRE long term plan (2012-2031) National Strategic Vision (2001-2025) National Clean Development Mechanism (CDM) Strategy (2011) Sudan's National Adaptation Programs of Action (NAPA, 2007) The Long-Term Power System Plan (2012-2031) Electricity Sector Development Framework (2015-2020) National Strategic Vision (2001-2025) National Energy Efficiency Action plan (NEEAP)	• Environmental Protection Act (2001) • Petroleum Wealth Act, (1998) • Regulations for Protection of the Environment in the Petroleum Industry (2001) • The national energy policy • Mineral Resources and Mining Act (2005) • Environmental Health Act (2008) • The Industrial Waste Local Order for Khartoum North (1971) • Environmental Protection Law 2008 by Khartoum State Ministry • Sudanese Standard and Meteorological Organization (SSMO)
Waste	Sudan National Sanitation and Hygiene Strategic Framework Sudan Sanitation and Water for All (SWA) Movement	• Standards of pollutants emitted from different industries
Land Use Change and Forestry	A 5-year forest program (2015-2019) The Natural Resources Strategy (2003-2027) Sudan's Forest Products Strategy (2003- 2027)	• Central Forest Law (1932) • Provincial Forest Law 1932, revised in 1989 and updated in 2005 • Royalty Order (1939), revised in 1989 and updated in 2005 • Sudan Forest legislation (2005) • Forests Act of (1989) • Forests National Corporation Act of (1986) • Forests and Renewable Natural Resources Act of (2002) • National Land Act (2009) • Combat Desertification Act (2009)

3.4. Penetration targets by 2030

In the intervening years since its earlier assessment of GHG mitigation options, there has been considerable progress is developing an expanded list of GHG mitigation opportunities in strategic sectors. Today, Sudan's long-term mitigation plan is to reduce GHG emissions

through the introduction of specific actions across energy, waste management and forestry that are closely aligned with national priorities to promote sustainable resource management, facilitate technology transfer, and strengthen capacity (see Table 3-3).

Table 3-3: Sudan's proposed GHG mitigation strategies and 2030 penetration targets

Type of strategy	GHG mitigation strategy	Units	2030 penetration target
Renewable energy	Solar PV	MW	1,000
	Wind	MW	1,000
	Concentrating Solar Power	MW	100
	Biomass (Sugar industry)	MW	80
	Geothermal	MW	300
	Small hydro	MW	50
	Solar home systems (@ 100 Wp per system)	MW	110
Energy efficiency	Efficient lighting	% all households	45%
	Efficient refrigeration	% urban households	25%
	Efficient refrigeration	% rural households	5%
	Efficient air-condition	% urban households	25%
	Replacement of old buses with high-efficiency buses	% buses	10%
	Replacement of old locomotives with high-efficiency locomotives	% locomotives	5%
	Adoption of electricity-based metro for urban mass transit	% fuel saved	5%
	Industrial energy efficiency	% fuel saved	20%
Fuel switching	Increasing use of electric stoves for cooking	% all households	10%
	Switching to Compressed Natural Gas (CNG) in public bus transport	% buses	10%
	Adoption of electric bus for urban mass transit	% buses	3%
Waste	Waste-to-energy (grid connected)	MW	80
	Waste-to-energy (off-grid)	MW	50
	Sanitary Landfill gas to electricity	% MSW	30%
	Composting and Recycling	% MSW	15%
	Wastewater sludge to biogas	MW	6
Forestry	Afforestation of mechanized rainfed agricultural areas in the Gedarif State	km^2replanted	3,400
	Reforestation of degraded forest reserve areas (Sennar, Gedarif, South Darfur)	km^2replanted	12,000
	Restoration of gum agroforestry system	km^2replanted	10,000
	Reforestation of areas in Gezira irrigated agricultural scheme	km^2replanted	300

These actions are consistent with the Twenty-FiveYear National Strategy (2007-2033) andhave been selected because they display strong synergies between Sudan's economic objectives and its sustainable development priorities. As such, they are expected to result in strengthening and accelerating the transition to a low-carbon development pathway guided

by long-term national development policies, plans, and strategies.

A total of 26 GHG mitigation initiatives are proposed, comprising strategies to introduce renewable energy, energy efficiency, fuel switching, waste management, and afforestation.

Sectoral activity targets by 2030 are expressed in terms of penetration levels in either absolute terms (i.e., MW of new capacity by 2030) or in relative terms (i.e., percentage of business-as-usual levels by 2030). While the actions are not associated with specific

estimates of corresponding GHG reduction targets, they are nevertheless expected to result in an overall reduction of at least 206 billion tCO_2e by 2030 relative to what emission levels would have otherwise been in that year without the mitigation actions.

3.5. Progress in the implementation of GHG mitigation actions

There has been significant progress toward realizing some of the penetration targets outlined in Table 3-3. This progress has been focused exclusively on energy supply project and currently accounts for annual GHG reductions of 17.8 Gg CO_2e, as briefly summarized in the bullets below. Notably, to date there have been no waste-related or energy efficiency projects introduced at any stage of implementation. Forestry initiatives are discussed in the next subsection. A detailed list of mitigation actions planned, implemented, and operational is provided in Annex A.

- *Solar water pumps:* In a 2018 project to promote the use of electric water pumps for irrigation, 28 solar pumps totalling 0.26 MW of solar water solar pumping systems were installed in 29 demonstration farms across 7 localities of Northern State. The project aimed to support the adoption of solar PV technology for water pumping to help Sudanese farmers reduce their reliance on fossil fuels, reduce their cost of production (via decreased diesel expenditures), increase the sustainability of water use, and increase income. The project has led to avoided GHG emissions of about 5.4 $GgCO_2e$ per year.
- *Wind power:* In a 2014 project to promote the use of wind power for electricity generation, 5 MW of onshore windfarms have been installed in the Dongola locality of Northern State. The project aims to support the removal of barriers to the adoption of utility-scale wind energy tied to the national grid in Sudan and will help diversify Sudan's power sources, reduce its reliance on fossil fuels, and increase energy security. The project has led to avoided GHG emissions of about 4.6Gg CO_2e per year.
- *Solar PV parks:* PV parks were installed in Alfashirin North Darfur and Al-Dienin East Darfur. The parksaimedto provide stable electricity supply to the two localities as well as to offset diesel fuel use and to reduce GHG emissions. The project has led to avoided GHG emissions of about 7.2Gg CO_2e per year.
- *Rooftop solar PV:* In a 2018 project to introduce grid-interactiverooftopsolar PV systems, 140 MW solar PV rooftop capacity is projected to be installed by 2024 for residential, industrial, and governmental building applications in urban and semi-urban areas across Sudan. The project aims to reduce electricity bills, avoid grid losses and overcome grid bottlenecks. At present a pilot project of 0.3 MW has been installed which has led to avoided GHG emissions of about 0.6Gg CO_2e per year.

3.6. National REDD+ strategy

Sudan considers REDD+ as an opportunity to undertake a participatory national forest and land use planning exercise that will contribute to mitigating the impacts of deforestation and forest degradation. This exercise will also help mitigate impacts due to developments in other sectors, such as agriculture and energy, and existing land tenure arrangements. The Forest National corporation (FNC) has proposed an integrated set of REDD+ strategy options to address the drivers of deforestation and forest degradation, as identified the bullets below:

- Substitute unsustainable fuelwood and charcoal with Liquefied Petroleum Gas (LPG) and other energy alternatives;
- Increase the use of sustainable charcoal;
- Increase firewood efficiency;
- Subsidize renewable energy production and grid infrastructure;
- Increase Gum Arabic production;
- Forest conservation and sustainable forest management;
- Reforestation programs; and
- Crop intensification and balanced livestock production.

These options are in the process of being screened and prioritized as part of an inclusive and participatory consultation process with key stakeholder groups. Significant progress has been made in recent years in developing the REDD+ mechanism in the forestry sector. Achievements to date include the following:

- *Data collection:* In 2017 FAO and FNC completed the main phase of the data collection of the National Forest Inventory (NFI). The NFI methodology follows the approach developed by the Support to National Forest Resources Monitoring and Assessment (NFMA) program of the FAO that is based on countrywide sampling and field data collection as well as on remote sensing.
- *REDD+ formal submissions:* In 2020, Sudan submitted its proposed subnational forest reference emission level (FREL) in accordance with COP Decision 12.CP/16. This submission is intended for technical assessment in the context of results-based payments for reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries (REDD+).
- *Identification of forestry mitigation activities:* The Subnational FREL proposed by Sudan covers two activities "reducing emissions from deforestation" and "Enhancement of forest carbon stocks" The FREL corresponds to the 2006–2018 reference period and results in 0.786 million tCO_2e in annual reductions from deforestation and the annual removal of 0.344 million tCO_2e due to enhancement of forest carbon stocks.
- *Methodologies:* The methodologies applied for estimating GHG emissions are consistent with the IPCC Good Practice Guidance for LULUCF as well as the guidance offered in the 2006 IPCC inventory development guidelines.

Sudan has elaborated plans for the implementation of national REDD+ activities, especially in the context of Sudan's NDCs. Under the LULUCF sector, the actions include:

- *Development of a national FREL:* A stepwise approach was applied in the construction of Sudan's first national FREL, with the main objective of developing knowledge, resources, and expertise within the related national institutions for the subsequent development of the national FREL step that builds on the experiences, capacities, resources, and lessons learned;

- *Activity data improvements:* Specific activities are planned to improve the quality and quantity of Activity Data, including the provision of high-resolution images, establishment of permanent sample plot networks, strengthening staff capacity, and the use of remote sensing and GIS techniques to provide high-quality data and information for the future national FREL submission. Advanced remote sensing technologies such as RADAR and LIDAR are planned for estimating biomass resources;
- *Data management:* Estimates of forest degradation are being included in Sudan's national FREL through improving relevant national data records; developing ground observations data including through the permanent sample plots established by the 2017 NFI; and using very high spectral and spatial resolution remote sensing data; and
- *Regulatory initiatives:* Future regulatory reforms in the forest and related policies are underway as one of the outcomes of the REDD+ readiness programme.

4. Measurement, Reporting and Verification

This chapter describes the steps that Sudan has taken to comply with BUR guidelines adopted by COP 17 Decision 2/CP.17 (Annex III) relative to the systems and processes that have been established for domestic Measurement, Reporting and Verification (MRV) of GHG emissions.

4.1. Institutional overview

As the focal point for all Multilateral Environmental Agreements (MEAs), the HCENR is the leading institution coordinating Sudan's efforts to meet its MRV obligations under the UNFCCC and Paris Agreement. Initially, the HCENR undertook this responsibility under the auspices of its climate change unit which was established in 1998. Addressing Sudan's obligations under the UNFCCC is characterized by significant engagement of multidisciplinary teams of scientists, engineers, and planners representing relevant national institutions (i.e., federal ministries, universities, research centers, private sector entities, NGOs and other governmental bodies).

Based on the provisions of recent environmental legislation passed in 2020, HCENR is chaired by the Prime Minister of Sudan, and has an Inter-ministerial Committee comprised of ministers and heads of national institutions whose mandate includes environmental protection and conservation of natural resources. A new organizational structure for HCENR has been developed, approved and is currently being implemented. The new structure includes 5 General Directorates (Policies and Planning; Environmental Inspection; Sustainable Resources and Environment Protection; Climate Change, Desertification and Disaster Prevention; and Finance and Human Resources) and 15 departments/units across those Directorates.

Under the 2020 legislation, the HCENR's Climate Change Unit operates as part of the General Directorate for Climate Change, Desertification and Disaster Prevention. It has five (5) major responsibilities as outlined below.

- Planning, preparation, compilation and submission of the national climate change reports, such as National Communications, Biennial Update Reports, Biennial Transparency Reports, National Adaptation Programme of Action (NAPA), National Adaptation Plan (NAP), Nationally Determined Contributions (NDC), etc;
- Establishment and coordination of the national climate change committee, as well as expert teams on GHG inventory development, GHG mitigation analysis, vulnerability assessment, identification of adaptation strategies, etc;
- Establishment of formal working arrangements and procedures with climate related national institutions and stakeholders;
- Definition and allocation of roles and responsibilities of the different institutions in meeting Sudan MRV obligations; and
- Management of the GHG inventory preparation processes, including technical and institutional capacity building, data collection and archiving, quality controls, technical validation and the formal government approval process.

During the preparation of the initial and second National Communication, the institutional arrangements related to MRV were established on an ad hoc basis. In contrast, the Third National Communication and First BUR have been prepared in the context of the 2020 environmental legislation with a key objective being to formalize institutional arrangements with relevant institutions in support of MRV activities. These arrangements have been codified in Memoranda of Understanding (MoU) established between the HCENR and 10 federal entities and 18 state-level ministries/adaptation focal points. These MoUs are designed to clarify institutional responsibilities and improve institutional capacity to meet Sudan's MRV and transparency obligations (see Table 4-1). They have involved the following developments:

Table 4-1: Responsibilities of national and state-level institutions that have signed a Memorandum of Understanding with the HCENR in support of MRV activities

Ministry or entity	Common responsibilities	Distinct responsibilities
Federal level: • Agriculture and Forests • Animal Resources • Forest National Corporation • Petroleum and Gas • Road and Transport • Electricity Holding Company • Industry	• *Capacity strengthening:* Participation by subsidiaries in training, capacity building and awareness raising • *QA/QC:* Coordinate with HCENR related to data management and archiving • *MRV and M&E:*Support in the development of tools and methods • *NDC:* Support in the preparation of the NDC • *Transparency:* Integration and implementation of arrangements promoting transparency	• *GHG inventory:* provision of activity data and emission factors related to AFOLU and its subsectors • *Mitigation:* Participation in GHG mitigation analysis • *Adaptation:* Participation in any potential adaptation activities • *MRV and M&E:* Developing tools/modalities for AFOLU activities • *NDC:* Support in the preparation of the mitigation component
Federal level: • Irrigation and Water Resources • Agriculture and Forests • Ministry of Health		• *Vulnerability:* Participation in assessments • *Adaptation:* Participation in planning & implementation • *NDC:* Support in the preparation of the adaptation component
State level: • Ministries/adaptation focal points		• *Coordination:* Engagement with national institutions on policy and capacity building • *Data:* Provision of local data/information for climate action plans and lessons learned. • *Networking:* Engagement of stakeholders and institutions to track implementation progress

- *Institutional focal points:* Climate change focal points have been established in each of the relevant federal institutions for which anMoU has been finalized. Climate change focal points have also been established with the state-level ministries/adaptation focal points in each of Sudan's 18 states;
- *Technical committees:* The institutional and state-level focal points act as data providers and members of separate technical committees devoted to GHG inventory development, GHG mitigation analysis, adaptation assessment, and NDC development;
- *Capacity strengthening:* Technical and institutional capacity building support has been provided to the relevant institutions with a primary focus on improving the accuracy and transparency of their sectoral contributions to the GHG inventory, as well as mitigation analysis, adaptation assessment, and NDC formulation; and

- *Long-term institutional commitments:* A long-term commitment was secured with relevant institutions to ensure the sustainability of data flows pertinent to future GHG inventory, mitigation, adaptation, and NDC development processes within an agreed-upon organizational structure (see Figure 4-1).

Institutional coordination arrangements have also been set up with other entities without MoUs. Several research and academic institutions in Khartoum have been enlisted to support a range of actions including data development; capacity building; tool development; GHG inventories, GHG mitigation analysis; NDC development; adaptation actions; QA/QC procedures, and data archiving.

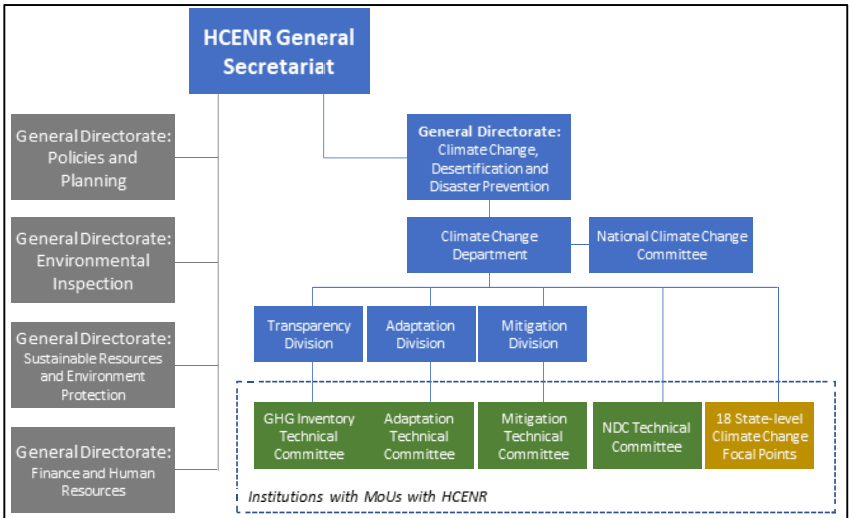


Figure 4-1: Organizational structure for institutional arrangement in support of MRV activities

The Ministry of Finance, Central Bureau of Statistics, and Council of Ministers have agreed to contribute in a support capacity for MRV action including management of financial resources, data supply, sectoral expertise; any needed legal and procedural arrangements; and endorsement of resulting national reports. Finally, civil society organizations have been recruited to contribute by participation in consultations on climate change planning, transparency and reporting; data provision, training and awareness events; and development of social and environmental safeguards.

4.2. MRV in forestry and land use change activities

MRV protocols and systems are furthest advanced in Sudan in the forestry sector. In 2012, the Forest National Corporation requested to join the Forest Carbon Partnership Facility. In the years since, Sudan has sought to continually strengthen its partnership with other countries in reducing its own emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks (i.e., REDD+). A key requirement of this partnership has been to develop a National Forest Monitoring Systems (NFMS) for REDD+ that represents an effective monitoring, measurement, reporting and verification system to provide accurate data on emissions.

The establishment of MRV/NFMS is a requirement for Sudan to achieve REDD+ readiness preparation and implementation of REDD+ activities. The NFMS provides needed information to measure results of implementing the REDD+ activities associated with land use change and forestry sector. Sudan has been developing its NFMS based on an agreed upon the December 2019 action plan for NFMS implementation that calls for both monitoring and MRV functions (see Figure 4-2) involving capacity building for

monitoring/MRV, monitoring of demonstration activities; and national monitoring of REDD+ activities. Sudan's NFMS consists of the following key objectives:

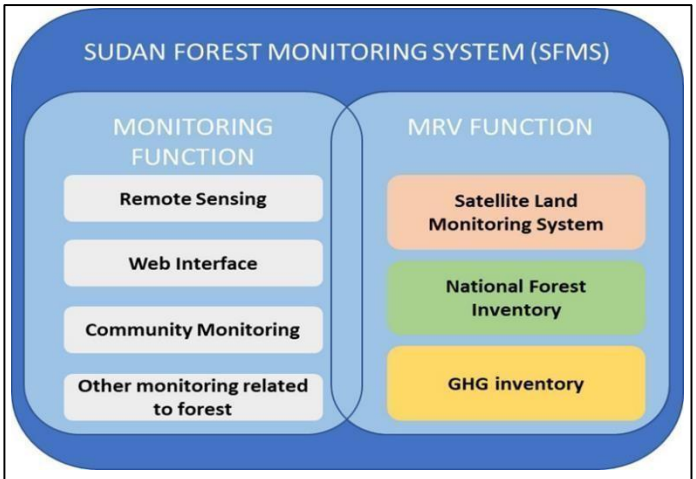


Figure 4-2:Key functions in Sudan's National Forest Monitoring system

a. To adopt and implement a sustainable and a participatory network of institutions with the necessary range of expertise and clearly documented roles and responsibilities to establish the NFMS;

b. To develop a transparent and integrated NFMS with complete separate functions of National Forest Inventory, the Land Management System and Greenhouse Gases Inventory in order to estimate forest related GHG emissions and removals through creation of consistent time series of forest cover and periodically assess the on-ground conditions of all forest resources in Sudan;

c. To implement COP decisions related to establishment of robust and transparent NFMS for REDD+ and IPCC's guidelines for preparation GHG Inventory of land use change and forestry activities;

d. To establish a central REDD+ Project Registry (RPR) as database and archiving system including the provision of information on REDD+ Safeguards; and

e. To develop a national forest and land use web portal for ensuring transparency, accessibility and quality of information related to Sudan's land use change and forestry activities.

4.3. MRV in the energy sector

In collaboration with the International Renewable Energy Agency (IRENA) has begun to address MRV issues in the energy sector. An initial workshop was held over 15-16 March 2021 in Khartoum. The main objective of the workshops was to bring all the key stakeholders of the energy sector in Sudan together to discuss various topics related to energy data management in Sudan, including reviewing the data required for NDC enhancement and energy related targets tracking and its availability; and discussing the establishment of an MRV System for the energy sector that can systematically provide the necessary data in the future.

Since the initial consultation workshop, progress has been achieved on establishing an MRV unit within the Ministry of Energy as well as an organizational structure for institutional coordination with other entities to ensure the flow of data (see Figure 4-3). The proposed key responsibilities and activities to be undertaken by the MRV unit in the Ministry of Energy unit are outlined in the bullets below:

- Maintain an updated list of all the data providers and collect updated contact information related to sectoral Focal Points from each relevant sectoral institution including auto

producers from the power sector e.g., sugar companies and allocates responsibilities for all components of the MRV system;

- Prepare an annual or biannual work plan/statistical calendar with the sectoral institutions within the MoE and HCENR to facilitate timely, complete, and accurate data provision and analysis for energy reporting and climate change related data;
- Maintain existing and develop Data Sharing Agreements (DSAs) or Memorandums of Understanding (MoUs) and Confidentiality agreements as needed between key partners and stakeholders such as HCENR, units of the MoE, Bureau of Statistics, Ministry of Industry, SCIA and others;

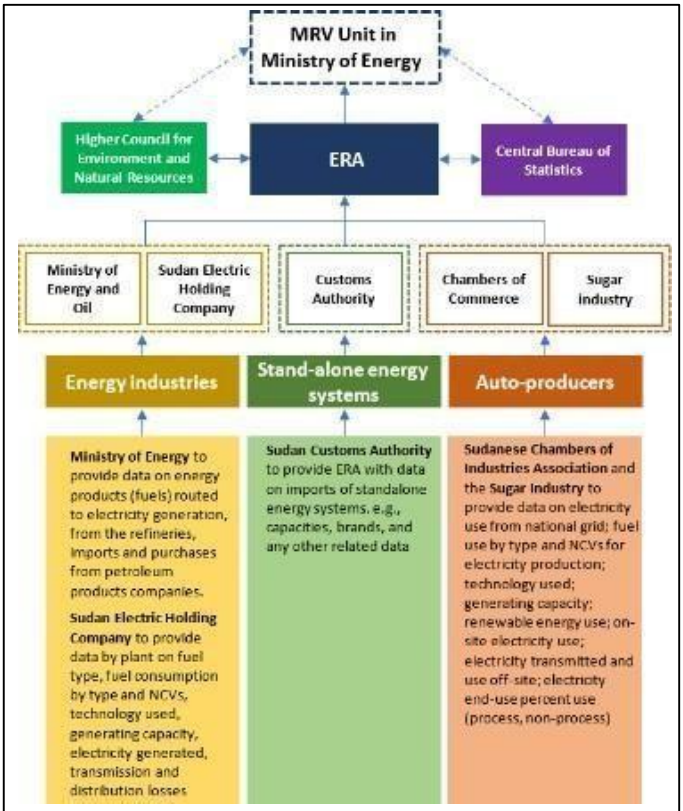


Figure 4-3:Organizational structure for institutional arrangements in support of MRV in the energy sector

- Develop new and updated data-collection questionnaires according to improvements identified in previous MRV cycles and new available information;
- Collect data from assigned focal points based on the identified plan via designed questionnaires and other methods based on set statistical calendar and conduct follow-up phone calls or meetings to request further or fine-tune information;
- Collect data sets required for contrasting Sudan's energy balance and ensure that focal point conduct internal quality checks to ensure that the provided info is complete and accurate;
- Track progress of energy related targets in the power sector whether they are national defined targets or energy related NDC targets;
- Construct and maintenance of Sudan's energy balance on an annual basis;
- Estimate generated energy emissions and avoided emissions due to the uptake of renewable based on collected data from focal points and the constructed energy balances;
- Contribute to reports within the planning unit and to HCENR;
- Perform internal quality checks to ensure that all information is complete and accurate;
- Prepare periodic internal and external reports for all stakeholders involved that include at a minimum the following: energy supply/demand trends, progress of implementation of sectoral mitigation actions such as RE targets and the NDC, financial support

received/needed, gaps and barriers, MRV procedures, and potential areas of improvement;

- Ensure that all data and supporting documents are made available for different type of stakeholders including international community, sectoral line ministries, donors, and the general public and the HCENR;
- Ensure that information pertaining to the current MRV reporting year is stored in a secure place with the aim to guarantee the credibility of results, encourage donor confidence, facilitate data verification and prevent information loss;
- Improve the overall MRV process according to the recommendations arising from the verification stage. The relevant experts in charge of the reports should undertake corrective action for immediate improvements identified by the external verification process;
- Conduct follow-up on compilation of data and conducting re-calculations and improving data collection methodologies as needed;
- Identify constraints and needs for both financial and technical, skills; and
- Build on the experiences gained to ensure continuous improvement.

5. Constraints, gaps, and related financial and capacity needs

This chapter presents updated information on constraints and gaps, and related financial, technical, and capacity-building needs that are confronting Sudan, together with information on nationally determined technology needs.

5.1. Constraints, gaps and related financial, technical, and capacity-building needs

Sudan faces two major challenges which face a variety of local constraints and gaps. These are the preparation of climate change reports and national communication on a continuous base, and implementation of climate change activities predicted to support the convention. The rest of this section provides an overview of the various related processes affecting these challenges.

5.1.1. Overview

Through the process of the national communication reporting, an effective network of climate change experts has been created during the preparation of the First and Third National Communication. This network was relied upon to develop the Third National Communication and the First Biennial Update Report (BUR1) and was consulted for recommendations regarding improvements to future national communication development processes relative to specific constraints and gaps encountered. The results of the consultations have identified the following constraints and gaps:

a. Lack of distinct sectoral strategies and policies joined with a weak integration and coordination between different government agencies;

b. Absence of proper legislative and strategic framework and capacity in policymaking, the deficiency of expertise, monitoring plans, and appropriate equipment;

c. A low level of public awareness and acceptability coupled with an underestimation of socio-economic gains can be derived from the implementation of the UNFCCC;

d. Policies and strategies do not effectively incorporate multilateral Multi-Environmental Agreements (MEAs) such as UNFCCC, since the structures and affiliations of government institutions related to climate change are subject to frequent changes due to political instability;

e. Difficulties encountered in accessing and mobilizing financial, technical assistance, and capacity-building support in terms of availability of demand-driven capacity-building, scope, and depth of the training;

f. Constraints related to collection, collation, and storage of data on financial resources, technical assistance, and capacity-building support available to implement actions, measures, and programs that have multiple uses or climate change co-benefits;

g. Climate change and UNFCCC concepts are not well integrated into the national policy and planning systems. This is partly because of the limitations of the national management and data processing system;

h. Significant challenges in setting up sustainable MRV systems and building the staff capacity required for national communication and BUR reporting;

i. Institutional challenges relating to the coordination of climate change finance flows; and

j. lack of institutional and individual technical and capacity building on climate actions.

5.1.2. Constraints and gaps related to financial resources

Sudan has received grants and loans from development partners and donors to develop a detailed GHG inventory, as well as to formulate, formally propose, and subsequently implement projects to build resilience against future climate change impacts and to mitigate emissions of GHGs. Despite this, the level of financial support in not commensurate with meeting the challenges facing Sudan for increasing the resilience of vulnerable communities, especially agro-pastoralists in rural areas throughout the country. Nor is it adequate to support the transition away from low-cost fossil fuels for meeting electricity demand to renewable sources.

At the administrative level, Sudan faces two major constraints to the flow of financial resources necessary to ensure regular reporting ofGHGinventories and an effective implementation of adaptation and mitigation actions. First, there is a low level of transparency of climate change finance concerning non-financial transfers for technical assistance and capacity-building supports. Second, there remain internal institutional challenges relating to the effective coordination of climate change financing received from external donors that need to be distributed across relevant governmental and non- governmental agencies. These are ongoing areas of focus to identify specific actions that will overcome these constraints.

5.1.3. Constraints and gaps related to technical and capacity-building

Thanks to international funding, numerous individuals have received short-term training on climate change-related tools and methods both in-country and abroad.Long-term scholarships to study climate change-related topics have also been awarded ranging from master's to doctoral levels. Nevertheless, Sudan continues to face limitations in the number of trained experts and researchers in the fields of GHG inventory development, GHG mitigation analysis, vulnerability assessments, evaluation of adaptation measures, and the economics of climate change.

As part of the National Capacity Self-Assessment (NCSA) process, priority needs and opportunities for capacity development have been identified. In general, the assessment showed that capacity building of climate change national experts, as well as expertise retention, remain key challenges in realizing the effective reporting and implementation of climate change projects. At the institutional level, this included a lack of awareness and limited capacity to monitor and evaluate, hinder the implementation of adaptation strategies and environmental management plans. More specifically, the following constraints and gaps were identified:

- Lack of capacity building in the areas of information technology, networking, and use of laboratory and field equipment for monitoring and evaluation;
- Inadequate number and qualifications of staff involved in climate change;

- Low levels of institutional capacities to deal with climate change;
- Climate change issues are not well included in universities and research center programs; and
- Shortage of training, capacity building, involvement, and networking of civil society organizations.

5.2. Financial, technical, and capacity-building needs

There has been significant institutional learning based on the preparation of two national GHG emission inventories conducted under the national communications submitted in 2003 and 2013. The estimation of emission levels was based mainly on activity assumptions, expert judgment, default IPCC emission factors, and guidance materials from the 1996 IPCC Guidelines. For the TNC, Sudan acknowledges general limitations related to obtaining reliable local data and information as well as the lack of national expertise to develop updates to the national GHG inventory continuously and autonomously. Specific issues related to financial, technical, and capacity-building needs are summarized in Table 5-1 as learned from the NCSA process.

On the basis of the specific needs identified, the following near-term priorities and recommendations are proposed:

- Strengthen HCENR as the proper institution to coordinate policy formulation and develop a national GHG inventory, mitigation measures, and adaptation plans. A coordination unit is to be established, properly equipped, and staffed with competent professionals;
- Strengthen the national legal and coordination power to meet the demands of integrating climate change issues into the policy formulation process;
- Build capacities of appropriate sectors and institutions to carry out inventories, undertake vulnerability and adaptation assessments and develop mitigation initiatives;
- Establish a climate change information database center;
- Conduct an intensive training program to include data collection; monitoring and evaluation; risk assessment in the field of GHGs and relevant scenarios of climate change; vulnerability and adaptation modeling; and information technologies; and
- Raise awareness among key stockholders on relevant aspects of climate change, with emphasis on socio-economic and health benefits of mitigation and adaptation.

The highest priority areas are to strengthen the HCENR as the proper institution to coordinate policy formulation and oversee the preparation of future national GHG inventories that adopt locally developed emission factors that better represent Sudanese conditions. While a permanent secretariat has been established within the HCENR to coordinate future updates to the national inventory, there is a need to establish a national system to develop protocols for GHG data collection, monitoring, reporting, and verification, with ongoing capacity-building. To improve local emission factors, studies should be carried out regarding enteric methane production from livestock, emissions of nitrous oxide from

Table 5-1: Overview of Sudan's financial, technical, and capacity-building needs regarding GHG inventories

Type of support	Sector	Needs identified	Support needed
Capacity building	Agriculture	IPCC methodology deficiencies	The general IPCC methodology on N_2O emissions for countries like Sudan that display highly diverse ecological zones, microclimates, and agricultural systems needs to be reconsidered. Also, since soil carbon and nitrogen cycles are tightly integrated, both carbon and nitrogen should be considered together so that various aspects of the carbon and nitrogen cycle and CO_2 and N_2O production can be more accurately defined
		Methodology and analysis	Additional in-depth training of national experts on the inventory methodological guidelines and software is needed. Also, local research and scientific studies are needed to develop emission factors and other parameters that are appropriate for Sudan's conditions.
	Industry	General	There is an overall need for greater local capacity building in the industrial process area of GHG inventory development.
	Land Use Change and Forestry	Methodologies	Additional in-depth training of national experts on inventory methodologies for the LUCF sector is needed.
	Waste	Public awareness	Encourage/support more household composting and establish larger composting facilities in partnership with the private sector. Similarly, most of the inorganic waste such as plastics, metal, and paper can be recycled by the private sector.
		Decision-making support	Increased awareness is needed for policymakers at the municipal, state, and federal levels on the economic, environmental, and public health benefits of proper waste management practices, including segregation, collection, recovery/reuse, recycling, and the need for sound engineering designs of landfills or incineration facilities.
Financial support	Agriculture	Livestock data systems	Development of new livestock population data systems is necessary. Such a system should be structured based on ecological zones and include information on the type, age, body weight change, and seasonal distribution of animals.
		Inter-ministerial cooperation	The Ministries of Agriculture, Animal Wealth, and the HCENR should cooperate on a wide range of data collection, including data on livestock, crop residue burning, soils, etc. Besides, the GHG inventory updating process should be institutionalized with a clear definition of responsibility and accountability.
	Energy	Data availability on energy consumption	A detailed study and survey of the energy sector is needed, particularly for petroleum products to improve activity data relating to: marine, aviation bunker fuels, lubricants; small-scale electricity self-generation in commercial/household sectors; biomass energy including all biomass end uses; and new modes of public transport (e.g., Rakshas).
		Local emission factors	The development of local/better emission and conversion factors is needed that are appropriate to Sudan for both biomass and petroleum products.
	Industry	Industrial database	The development of a systematic database system is needed. An industrial database needs to be developed and maintained regularly. This can be done by conducting surveys to better represent the production of local industries, and the use of bagasse in industrial facilities.
	Land Use Change and Forestry	Institutional cooperation	Improved data access and availability is needed across national institutions to enhance the quality and timely preparation of the GHG inventory.
		Data and information systems	The development of a LUCF-based database information system is needed based on systematic scientific research and field surveys.
	Waste	Municipalities	The financial means of municipalities and the amount of resources they can invest in solid waste management is very limited. Additional staffing and the allocation of resources will be necessary to improve solid waste management and the quality of data collection.
		Institutional cooperation	There should be a designated focal institution, which acts in support of other national agencies and ministries to collect and update waste generation and treatment data on a regional basis.
Technology transfer	Agriculture	Alternative measurement methods	Ground-based survey methods should be augmented to employ remote sensing techniques, low aerial surveys, and satellite imagery. Such information will be useful to validate livestock production and category distribution; assess pastoral conditions and stocking capacity in different ecological zonesand determine seasonal methane emissions relative to the animal type and pastoral activity.

Industry	IPCC software	A separate spreadsheet tabulation system should be developed to complement the IPCC inventory spreadsheet.

organic soils, assessment of the fraction of agricultural residues burnt on the site, and on and offsite burning of cleared vegetation.

In the mid- to long-term, the highest priority is to address the various gaps that have been identified in the data available. Attention to the three key areas summarized in the bullets below will help reduce uncertainty in future GHG inventories in Sudan.

- *Data availability:* Enhancing the availability of detailed and high-quality activity data will increase confidence in the inventory results. This will necessarily involve a government commitment to establishing systematic database systems.
- *Reducing uncertainty:*Improving the accuracy of local emission factors to calculate emissions from a variety of sources is vital. Many of the default emission factors are classified as having high uncertainty relative to Sudan conditions.
- *Capacity building:* Addressing the above areas through additional capacity strengthening and the development of dedicated observation networks is essential.

5.3. Financial, technology transfer.capacity building, and technical support received

Sudan has received and greatly benefitted from support by various international donor organizations that provide support for reporting and implementation of climate change-related activities. The Global Environment Facility (GEF) over 6 cycles (June 1994- June 2018) has been the main source of funding, with nearly 63 million USDapproved for climate change-related initiatives, thatpositions Sudan to fulfill its obligations under the Convention and to implement measures that address the impacts of climate change.

Sudan received GEF financial support equal to 0.352 million USD to prepare its first BUR. This amount was made available as a portion of an enabling project for its Third National Communication (TNC). The project has been executed by the HCENR and implemented in partnership with UNDP. The Government of Sudan through the Ministry of Finance (MOF) provided 50,000 USD in in-kind support to complete the first BUR. These resources and support were crucial in data collection and for ensuring transparency in the process. As the BUR is a relatively new requirement, Sudan's capacity has needed to be strengthened in order to comply with BUR content requirements.

With a recent grant of 25.6 million USD, Sudan has also begun to access resources of the Green Climate Fund (GCF). The funds are devoted to building resilience in the face of climate change within traditional rain-fed agricultural and pastoral systems in Sudan. The GCF also approved a grant of 9.75 million USD to enhance adaptive capacity of local communities and restore the carbon sink potential of the Gum Arabic belt. Both projects include significant support for capacity-building.

Across all sources of funding, Sudan has received 92.7 million USD between 1994 and 2020 for initiatives related to climate change. This level of funding has leveraged an addition 553.9 million USD in co-financing. A detailed summary of financial support received from GEF and GCF sources is provided in Table 5-2.

5.4. Development and transfer of technology

Table 5-2: GEF and GCF funding received by Sudan for climate change activities (million USD), 1994-2020

Status	Title	Funding	Co-financing	Total
Completed	First National communication	0.2	0.0	0.2
	Second National Communication	0.45	0.0	0.45
	Implementing NAPA Priority Interventions to Build Resilience in the Agriculture and Water Sectors to the Adverse Impacts of Climate Change.	3.3	3.5	6.8
	National Adaptation Programme of Action (NAPA).	0.2	0.0	0.2
	National Capacity Self-Assessment.	0.2	0.0	0.2
	Barrier Removal to Secure PV Market Penetration in Semi-Urban Sudan.	0.7	0.0	0.7
	Technology Needs Assessment for Climate Change Adaptation and Mitigation.	0.2	0.0	0.2
	Community-Based Rangeland Rehabilitation for Carbon Sequestration.	1.5	0.1	1.6
	Standardized Baseline for Low Carbon Development Strategy.	0.2	0.0	0.2
	National Adaptation Plan.	0.7	0.0	0.7
	Capacity Building to Enable Sudan's Response and Communication to the UNFCCC.	0.3	0.0	0.3
	GCF Readiness and Support Project	0.365	0.0	0.365
	National Adaptation Mitigation Action	0.15	0.0	0.15
	Climate Risk Finance for Sustainable and Climate Resilient Rainfed Farming and Pastoral Systems.	6.3	15.0	21.3
Concept Approved	Sudan's Capacity Building Initiative for Transparency Project.	1.2	0.4	1.6
	Sustainable Natural Resource and Livelihood Adaptive Programme (SNRLAP).	2.0	49.9	51.9
	The resilience of Pastoral and Farming Communities to Climate Change in North Darfur.	2.4	10.0	12.4
Project Approved	Sustainable Natural Resources Management Project –AF.	5.9	17.6	23.5
	Sudan Sustainable Natural Resources Management Project-Additional Financing.	5.5	27.5	33.0
	Strengthening Targeted National Capacities for Improved Decision Making and Mainstreaming of Global Environmental Obligations.	1.1	1.0	2.1
	Rural Livelihoods' Adaptation to Climate Change in the Horn of Africa - Phase II (RLACC II).	7.1	29.6	36.7
	Leapfrogging Sudan's Markets to More Efficient Lighting and Air Conditioners	1.8	5.6	7.4
	Third National Communication (TNC) and First Biennial Update Report (BUR).	0.852	0.5	1.4
	Enhancing the Resilience of Communities Living in Climate Change Vulnerable Areas of Sudan Using Ecosystem-Based Approaches to Adaptation (EbA).	4.3	7.9	12.2
	Promoting the Use of Electric Water Pumps for Irrigation.	4.4	20.2	24.5
	Livestock and Rangeland Resilience Program.	8.5	32.3	40.9
	Promoting Utility-Scale Power Generation from Wind Energy.	3.5	214.0	217.5
	Integrated Carbon Sequestration Project in Sudan.	3.7	11.1	14.7
	Expedited Financing of Climate Change Enabling Activities (Phase II).	0.1	0.0	0.1
	Building resilience of in the face of climate change with the traditional rain fed agriculture and pastoralist system in Sudan (GCF Project).	25.6	15.0	40.6
Total		**92.7**	**461.2**	**553.9**

Sudan undertook a Technology Needs Assessment Project (TNA) in 2013 based on the agreement signed between the Government of Sudan (GoS) represented by the HCENR, the United Nations Environmental Program (UNEP), Risoe Centre (URC), Denmark, and supported by the Global Environmental Facility (GEF) grant financing. Under the mitigation area, priority technologies identified were biogas units, improved stoves, mass transportation, high efficiency lighting, and high efficiency dual-fuel boilers. Under the adaptation area, agriculture and water sector were identified as top priority sectors, with improved crop varieties, zero tillage conservation agriculture, seasonal forecasting, early warning systems and rainwater harvesting techniques identified as the most relevant for Sudan.

5.5. Data and information gaps

A comprehensive Sudanese needs assessment for finance and technical assistance has not been undertaken yet. Where related support has been received that has sought to address data and information gaps, information is generally not available in the public domain. Going forward, the proposed Climate Information Centre to be hosted by the HCENR will pay a vital role in addressing data and information gaps, as well as corresponding transparency and access issues.

5.6. Suggestions and needs for improvement of reporting

To a large extent, suggestions and needs for improving reporting under the BUR have much to do with the available guidelines. The experience of the Sudan national team relying on these guidelines found them to be not sufficiently explicit. Difficulties were encountered on distinguishing between needs regarding technology and needs regarding capacity-building, and how these should be reported in the BUR. The national team also considered that methodology and reporting guidance available to non-Annex I countries lacked adequate clarity with the potential for an under reporting of required information. Finally, the national team considered some reporting elements duplicative (e.g., technology transfer support addressed in both in Table 5-8 and Table 10 of the guidance materials; capacity- building support addressed in both Table 3 and Tables 5-8 of the guidance materials). Going forward, some areas that would benefit from clearer guidance include:

- How to distinguish more clearly between technical, capacity-building, and technology categories to report on needs and support received.
- The establishment of a national entity to facilitate reporting on finance, technology, and capacity-building constraints, gaps, and needs through collecting and analyzing related information
- Constraints and gaps associated with the implementation of climate measures rather than focusing on challenges associated with reporting itself to facilitate more comprehensive reporting.
- Provision of further support to developing country parties in assessing the gaps, constraints, and associated needs for both technology and capacity-building; such efforts could potentially facilitate reporting in this area under the Paris Agreement.

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Annex A: Detailed Information on Mitigation Actions

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
Promoting the use of electric water pumps for irrigation in Sudan (2018)	ENERGY	The project aims to support the adoption of solar PV technology for water pumping for irrigation in agriculture in Sudan, particularly in the North State. The project aims to help Sudan and Sudanese farmers reduce their reliance on fossil fuels, reduce their cost of production (via decreased diesel expenditures), increase the sustainability of water use, and increase their income.	CO_2	Reduction of 15,659 tCO_2/year, or 313,174 tCO_2 over the 20-year life of the pumps.	UNDP	Ministry of Water Resources and Electricity (MWRE)	Investment in green energy and access by needy communities to sustainable energy improved. Target: 50 communities with limited access to renewable energy. The cumulative installed capacity of off-grid PV 6,531 kWp as of 1,468 solar pumps.	Operating	257.405 kW of solar water solar pumping systems were installed in 29 demonstration farms across the 7 localities of the North State. 28 solar pumps were installed and operational.	Reduction of 5,440 t CO_2/year in irrigated sector.
Promoting Utility-Scale Power Generation from Wind Energy (2014)	ENERGY	The project aims to support the removal of barriers to the adoption of utility-scale wind energy tied to the national grid in Sudan. The project aims to help diversify Sudan's power sources and reduce its reliance on fossil fuels, particularly for future expansion and to reduce greenhouse gas (GHG). The	CO_2	Reduction of 91,780 tCO_2/year, or 1,835,600 tCO_2 over the 20-year life of the wind farm in Dongola	UNDP	Ministry of Water Resources and Electricity (MWRE)	Installing 100 MW capacity in Dongola, generating 300,917 MWh/year from wind energy. Installing 4 small wind farms.	Operating	5 MW wind power plants installed.	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
		project will therefore help increase Sudan's energy security and support its development								
Building Resilience in The Face of Climate Change Within Traditional Rain Fed Agricultural and Pastoral Systems in Sudan (2020)	AFOLU	The project supports climate change adaptation efforts among subsistence agro-pastoralist and nomadic pastoralist communities in dryland zones across nine states in Sudan. Its overall goal is to promote a paradigm shift in dryland pastoral and farming systems through an integrated approach by increasing resilience of food production systems; improving availability/access to climate-resilient water sources, and strengthening capacities of institutions/communities on climate resilience.	CO_2	Up to an incremental 90,000 tCO_2e sequestered by the end of the project in rehabilitated rangelands, afforested areas, and shelterbelts.	UNDP	Higher Council for Environment and Natural Resources	First, the project disseminates a set of sustainable technologies and practices. Second, the project increases the availability of water resources through the construction and/or rehabilitation of hafirs. Third, the project strengthens local governance by building capacity among local leaders and stakeholders.	Being implemented	N/A	N/A
Leapfrogging Sudan's Markets to More Efficient Lighting and Air Conditioners (2019)	EE	The main objective of the project is to transform Sudan's markets for energy-efficient (EE) lighting and air-conditioners providing climate change mitigation benefits and decreased energy poverty. The top-down component comprises the development of	CO_2	Reduction in the lighting sub-sector would be approximately 320,000 tCO_2/year. Reduction in the A/C sub-	UNDP	Ministry of Water Resources, Irrigation and Electricity (MWRIE) Electricity Regulatory	Total of 1,435 GWh electricity saved as a result of introducing more energy-efficient air conditioning units and lamps/luminaires	Operating	N/A	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
		standards, enforcement of regulations supporting energy-efficient products, and building the institutional framework capable of maintaining steady market development. Bottom-up activities target the creation of a positive ambiance for the implementation of the new regulations on the levels of distributors and end-users.		sector 45,500 tCO_2/year. A total reduction of 365,106 tCO_2/year by the year 2021.		Authority (ERA)	.			
Solar Water Pumps for Sustainable Agriculture in Sudan (2019)	ENERGY	The project aims to support sustainable agriculture in Sudan by promoting the use of solar photovoltaic (PV) instead of diesel-based irrigation water pumping in farmlands. The project will install 450 solar pumps with the KOICA fund.	CO_2	Reduction of 9,504 tCO_2/year	UNDP	Ministry of Water Resources and Electricity (MWRE)	Install 450 solar pumps in the farmlands and an accompanying financing mechanism for continued finance of the project. Technical know-how on effective management of the agronomic practices and water in the farmland. Promote enabling activities to access the fund for scaling up and further	Being implemented	N/A	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
							replication of the solar pumps.			
Integrated Carbon Sequestration Project in Sudan (2012)	AFOLU	The proposed project would target the Butana region, the principal objective of the project is to promote a climate-friendly rural development path in Central and Eastern Sudan by increasing the carbon stock and reducing net GHG emissions in the country, while at the same time sustaining rural development in the project area.	CO_2	Total removal by 2016 of 260,172 $tCO_2$from rainfed areas 135,699 irrigated areas Total removal by 2032 of 1,806,760 $tCO_2$from rainfed areas 995,120 irrigated areas	IFAD	Forest National Corporation (FNC), Higher Council for Environment and Natural Resources, Ministry of Agriculture	Afforestation/reforestation activities to increase the national carbon sequestration potential Forest and carbon stock management and maintenance. Promotion of sustainable energy production at the community level. Capacity building at the national level for monitoring and reporting on carbon stock and local awareness-raising	Operating	N/A	N/A
Gums for Adaptation and Mitigation in Sudan (2020)	AFOLU	Enhancing adaptive capacity of local communities and restoring carbon sink potential of the Gum Arabic belt, expanding Africa's. The project will support smallholders in restoring their CC resilient gum	CO_2	Sequestering 461,441 tCO_2eq per year and 9,228,818 tCO_2eq over the 20-year	FAO	Forest National Corporation (FNC)	75,000 ha of gum agroforestry systems restored (40,000 ha in West Kordofan and 35,000 ha in North Kordofan)	Being implemented	N/A	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
		agroforestry systems and reforesting degraded lands, thus contributing to the implementation of the national REDD+ strategy, and fund rehabilitation of livestock corridors and associated rangelands to restore herd mobility needed for pastoral CC adaptation and to protect the restored gum tree stands from livestock damage. The Great Green Wall.		project lifespan			50,000 ha of degraded land reforested (40,000 ha in South Kordofan, 5,000 ha in North Kordofan, 5,000 ha in West Kordofan) Technical, organizational, and commercial capacity strengthening program for gum value chain actors implemented (focusing on 500 smallholder Gum Arabic Producer Associations) 280 Smallholder gum producer groups linked up with gum exporters paying a premium price for clean dry gum 120 Smallholder gum producers' groups selling clean dry gum in			

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
							standardized auction markets 180 Smallholder gum producer groups linked up with microfinance institutions (MFI).			
Bioremediations and afforestation in oil fields concession areas (2011)	AFOLU	The project aims to develop an effective REED bed system, meeting the Sudan government environment standards in the bioremediations of hydrocarbons, in the produced water and to develop discharge management systems for the treated water to be used for forestry rehabilitation.	CO_2	N/A	GNPOC, Petro-energy	Forest National Corporation (FNC)	To clean (bio-remediate), the large quantities of the discharged petroleum produced water and use it as the main source of irrigation in establishing an irrigated forest plantation. The target is for one million seedlings to be produced annually in both irrigated and rainfed plantations.	Operating	N/A	N/A
Sudan REDD+ Reducing Emissions	AFOLU	(REDD+) is a global mechanism to mitigate the climate change caused by forest loss or degradation, while mobilizing	CO_2	Reduction of344,458tCO_2 eq/year due to the	World Bank	Forest National Corporation (FNC)	Strengthen Sudan's capacity to design socially and	Operating	N/A	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
from Deforestation and forest Degradation (2015)		financial resources for socio-economic development in forest countries.		enhancement of forest carbon stocks Reduction of 786, 202 tCO_2eq/year through the activity of reducing emissions from deforestation			environmentally sound national REDD+ strategies. National and state levels institutions are strengthened and are effectively coordinating the implementation of REDD+ readiness activities; A National REDD+ Strategy, incorporating SESA outcomes and recommendations, is prepared and validated by national stakeholders; An Environmental and Social Management Framework (ESMF) for managing potential social			

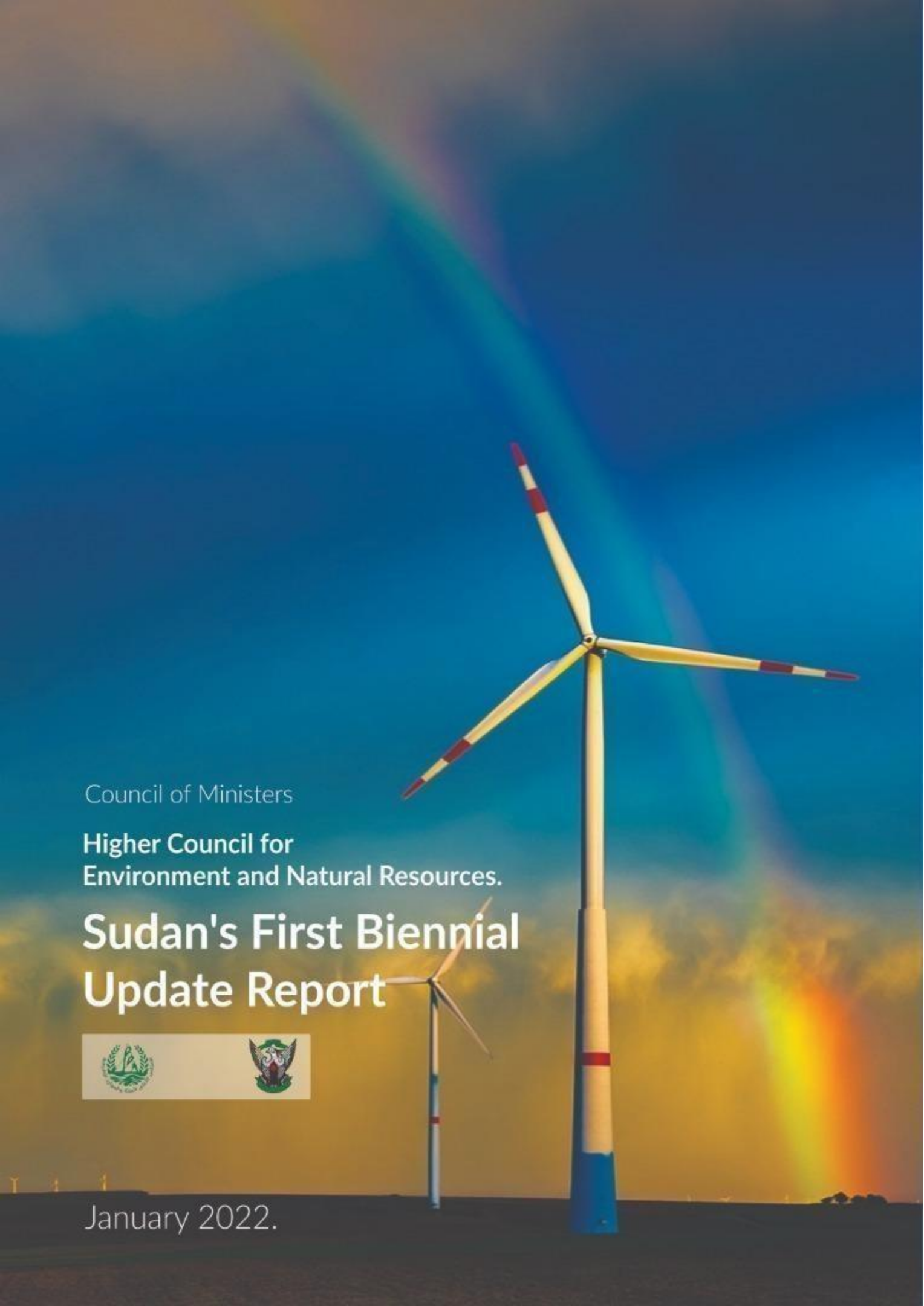
Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
							and environmental risks of agreed REDD+ strategy options is prepared and validated An operational feedback grievance and redress mechanism (FGRM) is in place.			
Sudan Sustainable Natural Resources Management Project (2013)	AFOLU	The objective of the project is to increase the adoption of sustainable land and water management (SLWM) practices in targeted landscapes. The project is part of the Sahel and West Africa Program (SAWAP) which supports the Great Green Wall Initiative (GGWI). The project strives to achieve its goal through the following components: 1) institutional and policy framework; 2) community-based sustainable management of rangelands, forests, and biodiversity; and 3) project management, monitoring, and evaluation.	CO_2	Reduction of 16,142,426 tCO_2eq per year by June 2022	World Bank	Ministry of Agriculture and Natural Resources, Higher Council for Environment and Natural Resources	Land area where sustainable land and water management practices are adopted as a result of the project (164,000. ha) Direct project beneficiaries (85,000.within 7,000 households with 35 percent female beneficiaries) Areas brought under enhanced biodiversity	Operating	Land area where sustainable land and water management practices are adopted as a result of the project (111,256 ha) Direct project beneficiaries (47,210) Areas brought under	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
							protection (23,400 ha)		enhanced biodiversity protection (20,687.50 ha)	
Alfashir& Al-Dien Solar PV Power Plant Project (2019)	ENERGY	The 5 MW Solar PV each in both Alfashir and Al-Dien is a self-financed project by the government of Sudan and its objective is to (1) provide stable electricity supply (2) fuel-saving (3) preserving the environment and reducing GHG emissions.	CO_2	Reduction of 7,749tCO_2/year for each plant.	Ministry of Energy and Mining	Sudan Electricity Holding Company	Expected annual energy yield: 10,000 MWh 16,220 solar PV modules, each module 325W 84 Inverters, each inverter 60 kW, for converting DC to AC Current (SMA Solar Technology) 4 Power Transformers raising 400 V to 33 kV (Schneider Electric).	Ongoing	5,161 MWh generated for each plant	3.6 Kt per plant
Grid-Interactive Rooftop Solar PV System (2018)	ENERGY	The 140 MW rooftop Solar PV system projects aim to reduce electricity bills, avoid grid losses and Solve grid bottlenecks using clean energy placed on Households and public/private buildings.	CO_2	N/A	Ministry of Water Resources and Irrigation	Sudan Electricity Holding Company	Roof-Top implementation for Sectors (Governmental – Industrial – residential) 300 KW pilot project Generate 140 MW by 2024.	Ongoing	Generated 414,203.61 MWh Fuel-saving 165 Tons	171.9 MT CO_2eq

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
Solar Pumping for Agriculture in Northern state (2016)	ENERGY	The project is aiming at installing 1428 solar pumps to irrigate 150,000 acres over 5 years.	CO_2	N/A	UNDP	Ministry of Energy and Mining	N/A	Ongoing	Installed 428 solar pumps	N/A
Rural Electrification with Solar Home Systems (SHS) (2019)	ENERGY	The objective is to install 1.1 mission SHSs of 50-100-200 Watts in rural areas far from the grid to satisfy basic needs.	CO_2	N/A	Ministry of Energy and Mining	Sudan Electricity Holding Company	The objective is to install 1.1 mission SHSs of 50-100-200 Watts	Ongoing	Project implemented across 4 different states 10,000 SHS ongoing	N/A
Sudan Pilot Wind Turbine (2021)	ENERGY	This pilot project will create the case study for replication in later utility-scale wind farms that Sudan plans to develop in three regions: Dongola in the North, Nyala in the South, and the Red Sea coastal region.	CO_2	N/A	Ministry of Energy and Mining	Sudan Electricity Holding Company	900 KW wind turbine	Being implemented	• Supply of material: the anchor delivered and turbine and turbine blades fabricated. • Civil work: site preparation, civil work, access road ongoing • 33 KW Grid connection line: ongoing.	N/A
Sudan - Solar PV Powered Pumping for	ENERGY	The proposed project aims to develop and accelerate the adoption of off-grid solar PV-	CO_2	376 kt CO_2eq / year1 in 2024 Average of	Electricity, National	Ministry of Water Resources,	Install 1,170 solar PV pumps Establish	Implementing	N/A	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
Irrigation Project in North Kordofan and West Kordofan (2020)		powered pumping systems in irrigation in farmlands by replacing the diesel-based water pumps with solar PV-powered pumps. The project covers two states, North Kordofan and West Kordofan.		4,605 metric tons per year over the 20-years life span.	Energy Research Center (NERC), Sudan Standards and Metrology Organization (SSMO), Ministry of Agriculture and Forests.	Irrigation Selected State government (North Kordofan and West Kordofan State Ministries of Agriculture), Ministry of Finance and Economic Planning, Higher Council for Environment and Natural Resources (HCENR).	workshops, one in North Kordofan and another in West Kordofan, for maintaining, servicing, and repairing solar-powered pumps Supply additional testing equipment for the solar PV pumps testing laboratory to ensure quality standards, quality assurance, testing and certification, and training and capacity building.			
Sudan Energy Transition and Access Project (2021)	ENERGY	The development objective is to improve the financial sustainability of the electricity sector, enhance access to reliable electricity services, and facilitate clean energy transition in Sudan.	CO_2	N/A	Ministry of Energy and Mining	Sudan Electricity Holding Company	The project will have an overall positive impact on the country's population, as it is expected to provide new/improved access to electricity	Pipeline	N/A	N/A

Project or program	Sector	Description	Gas	Estimated mitigation impact	Implementing Entity	Executing Entity	Main objective	Project Status/ Progress	Outcomes Achieved	GHG Gas Reduction
							mitigate the ongoing power shortage address power supply deficit			



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