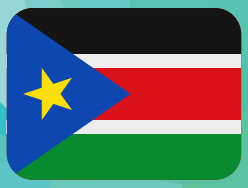

# REPUBLIC OF SOUTH SUDAN

## INITIAL NATIONAL COMMUNICATION TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE


UN environment

gef


## Government of South Sudan

2018

# Government of South Sudan
# Initial National Communication to the United Nations Framework Convention on Climate Change



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# FOREWORD

South Sudan is the world's youngest and least developed country (LDC). It gained independence from Sudan on 9 July 2011, following a referendum held in January 2011. The new nation has made considerable efforts to participate in multilateral environmental agreements (MEAs) and has also joined global efforts to address environmental issues by becoming a Party in 2014 to the following three Rio Conventions: the United Nations Convention on Biological Diversity (CBD), the United Nations Convention to Combat Desertification (UNCCD) and the United Nations Framework Convention on Climate Change (UNFCCC). Article 12.5 of the UNFCCC states that Parties that are LDCs, such as South Sudan, may make their initial communication at their discretion.

On behalf of the Government of South Sudan, it is a privilege and a great honour to present South Sudan's Initial National Communication (INC) to the UNFCCC Conference of Parties (COP). This communication represents the commitment of the Government and its people to address global warming and climate change, along with the strong belief that all countries must make an effort to greatly reduce greenhouse gas (GHG) emissions in order to avoid the dangerous and potentially catastrophic impacts of climate change. This report marks an important step for South Sudan in meeting its international obligations and ensuring that climate change is considered in national policies, activities and development plans.

Although South Sudan is a minor emitter of GHGs, the country is negatively impacted by climate change in nearly all its key economic sectors, such as agriculture, transport and forestry. Besides conflict and insecurity, climate change is expected to be the country's single most important contributor to food insecurity. As a developing country that is highly vulnerable to the impacts of climate change, South Sudan believes that the issue can be addressed through developing and implementing sustainable development initiatives that promote strong, clean and climate-resilient economic growth. It is crucial that South Sudan learns to adapt to the impacts of climate change and should focus on strengthening the capacity of its institutional and human resources for this purpose. The country is endowed with adequate natural resources that make a low-carbon climate-resilient development path possible. At present, insecurity and insufficient funding are limiting its opportunities to address climate adaptation and mitigation.

This INC assesses South Sudan's national circumstances and responses to climate change, providing the basis for future research and presenting opportunities for policy development and refinement. The document serves as a useful tool upon which to base decisions and plans concerning climate change and future national development, which will be approached in the spirit of global cooperation.

The report contains South Sudan's GHG inventory and examines potential measures to abate the increase of GHG emissions. It also analyses the main findings on the likely impact of climate change for the country, and how vulnerable its various economic sectors may be to such impacts, before presenting possible adaptation measures.

While South Sudan's national efforts mark a significant milestone towards capacity-building and institutional strengthening, as well as improving its climate information and understanding, this report has identified certain related constraints and gaps. Addressing these constraints will help

to further improve National Communications (NCs) and will allow for ongoing and consistent reporting in accordance with applicable guidelines.

As the national focal point for climate change, the Ministry of Environment and Forestry is responsible for ensuring the full implementation of strategies and measures for curbing the adverse impacts of climate change and that support the sectors of economic growth, and also for promoting sustainable economic growth and development. However, this will require collective efforts among all stakeholders in public and private organizations, including non-governmental organizations (NGOs), civil society, donors and local communities. The Government will provide the support needed to successfully implement strategies and measures outlined in this report.

Although many challenges were encountered in preparing this report, the process further developed national capacity on climate change issues, and also provided valuable experience and many lessons, thereby establishing a foundation to sustainably prepare future NCs.

On behalf of the Government of South Sudan, I would like to express my sincere gratitude to the Global Environment Facility (GEF), and the United Nations Environment Programme (UNEP) as its implementing agency, for their support throughout the preparation of this report, as well as all those who have contributed.

*Josephine Napwon Cosmas*
*Minister of Environment and Forestry, Republic of South Sudan*

# PREFACE

Since its ratification of the United Nations Framework Convention on Climate Change (UNFCCC) on 17 February 2014, the Government of South Sudan has worked towards achieving the Convention's objectives. As a Party to the UNFCCC, South Sudan is obliged to periodically report to the Convention through a National Communication (NC), which details common but differentiated responsibilities and specific national and regional development priorities, objectives and circumstances.

To fulfil this obligation, South Sudan has prepared this Initial National Communication (INC) to be presented to the Conference of the Parties (COP). This report marks South Sudan's initial assessment of its national circumstances and responses to climate change, and enriches its National Adaptation Programme of Actions (NAPA), which provides the basis for building climate change resilience throughout the country. In addition, the report reflects the relevant aspects of the country's aspirations as envisaged in Vision 2040, as well as several other national sector-specific policy documents and plans, such as the Comprehensive Agriculture Development Master Plan, and also provides an overview of national and state-level climate change issues.

This document was prepared in accordance with the provisions of articles 4.1 and 12.1 of the Convention and the guidelines contained in decision 17/CP.8 of the COP. Producing the report was a national effort and involved contributions of various stakeholders, including the Government, civil society and humanitarian organizations, with development partners organizing four broad thematic working groups (TWGs). The process was inclusive and participatory, and included a series of workshops, meetings and interviews, most of which were held in Juba due to ongoing conflict and insecurity in many parts of the country. Findings were validated through visits by consultants, the United Nations Environment Programme (UNEP) South Sudan and representatives of the Ministry of Environment and Forestry to Bor, Aweil and Kapoeta.

The Government of South Sudan views the process of preparing the country's INC as an opportunity to enrich and enhance its capabilities to identify constraints, gaps and related financial, technical and capacity needs to adequately fulfil its obligations under the UNFCCC. The process has also helped to identify opportunities and threats that may arise as a result of the changing climate. This document builds on the various studies, reports and plans that have been developed since the country's independence in 2011, including the South Sudan Comprehensive Agricultural Development Master Plan, Vision 2040 and NAPA, revealing the country's high climate variability and vulnerability. When producing this report, the main challenge was that data were often insufficient and inaccurate for various economic sectors. This INC will therefore act as the basis for future improvements in this area. The exercise was coordinated by the Ministry of Environment and Forestry on behalf of the Government.

The structure of this INC is based on the guidelines for the preparation of NCs from Parties not included in Annex I to the Convention (decision 17/CP.8) and includes, as required, information on national circumstances, greenhouse gas (GHG) inventory and climate change mitigation measures, vulnerability and adaptation to climate change, as well as information relevant to achieving the Convention's objective, including research, education and systematic observations specific to climate change.

This document not only highlights South Sudan's efforts to address climate change, but also provides a solid foundation for further work on scientific and policy issues, while clearly defining climate change-related concerns within the national context and identifying potential areas for action. It also aims to alert policymakers on the importance of mainstreaming climate change issues in policy and legal frameworks and highlight the need for awareness-raising among stakeholders and decision makers.

The INC notes that South Sudan needs to better capture, manage and effectively disseminate climate-related information. It also recommends that the country needs to integrate climate change resilience-building into all its development strategies, especially those targeting food security and poverty reduction. This INC will help the Government, its development partners and other stakeholders to focus on priority areas with regard to climate change and also to identify existing information gaps that need to be addressed. The report is structured as follows:

- Chapter 1: **The national circumstances of South Sudan** covers the country's situation, including its governance, conflicts, geography, population, culture, natural resources, economy, agriculture, energy and health.
- Chapter 2: **South Sudan national greenhouse gas inventory** provides information on South Sudan's GHG emissions and removals by sinks between 2011 and 2015.
- Chapter 3: **Programmes containing measures to facilitate adequate adaptation to climate change** analyses climate change scenarios and impacts, the vulnerabilities of various regions and communities to the predicted impacts and the proposed adaptation measures. This chapter builds on South Sudan's NAPA.
- Chapter 4: **Programmes containing measures to mitigate to climate change** provides information on climate change mitigation opportunities for South Sudan's various economic sectors.
- Chapter 5: **Other information considered relevant for implementation of the Convention** reports any other information relevant to achieving the Convention's objectives, analysing mainstreaming efforts, technology transfer, research and systematic observation and capacity-building.

Sincere gratitude is given to the officials and experts of the Ministry of Environment and Forestry, related government departments, development partners, civil society organizations, members of the thematic working groups (TWGs), the consulting team and individuals for their dedication and commitment in preparing this INC. It is hoped that all government officials, experts and stakeholders will use this information and knowledge to the best of their ability to generate national, regional and global benefits.

*Joseph Africano Bartel*
*Undersecretary of Environment, Ministry of Environment and Forestry*

# ACKNOWLEDGEMENTS

This Initial National Communication (INC) has been prepared in accordance with South Sudan's reporting commitments under articles 12.1 and 4.1 of the United Nations Framework Convention on Climate Change (UNFCCC), through local and international collaborative efforts. The Ministry of Environment and Forestry, on behalf of the Government of South Sudan, acknowledges the assistance provided by various institutions and individuals during the preparation and finalization of South Sudan's INC for submission to the UNFCCC's Conference of the Parties (COP).

Special gratitude goes to the Global Environment Facility (GEF) for funding this INC and to the United Nations Environment Programme (UNEP) for facilitating its implementation. Special thanks also goes to the consulting team, led by Tom Owina of ClimateCare, who worked tirelessly to guide the process and prepare the INC. Further thanks to Seton Stiebert for carrying out the greenhouse gas (GHG) inventory work and updating the mitigation analysis; Joash Obare for leading the preparation of the chapter on South Sudan's national circumstances; Irene Karani for preparing the chapter on climate change vulnerability and adaptation; and Elizabeth Mwangi for preparing the chapter other issues related to the implementation of the Convention.

Several employees of the Government, local non-governmental organizations (NGOs), community-based organizations, the University of Juba and international development partners participated in the consultations and helped to review the various documents, provide feedback and validate the consultants' work. Special acknowledgement goes to the INC Steering Committee members for leading and directing the project, and to Mr. Arshad Khan and Mr. Martin Dramani (both from UNEP South Sudan), for their efforts to progress the process despite the many challenges encountered, and also for spearheading, managing and coordinating the preparation process.

Members of the thematic working groups (TWGs), various national institutions, government departments, academic institutions, private sector organizations, civil society organizations and development partners provided expertise and data to prepare this INC. Their contributions are greatly appreciated and the names of all contributors have been listed in Annex 1. Special acknowledgement also goes to the National Adaptation Programme of Actions (NAPA) and Comprehensive Agriculture Development Master Plan report teams, for their invaluable input regarding vulnerabilities, adaptation and the GHG inventory sections included within this document. The GEF and all other contributors are also gratefully acknowledged for their steadfast support and assistance.

*Joseph Africano Bartel*
*Chair of the Project Steering Committee*

# ABBREVIATIONS

| | |
|---|---|
| 2SCALE | Toward Sustainable Clusters in Agribusiness through Learning in Entrepreneurship |
| AAH | Action Africa Help |
| ADRA | Adventist Development and Relief Agency International |
| AfDB | African Development Bank |
| AGRA | Alliance for a Green Revolution in Africa |
| ASSAR | Adaptation at Scale in Semi-Arid Regions |
| AWF | African Wildlife Foundation |
| CAR | Central African Republic |
| CBD | Convention on Biological Diversity |
| CBOs | community-based organizations |
| CDM | Clean Development Mechanism |
| CFRs | Central Forest Reserves |
| $CH_4$ | methane |
| CIDA | Canadian International Development Agency |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| COP | Conference of the Parties |
| CPA | Comprehensive Peace Agreement |
| CRS | Catholic Relief Services |
| CRU | Climatic Research Unit |
| DFID | Department for International Development |
| DJF | December, January and February |
| DRC | Democratic Republic of the Congo |
| DTU | Technical University of Denmark |
| EFA | Education for All |
| EIA | Environmental Impact Assessment |
| ENDA | Environmental Development Action in the Third World |
| ESAs | Environmentally Sensitive Areas |
| ESMF | Environmental and Social Management Framework |
| FAO | Food and Agriculture Organization of the United Nations |
| FEWS NET | Famine Early Warning System Network |
| FFI | Fauna and Flora International |
| FMI | Finnish Meteorological Institute |
| GCMs | General Circulation Models |
| GDP | gross domestic product |
| GEF | Global Environment Facility |
| GESP | General Education Strategic Plan |
| Gg | gigagram |
| GHG | greenhouse gas |
| GIZ | *Deutsche Gesellschaft für Internationale Zusammenarbeit* [German Society for International Cooperation] |
| GMOs | genetically modified organisms |
| GPAA | Greater Pibor Administrative Area |
| GRSS | Geoscience and Remote Sensing Society |
| HARC | Halima Agricultural Research Centre |

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| HEI-ICI | Higher Education Institutions Institutional Cooperation Instrument |
| HFCs | hydrofluorocarbons |
| HFO | heavy fuel oil |
| ICRAF | International Centre for Research in Agroforestry |
| IDPs | internally displaced persons |
| IFC | International Finance Corporation |
| IFPRI | International Food Policy Research Institute |
| IGAD | Intergovernmental Authority on Development |
| INC | Initial National Communication |
| INDCs | Intended Nationally Determined Contributions |
| IPCC | Intergovernmental Panel on Climate Change |
| IRG | International Resources Group |
| IUCN | International Union for Conservation of Nature |
| JICA | Japanese International Cooperation Agency |
| JJA | June, July and August |
| KCA | Key Category Analysis |
| LAMPTESS | Landscape Management Planning and Training for the Environment in South Sudan |
| LDCs | least developed countries |
| LGCs | Local Government Councils |
| LULUCF | land use, land-use change and forestry |
| MAM | March April and May |
| MARF | Ministry of Animal Resources and Fisheries |
| MDGs | Millennium Development Goals |
| MEAs | multilateral environmental agreements |
| MOU | memorandum of understanding |
| MRV | monitoring, reporting and verification |
| Mt | million tons |
| $MtCO_2e$ | million tons of carbon dioxide equivalent |
| $N_2O$ | nitrous oxide |
| NAMAs | Nationally Appropriate Mitigation Actions |
| NAP | National Adaptation Plans |
| NAPA | National Adaptation Programme of Action |
| NBI | Nile Basin Initiative |
| NBS | National Bureau of Statistics |
| NBSAP | National Biodiversity Strategies and Action Plans |
| NC | National Communication |
| NCCAP | National Climate Change Action Plan |
| NCSA | National Capacity Self-Assessment |
| NEMA | National Environmental Management Authority |
| NFF | National Forest Fund |
| NFRs | national forest reserves |
| NGOs | non-governmental organizations |
| NMVOC | non-methane volatile organic compounds |
| NOx | nitrogen oxides |
| NPA | Norwegian People's Aid |
| NTC | National Telecommunication Council |
| PA | protected areas |

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| PARC | Palataka Agricultural Research Centre |
| PMT | Project Management Team |
| QA/QC | quality assurance and quality control |
| RCS | radio communication services |
| SCCF | Special Climate Change Fund |
| SDGs | Sustainable Development Goals |
| SEIA | Social and Environmental Impact Assessment |
| SFRs | state forest reserves |
| SMA | Sudan Meteorological Authority |
| SMEs | small and medium-sized enterprises |
| $SO_2$ | sulphur dioxide |
| SPI | Standardized Precipitation Index |
| SPLA/M | Sudan People's Liberation Army/Movement |
| SSCCSE | Southern Sudan Centre for Census, Statistics and Evaluation |
| SSDP | South Sudan Development Plan |
| SSEC | South Sudan Electricity Corporation |
| SSFC | South Sudan Forest Commission |
| SSMS | South Sudan Meteorological Service |
| SSNEP | South Sudan National Electricity Policy |
| SSRRC | South Sudan Relief and Rehabilitation Commission |
| SSWS | South Sudan Wildlife Service |
| SWDS | solid waste disposal sites |
| TAP | Technology Action Plans |
| tC | ton of carbon |
| TNA | Technology Needs Assessment |
| TWGs | thematic working groups |
| UMCOR | United Methodist Committee on Relief |
| UN-REDD | United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation |
| UNCCD | United Nations Convention to Combat Desertification |
| UNDP | United Nations Development Programme |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNICEF | United Nations Children's Fund |
| UNMISS | United Nations Mission in the Republic of South Sudan |
| US EPA | United States Environmental Protection Agency |
| USAID | United States Agency for International Development |
| USGS | United States Geological Survey |
| VITRI | Viikki Tropical Resources Institute |
| VSAT | very small aperture terminal |
| WASH | water, sanitation and hygiene |
| WCS | Wildlife Conservation Society |
| WFP | World Food Programme |
| WiMAX | Worldwide Interoperability for Microwave Access |
| YARC | Yei Agricultural Research Centre |

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# EXECUTIVE SUMMARY

South Sudan is the youngest least developed country (LDC) in the world. It gained independence from Sudan on 9 July 2011 and since then has made considerable efforts to participate in multilateral environmental agreements (MEAs) as well as global efforts to address environmental issues by becoming a Party to the following three Rio Conventions:

- United Nations Convention on Biological Diversity (CBD)
- United Nations Convention to Combat Desertification (UNCCD)
- United Nations Framework Convention on Climate Change (UNFCCC).

Following its accession to the UNFCCC on 18 May 2014, the young nation has launched various initiatives to meet its climate change-related obligations and commitments, which includes the preparation of this Initial National Communication (INC). According to article 12.5 of the UNFCCC, Parties that are LDCs, such as South Sudan, may make their initial communication at their discretion.

The Transitional Constitution of the Republic of South Sudan commits all levels of government in the Republic of South Sudan to securing sustainable development in order to ensure that the environment is protected for present and future generations, through reasonable legislative action and other measures. The Transitional Constitution also gives every person or community in South Sudan the right to a clean and healthy environment and also obliges each person to protect the environment.

South Sudan has also prepared a National Adaptation Programme of Actions (NAPA) for 2016 onwards and is in the process of developing various policies and legislation to address climate change, among other issues. Through implementing action plans, South Sudan will be able to reduce its vulnerability to climate change and improve the country's ability to take advantage of the opportunities such change offers. This INC therefore identifies priority mitigation and adaptation measures and provides information on how to integrate these into national development plans. As a next step, South Sudan needs to explore financial instruments and other available sources of funding, such as from the public and private sector, multilateral initiatives and carbon markets for climate action.

This report was supported by the Global Environment Facility (GEF) through the United Nations Environment Programme (UNEP). The funding provided made it possible to develop the greenhouse gas (GHG) emissions inventory and supported the consultants' preparation of reports, as well as stakeholder reviews and validation of the work needed in order to deliver a high-quality INC. The consultations included visits to Bor, Aweil and Kapoeta by the international consultant, national consultant, UNEP and government representatives. The National Communication (NC) process included individual and public consultations with representatives from government institutions, academia, the private sector and non-governmental organizations (NGOs), in order to capture their opinions and ensure inclusiveness.

# National Circumstances

## Government profile

South Sudan is the world's newest nation and Africa's fifty-fifth country. As a new country, South Sudan has the challenge of dealing with a legacy of almost 50 years (1955–1972, 1983–2005 and 2013 to date) of conflict and continued instability, as well as huge development needs. Formal institutions are gradually being established and the Government is growing its limited capacity to formulate and implement policies and programmes.

After independence, the Government promulgated the Transitional Constitution as the country's first constitution, which expects all levels of government in South Sudan to promote democratic principles, political pluralism underpinned by decentralization and devolution of political and economic powers, with the ultimate goal being national reconciliation, healing, harmony and peaceful co-existence.

South Sudan is a unitary State with a multiparty political system. The Government comprises a devolved three-tier system made up of the national government, 32 state governments and several local governments, with defined roles and responsibilities and a separation of powers between the executive, legislature and judiciary.

In August 2011, South Sudan launched its South Sudan Development Plan (SSDP) 2011–2013, titled "Realising Freedom, Equality, Justice, Peace and Prosperity for All". The SSDP was originally designed for 2011–2013, but was later extended to 2016 in order to streamline its planning initiatives. The plan acted as a prelude for the South Sudan Vision for 2040 and established effective nation-building and peacebuilding as the key national development priorities for the country as a new state. By the end of the plan period, South Sudan was expected to be a peaceful, stable, viable and secure nation with a strong foundation in place for effective governance, economic prosperity and enhanced quality of life for all citizens.

Under the Transitional Constitution, the Government has overall responsibility for ensuring that national programmes are implemented to deliver developmental gains. The Government is also responsible for meeting its obligations under the UNFCCC, which it ratified on 18 May 2014. Since climate change is crosscutting and multi-sectoral in nature, the national government is best placed to address it.

Between December 2013 and April 2016, the country experienced armed conflict, with fighting erupting again in mid-July, which continued into 2017, resulting in increased violence and insecurity throughout the country. Continued armed conflict has hindered South Sudan's economic activity and undermined potential developmental gains, which has reduced the country's capacity to respond to the impacts of climate change, thereby constraining economic growth and worsening the humanitarian situation.

## Geographical profile

South Sudan is a landlocked country that lies between latitudes 3°N and 13° N and longitudes 24°E and 36°E. It is bordered by Ethiopia to the east, Kenya to the south-east, Uganda to the south, the Democratic Republic of the Congo to the south-west, the Central African Republic to the west and Sudan to the north. The country's territory totals 644,329 $km^2$ and has many plains and plateaus that are drained by the Nile and its numerous tributaries. The Nile River system runs from south to north across the entire length of the east-central part of South Sudan. The central part of the country has a clay plain where the Sudd Wetland cover around 100,000 $km^2$, comprising lakes, marshes and extensive floodplains. The Ironstone Plateau lies between the Nile Congo Watershed and the clay plain and has numerous inselbergs, which are isolated hills that rise abruptly from the plains. In the southern part of South Sudan are the Imatong Mountains, with peaks of more than 3,000 metres.

It is estimated that about 80 per cent of South Sudan's land is arable and suitable for growing a wide range of food and cash crops. High rainfall in the country also makes the land ideal for agricultural activities, though its agricultural system is poorly developed and there is a lack of irrigation systems. As such, the South Sudanese rely on rain-fed agriculture and livestock products for food. During the dry season from November to March, tall grasses that surround the grasslands are burned, releasing a lot of smoke and particulates into the atmosphere.

South Sudan is an LDC with large amounts of natural resources (other than oil), which are mostly untapped. The country is underdeveloped and has a subsistence economy. Despite its vast arable land, oil reserves, untapped water resources and large stocks of cattle and fisheries, the general lack of road infrastructure, market integration and agriculture investments, along with several years of conflict, have led to widespread economic challenges for its people beyond food and nutrition insecurity.

In 2016, South Sudan's gross domestic product (GDP) grew 0.3 per cent compared with 5.1 per cent in 2017, when the country's estimated GDP was US$3.6 billion. South Sudan is the most oil-dependent nation in the world, with the resource accounting for almost all its exports, which is around 60 per cent of its GDP and over 95 per cent of government revenues in previous fiscal years. Macroeconomic performance has continued to deteriorate because of the country's fragile situation, the civil war, the sharp fall in oil production and continuing low oil prices worldwide. In 2015, its economic growth fell by 0.2 per cent, with fiscal and current account deficits increasing sharply since then. Most of the population (85 per cent) is engaged in non-wage work, largely subsistence agriculture, which is highly sensitive to climate change. In 2015/16, net oil revenues fell to only 17 per cent of the previous year's revenues, adversely impacting South Sudan's economic performance, with real GDP growth falling by 0.2 per cent in 2015.

## Climatic profile

The country has distinct climatic areas, which are influenced by the annual movements of the Intertropical Convergence Zone. The climate ranges from hot and dry in the south-east near the border with Kenya and north-east near the border with Sudan to temperate in the southern highlands. The climate is semi-humid, with annual rainfall ranging from 200 mm in the south-east (Eastern Equatoria) to 1,200–2,200 mm in the forest area of Western Equatoria and the

highland areas. In South Sudan's northern states, rainfall varies between 700 and 1,300 mm. The rainfall pattern is seasonal, with its wet season lasting from April to October, followed by its dry season from November to March. Most of South Sudan experiences monsoons between June and September during its long rainy season, though the extreme south region tends only to experience two peaks during this period.

Historical data show a low precipitation pattern in the north-east, with high precipitation in the south-west. The area along the border with the Central African Republic, the Democratic Republic of the Congo and Uganda receives the most rainfall throughout the year. However, the volume of rainfall varies greatly from year to year and also from location to location.

South Sudan receives most of its rain during the rainy season (June–September), which provides enough water across parts of the country for farming and livestock. The heavy rains that fall in August and September cause the Nile River and its tributaries to flood, though many parts of the country are prone to flooding during the wet season, including the states of Jonglei, Unity, Upper Nile, Warrap and Northern Bahr el Ghazal, as well as parts of Western and Eastern Equatoria. Due to the increasing variability in the volume and onset of the rains, fewer areas are now receiving 500 mm or more of rain, resulting in deficits for populations in Upper Nile, Jonglei and Eastern Equatoria.

South Sudan's temperature varies across locations. Average temperatures range between 18°C and 30°C, with the coldest temperatures experienced in elevated areas. The hottest month is generally March, whereas the coldest is August.

Due to changing climatic conditions, South Sudan has been warming at a rate that is two and a half times greater than the global average air temperature change (0.4°C per decade), with projections estimating a temperature rise of 1°C by 2060 from 2020 values.

## Population profile

In 2017, South Sudan had an estimated population of 13 million, which is rapidly growing at 2.052 per cent per annum. Its population is very young, with 72 per cent under the age of 30. Poverty is prevalent and people are increasingly living below the poverty line (51 per cent in 2014 and 64 per cent in 2016), lacking critical services such as access to good, quality health care, water supply and education. Around 83 per cent of the country's population resides in rural areas and relies predominantly on an ever-degrading environment and scarce natural resources for livelihoods. However, urbanization is increasing and it is estimated that by 2020, 74 per cent of the population will be rural, decreasing to 34 per cent by 2050. The population's literacy rate is 40 per cent for men and only 16 per cent for women, while the infant mortality rate is 105 per 1,000 births.

## Cultural profile

South Sudan is ethnically and culturally diverse and has 64 major ethnic groups, whose diversity presents a unique opportunity for the country to enjoy the richness of various traditions, but also poses a threat to national unity and a collective sense of national identity. Livestock are typically a central part of the local culture and households therefore often have large herds, which contribute

to relatively high GHG emissions. South Sudanese households attach a high value to their animals and will therefore be severely affected as a result of any climate change impacts on livestock.

South Sudan has experienced various armed conflicts since 1955. Ongoing tensions with Sudan over oil revenues, land borders, armed groups, rebellions and inter-communal violence have threatened South Sudan since its independence in 2011. These tensions have resulted in frequent conflicts, which have adversely impacted the environment, the South Sudanese people and the country's natural resources. Flooding is now an annual occurrence in South Sudan and causes large swaths of pastureland and cropland to be submerged, resulting in food insecurity. Such flooding also acts as a source of conflict between communities: when pastoralists move their herds, they come into contact with other communities whose lands have not been flooded without having received proper permission for access, which often results in conflicts as each community tends to protect their pastureland or crops.

Bush fires are prevalent in South Sudan and have several causes, including socioeconomic and ethno-cultural activities and community lifestyles, among others.

## Natural resources profile

South Sudan is endowed with a wealth of biodiversity, which provides the country with great opportunity for socioeconomic development, as well as many biological resources that have considerable economic, social and intrinsic value. Most South Sudanese depend on biological diversity for goods and services, either directly or indirectly, for their basic and development needs.

The country has a wide range of habitats, including lowland forest, montane forest, savannah woodland, savannah grassland, wetlands and floodplains, the Sudd Wetland and the semi-arid region in the north, which support a very rich diversity of animal and plant species. However, such biodiversity, including wildlife, is currently under threat, due to weak environmental regulation, poor development planning, fires, and most importantly, fragility resulting from conflict, instability and insecurity.

In the south of the country, extensive and diverse forest and woodland resources provide food, oils, medicines, timber and firewood for communities, as well as habitats for much of South Sudan's wildlife. Forest ecosystems are generally robust, yet in some areas they have been degraded by decades of uncontrolled fire, uncontrolled grazing and overcutting of more desirable species. The country has experienced a significant decrease in forest cover, which reduced from 56.65 million hectares in 2007 to 20.74 million hectares in 2016.

Forest resources play an important role in the livelihoods of South Sudan's rural people, with the forestry sector contributing US$395.4 million to the economy in 2011 (0.7 per cent of the GDP). The main challenges to the country's natural forests and woodlands include forest base degradation from wild fires, overgrazing and overcutting of trees during continuous conflicts.

South Sudan has substantial water resources, mostly from the Nile River (White Nile and Blue Nile), its tributaries and aquifers. However, these resources are unevenly distributed across the region and vary considerably from year to year. Water demand for domestic and productive uses has been growing rapidly, a trend that is expected to continue, which will place even greater

pressure on water availability. The Sudd Wetland, which comprises lakes, swamps, marshes and extensive floodplains, covers a large part of the country (around 15 per cent of the total national territory), and was designated a Ramsar site in 2006.

The total renewable water resources for South Sudan are estimated at 49.5 $km^3$/year (per capita availability of around 4,567 $m^3$/year). Despite the availability of abundant surface-water and groundwater resources, millions of South Sudanese suffer from a lack of access to improved water supply and sanitation services.

Most households rely on surface water for their needs and will therefore be severely impacted by climate change, which will reduce their resilience to natural hazards, such as droughts and floods.

## Economy, industry and services profile

### Economy

South Sudan is an LDC and the world's newest nation, which gained independence from Sudan in 2011. Although South Sudan has large base of natural resources other than oil, most of which are untapped, it remains relatively undeveloped and is characterized by a subsistence economy. Despite the nation's vast arable land, oil reserves, untapped water resources and large stocks of cattle and fisheries, the general lack of road infrastructure, market integration and investment in agriculture, coupled with years of conflict, has led to widespread economic challenges besides food and nutrition insecurity.

South Sudan's economy is fragile and nascent, and does not reflect its tremendous economic potential. The country's 2017 GDP was estimated at US$3.6 billion, with the key contributors being oil and public and non-oil private sectors. South Sudan is an oil-dependent nation: the resource accounts for almost all its exports, around 60 per cent of its GDP and over 95 per cent of government revenues in previous fiscal years. It is estimated that as its oil reserves are depleted, production will gradually reduce to almost nothing by 2035. The country's economic performance is deteriorating, due to the ongoing armed conflict, sharp fall in oil production and collapse of global oil prices, which has resulted in increased relative food prices and shortages. According to South Sudan's National Bureau of Statistics, its real GDP grew 0.3 per cent in 2016 compared with 5.1 per cent in 2015.

Industry and infrastructure in South Sudan are severely underdeveloped and poverty is widespread, as a result of several decades of civil war with Sudan. Outside the oil sector, livelihoods are predominantly low productive, unpaid agriculture and pastoralist work, with roughly 85 per cent of the population engaged in non-wage work (78 per cent in agriculture), which accounts for around 15 per cent of the country's GDP. Markets are disorganized which has resulted in insecure property rights and weak price signals. South Sudan has not yet developed an entrepreneurial culture, likely due to its limited development of the private sector.

The country's economic performance, which is directly linked to oil revenues (oil production and prices) and escalation of armed conflict, has varied significantly since its independence. To strengthen its economy in the long term, South Sudan needs to end its over-reliance on oil and diversify its non-oil sectors, such as agriculture, mining, forestry and manufacturing, which

potentially have greater regional linkages. The long-term challenges include diversifying the formal economy, alleviating poverty, maintaining macroeconomic stability, improving tax collection and financial management, and improving the business environment within the context of a rapidly changing climate. South Sudan's trade policy and regulatory environment are still in their early stages and several important laws are yet to be enacted. There is also a lack of clarity among federal, state and county jurisdictions over business licensing, taxes and customs. Although some progress has been made in terms of drafting laws, addressing infrastructure and institutional gaps will remain a major challenge.

Private sector operations largely revolve around trade financing and informal traders dominate merchandise trade, both in terms of volume and value.

### Industry

South Sudan's industrial sector mostly comprises mining other extractive ventures, all of which are closely related to oil production. There are no major manufacturing or construction activities. South Sudan has abundant mineral wealth of unknown commercial quantities, including gold, uranium, diamonds, tungsten, mica and iron ore. The extractive sector is currently very small, accounting for less than 5 per cent of the country's GDP. In 2010, there were only 295 registered businesses in the industrial sector: 199 in manufacturing, 89 in construction and seven in water and waste management services. A large push in agriculture and infrastructure in the decade ahead will provide numerous possibilities for new investment in industrial activities, especially for the domestic market.

Manufacturing activities are limited in South Sudan and it is estimated that the subsector accounted for around 2 per cent of the GDP in 2010. Since there are few important manufacturers in South Sudan, most of the country's manufactured goods are imported from neighbouring countries. Efforts are under way revive several agro-processing industries that operated in the region before the outbreak of civil war some 30 years ago.

Most firms and businesses in South Sudan face a number of major constraints that adversely affect their competitiveness with imports and their future ability to export. These include acute power shortages and high costs of running generators, high labour costs, a lack of access to foreign exchange, poor transport infrastructure, difficulty in securing credit facilities and high rental costs for office space. Due to the country's low level of industrial activities, the sector is expected to contribute very little to national GHG emissions.

## Services

### Transport

At present, there are no reliable and efficient road, rail, air and water transport infrastructure in South Sudan, which is hindering the country's economic and social activity. Most roads radiating from Juba are gravel, except the road to Nimule from Juba, which is paved. The 1,300 km section of the White Nile between Juba, Renk and the border with Sudan is navigable and has seven main river ports, though water transport is yet to be developed. As regards rail transport, there is no line in use along the country's 248 km of narrow-gauge, single-track railroad. South Sudan

has one heliport and about 85 airports (as at 2013), of which only three have paved runways. Most of the airports are used for local air transport by humanitarian services and small private airlines operating within the country. The busiest and most developed airport in South Sudan is Juba International Airport, which has regular international connections to regional international airports. A single pipeline leads north from South Sudan's oil fields to Sudan's only seaport, Port Sudan, which is used to export crude oil.

While South Sudan's transport infrastructure is vulnerable to the impacts of climate change, especially heavy rains and floods, it is also a significant and growing contributor of GHG emissions that lead to climate change. The development of an efficient, effective and climate-resilient transport sector is therefore crucial for South Sudan in order to lower its overall cost of doing business and to increase its competitiveness.

## Trade

South Sudan's private sector is predominantly informal and applies barter trade. The national rate of employment stands at 11.5 per cent (10.8 per cent for men and 12.2 per cent for women). Most of the population is engaged in non-wage activities that are part of the informal and/or subsistence economy. In 2012, it was estimated that up to 80 per cent of non-oil economic activity takes place in the informal sector, which has grown exponentially since 2005. Nearly all formal businesses in South Sudan are small and medium-sized enterprises (SMEs), which dominate most sectors of the economy, including retail and wholesale trade, construction, hotels and restaurants, and transport and communication sectors.

## Agriculture profile

South Sudan's economy is largely agricultural, with 78 per cent of all households owning or using agricultural land. However, the country is endowed with immense natural resources, including fertile land (90 per cent of its land), extensive hardwood forests, large amounts of fresh water and minerals, and a wide variety of livestock, as well as native flora and fauna. These have made South Sudan suitable for a wide range of agricultural and natural resource-based production activities. At present, the country supports 10–20 million cattle. The country has over 30 million hectares of arable land, though only 5 per cent is currently in use.

Since the signing of the Comprehensive Peace Agreement (CPA) in 2005, agricultural development has been viewed as an alternative driver of growth. This will not only allow South Sudan to diversify its economy away from its oil dependency in the medium term, but also to directly reduce poverty and food insecurity.

## Crop husbandry

South Sudan has diverse soil and climatic conditions which favour the growth of various crops such as sorghum, maize, finger millet, rice, groundnuts, cassava, sesame, beans, fruits and vegetables, as well as coffee, tea, cotton and sugar cane, which the country also produces. In general, cereal crop yields are lower than in the neighbouring countries due to several factors that reduce national production. Despite the great potential for irrigation, it is currently only carried out as part of the Aweil Rice Scheme and is therefore limited.

South Sudan's cereal production has the potential to reach a maximum 2.5 million tons if 96 per cent of unused agricultural land is brought under cultivation. This would not only produce the estimated 1.04 million tons of cereal per annum as required, but would also leave a surplus of 1.5 million tons that could be exported to regional markets.

## Livestock

South Sudan has one of the largest livestock populations in Africa, with a variety that includes cattle, goats, sheep and chickens. The country has potential to invest in cattle rearing, dairy products, poultry products, meat processing, fishery and cattle feed development. Climate change poses a serious threat to livestock, as well as the livelihoods of pastoralist communities, due to the loss of pasture lands and reduced access to water resources. This has further resulted in armed conflicts among the pastoralist communities that have claimed many lives.

In South Sudan, cattle are much more than a source of food, signifying status and wealth and serving as the main livelihood asset for pastoralist communities. Livestock are sold for cash, slaughtered for cultural practices, bartered for grain, used as payment for penalties and given for dowry. The dislocation of massive numbers of livestock into areas outside their normal domains is causing dramatic rises in disease outbreaks and livestock deaths, which poses a grave threat to the livelihoods and food security of pastoralist communities across the country.

Women usually have a primary role regarding the nutritional status of their household, especially their children. The loss of cattle and decline in milk production due to disease implies that household coping strategies are being affected, impacting on overall household well-being and, in particular, nutrition. Lack of access to livestock increases the risk of malnutrition in pastoralist groups, particularly in children and lactating women, who rely on milk and blood as an essential part of their diet. This drop in production and lack of access is also likely to reduce women's income from milk sales, which benefit and contribute to household food security and well-being.

South Sudan's livestock sector contributes to GHG emissions through enteric emissions and manure decomposition.

## Energy profile

Energy production is crucial for South Sudan's economy and its population's standard of living. The SSDP 2011–2013 has identified energy as a key factor that will drive the country's economic growth.

Households in South Sudan predominantly use biomass to meet their energy needs, which involves burning charcoal, wood, grass, cow dung and agricultural residues. Over 96 per cent of the population use firewood or charcoal as their primary fuel for cooking. Firewood (35 per cent), grass (15 per cent) and paraffin lamps (13 per cent) are the most used sources for lighting, while 27 per cent of the population has no source of lighting at all. Only 3 per cent of the total population has access to electricity. Those who have electricity mainly reside in Juba, with the remaining few residing in the towns of Wau, Kapoeta and Malakal. Costly diesel generators are mostly used to produce the electricity, as there is no national grid electricity supply. All fossil fuel products used in the country are imported through Kenya.

In recognition of the critical role that electricity plays in South Sudan's economy, the Government has adopted the South Sudan National Electricity Policy (SSNEP) Paper, which outlines the framework for developing and operationalizing the electricity supply industry.

### Oil products

Though there are plans to build refineries in the future, South Sudan imports fuel for its power generators and transport sector, which is likely to remain the situation for 3–5 years until three proposed refineries are operational. The demand for oil products is expected to double in the next two years according to growth projections for industries such as roads, oil exploration and production, and agricultural schemes.

### Renewable energy and biomass

South Sudan has a large amount of renewable energy resources, which include biomass supplies, hydropower (4,860 MW), solar (approximately 6.9 GJ/$m^2$/year), wind (285–380 W/$m^2$) and agricultural residues. Woody biomass (fuelwood) is the main source of energy for cooking, while charcoal is mostly used by urban population.

South Sudan has high potential for renewable energies to generate electricity through small-scale and large-scale hydropower, solar photovoltaic systems, wind, biomass, geothermal energy and waste-to-energy, which are yet to be exploited.

### Health profile

South Sudan has an under-five mortality rate of 108 deaths per 1,000 live births, an estimated child mortality rate of 32 deaths per 1,000 children aged 1 year, and an estimated infant mortality rate of 79 deaths per 1,000 live births. One in four children (28 per cent) under 5 years is moderately or severely underweight and 12 per cent are classified as severely underweight, which is due to a poor diet resulting from a lack of food.

Climate change is likely to negatively impact the health sector by increasing the spread of various diseases, such as malaria.

Nearly 69 per cent of household members in South Sudan are using improved sources of drinking water. However, most households do not treat their water, exposing a large percentage of the population to waterborne diseases. Due to changing rainfall patterns, more people will be impacted by droughts and flooding.

Since the environment, water, health and sanitation sectors are interconnected, any climate change-related impacts in the environment and water sectors will also affect the health and sanitation sectors. Actions targeting these sectors should therefore take a holistic approach to avoid mal-adaptation.

## Education profile

The South Sudanese education sector is not as developed as other neighbouring countries and faces several challenges. These include a shrinking national education budget, low teacher remuneration, an inadequate number of qualified teachers and other human resource limitations, inadequate physical facilities and school infrastructure, and gaps between policy formulation and implementation.

Only 27 per cent of adults aged 15 and older are literate. However, the 15–24 age group has a higher literacy rate at 40 per cent and is the group that will drive the country's economy in terms of human capital in the future.

## Institutional profile

South Sudan's long conflicts destroyed its little infrastructure and governance structures, which has made the new country one of the least developed countries in Africa and, as a result, highly vulnerable to climate change. The country currently has limited institutional and technical capacity, and appropriate technologies and financial resources to support the implementation of interventions for adaptation to climate change. Article 41 of the Transitional Constitution highlights the importance of South Sudan's environment to the lives of its citizens.

The Government of South Sudan has developed some relevant legislation and policies to ensure the sustainability of the country's natural resources. When operationalized, these will address the drivers of economic degradation and help mitigate climate change, while ushering the country towards environmentally sustainable development.

The lead government institutions for climate change include the Ministry of Environment and Forestry, Ministry of Wildlife Conservation and Tourism, Ministry of Agriculture and Food Security, Ministry of Electricity and Dams, Ministry of Irrigation and Water Resources, Ministry of Animal Resources and Fisheries, and Ministry of Petroleum and Mining.

## South Sudan's ongoing responses to climate change

The Government of South Sudan is implementing many interventions that are directly and/or indirectly relevant to climate change adaptation and mitigation. These measures aim to help the country meet its development agenda and improve the welfare of its citizens, addressing, in particular, agriculture, water resources, electricity and forestry.

NCs are important for predicting, monitoring and evaluating a Party's contribution to attaining the objectives of the UNFCCC and also for reducing the impacts of adverse effects of climate change on its people and economy. South Sudan will address climate change and its impacts on the basis of national and regional development priorities, objectives and circumstances. These are important as they determine South Sudan's ability to mitigate and adapt to climate change, while at the same time achieving the country's development objectives.

## National greenhouse gas inventory

In accordance with article 4, paragraph 1 (a) of the UNFCCC, all Parties to the Convention are requested to "Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties". Parties that are least developed countries, such as South Sudan, may make their INC at their discretion.

In 2003, Sudan submitted its INC which included the South Sudan region, as it had not yet gained independence. However, since then, no inventory for South Sudan has been separately prepared or submitted. The sixteenth session of the Conference of the Parties (COP 16) decided that non-Annex I Parties should submit their NCs to the COP every four years or in accordance with any further decisions on this frequency to be adopted in the future. As an LDC, South Sudan is permitted to estimate its national GHG inventory years at its discretion in its initial and second NCs.

This inventory reports GHG emissions and removals by sinks for the base year 2015, as well as for the years between 2011 and 2015. This represents the time period since independence and the years for which there are recent data available to estimate emissions per sector. Some inventory data are also reported for 2016, though emissions have not been estimated for this year as there were insufficient data available to do so accurately.

This report provides a description of the appropriate methodologies used and an analysis and interpretation of the data generated on anthropogenic GHG emissions and sinks per sector for South Sudan. The GHG inventory was conducted for each of the following sectors: energy, industrial processes, agriculture, land use, land-use change and forestry (LULUCF) and waste. No information on solvent and other product use has been provided in this report due to the insufficient data available and the very low contribution of this sector to overall GHG emissions. The GHGs included are: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and partial hydrofluorocarbons (HFCs) not covered by the Montreal Protocol. Indirect GHGs, including non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), nitrogen oxides (NOx) and sulphur dioxide ($SO_2$) are also reported, as these have an important influence on chemical reactions in the atmosphere.

The "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" (Volumes 1, 2 and 3) and the "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" were used as the primary basis for undertaking the necessary calculations on GHG emissions and removals. The use of these IPCC guidelines for all years fulfils the objective of the UNFCCC COP to use comparable methodologies. The "2006 IPCC Guidelines for National Greenhouse Gas Inventories" was also drawn upon for instances in which the emission estimates could be significantly improved. In accordance with the guidelines, $CO_2$ emissions from international bunkers and burning of biomass are not included in the national totals, but are reported separately as memo items in the inventory.

Emissions were calculated using the UNFCCC Greenhouse Gas Inventory Software for non-Annex I Parties (NAIIS) (version 1.3.2). For verification and transparency purposes, the completed

relevant IPCC summary report sheets used to prepare the inventory report for South Sudan have been provided separately.

Overall GHG emissions in South Sudan increased slightly between 2012 and 2015. In three years, total emissions are 5 per cent higher, which is equivalent to an annual increase of 1.8 per cent. Despite an overall decline in domestic fuel consumption, increased activity in the oil and gas sector is driving the increase in emissions, with overall production and emissions from the sector rising by more than 400 per cent in the same time frame.

The following is an overall summary of GHG emissions for South Sudan between 2012 and 2015. GHG emissions are expressed as $CO_2e$ (carbon dioxide equivalent) by IPCC sectors, based on global warming potentials (GWP) from the "IPCC Fourth Assessment Report", as indicated in Table 1.

**Table 1: Global warming potentials of greenhouse gases identified in South Sudan**

| Gas | 100-year GWP |
|---|---|
| Carbon dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 21 |
| Nitrous oxide ($N_2O$) | 310 |
| HFC-134a | 1,300 |
| HFC-404a | 3,260 |
| HFC-407c | 1,610 |
| HFC-410a | 1,725 |

Note: Since the publication of the "Revised 1996 IPCC Guidelines", new GWP have been estimated based on improved research. However, national inventories of non-Annex I Parties reported to the UNFCCC are currently still prepared using the GWP indicated above.

Total $CO_2e$ emissions for 2015 are estimated to be 33.5 megatons of carbon dioxide equivalent ($MtCO_2e$), excluding LULUCF contributions. This is an increase of 2.0 $MtCO_2e$ (6 per cent) from 2012 emissions, without LULUCF. With LULUCF sector $CO_2e$ emissions, the total rises by 2.0 $MtCO_2e$ (2 per cent) to 36.3 $MtCO_2e$ for 2015.

Figure 1 and Figure 2 indicate the relative contribution of the four main GHGs ($CO_2$, $CH_4$, $N_2O$ and HFCs) to the total emissions for each of the inventory years (2012, 2013, 2014 and 2015).

**Figure 1:** Total GHG emissions, excluding LULUCF ($GgCO_2e$), 2012–2015

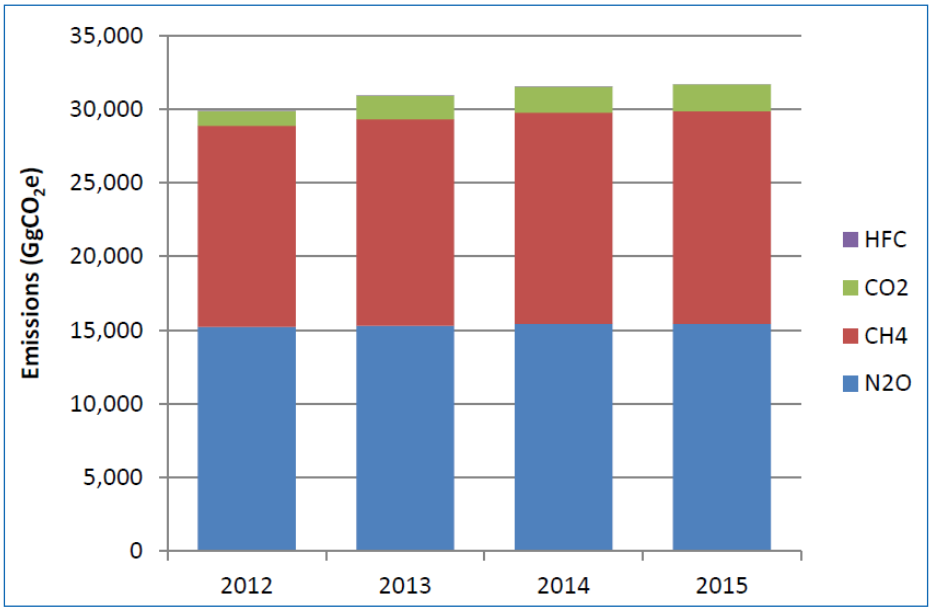
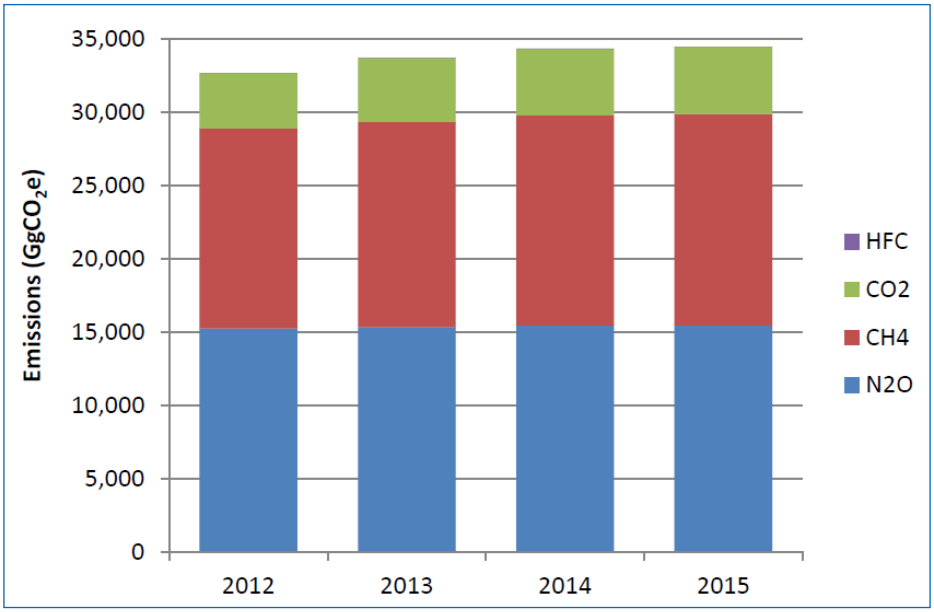
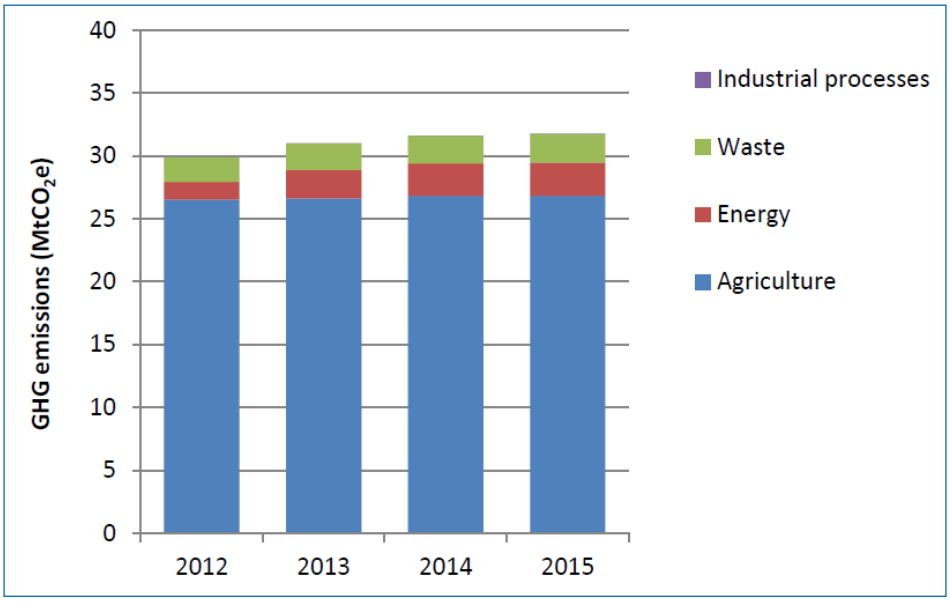



**Figure 2:** Total GHG emissions, including LULUCF ($GgCO_2e$), 2012–2015



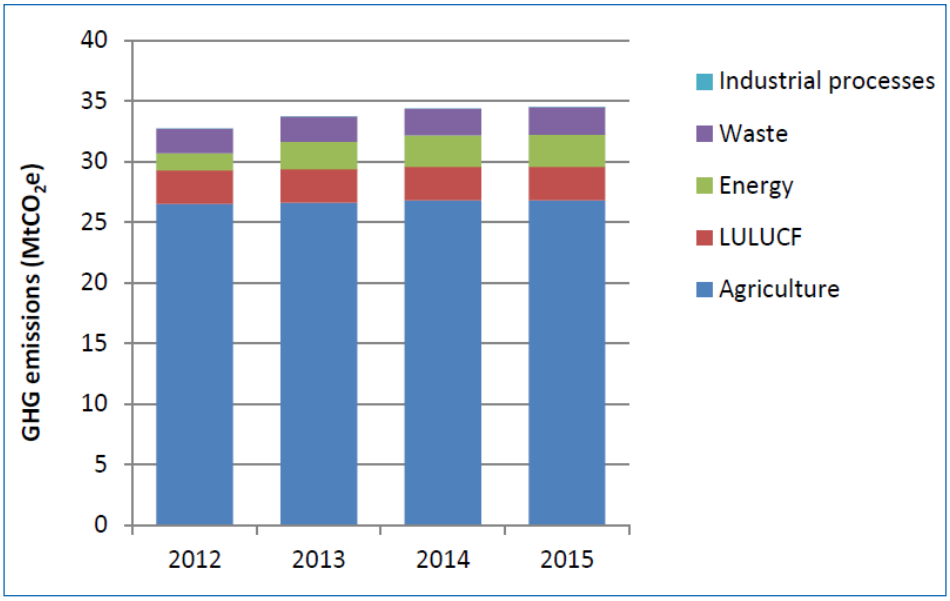

Trends in total $CO_2e$ emissions for each IPCC category, excluding the LULUCF sector, for the complete period (2012–2015) are shown in Figure 3. Figure 4 identifies the emissions profile with the LULUCF sector included, while Table 2 summarizes the emissions by sector in figures.

**Figure 3:** GHG emissions, excluding LULUCF ($MtCO_2e$), 2012–2015




Note: Industrial process emissions are so small that they are not visible in the chart.

**Figure 4:** GHG emissions, including LULUCF ($MtCO_2e$), 2012–2015




Note: Industrial process emissions are so small that they are not visible in the chart.

**Table 2: Emission patterns by sector and year ($MtCO_2e$), 2012–2015**

| | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|
| Agriculture | 26.5 | 26.6 | 26.8 | 26.8 |
| LULUCF | 2.8 | 2.8 | 2.8 | 2.8 |
| Energy | 1.4 | 2.3 | 2.6 | 2.6 |
| Waste | 3.6 | 3.7 | 3.9 | 4.1 |
| Industrial processes | 0.003 | 0.006 | 0.006 | 0.004 |
| **Total GHG emissions** | **34.3** | **35.4** | **36.1** | **36.3** |

The LULUCF sector was a net emitter in 2015, contributing approximately 2,800 $GgCO_2e$ (2.8 $MtCO_2e$) or 8 per cent of the total emissions. The agricultural sector was the highest contributor to GHG emissions, mostly due to $CH_4$ emissions from livestock-related enteric fermentation and $N_2O$ from agricultural soils. Small amounts of synthetic gases (HFCs) were emitted from imported equipment and gas refills.

Since its independence, South Sudan has suffered deep political, socioeconomic and humanitarian strife and the country has also struggled to deliver the most basic services. A significant number of gaps, needs and constraints were identified during the preparation of this INC inventory for South Sudan. Gaps not only include information on activity data, but also resources and capacity. There is a strong need for institutional capacity-building and training of government staff to carry out the necessary data collection and analysis required to reduce inventory uncertainties and improve the quality of activity data and emission factors used to generate the inventory. Several recommendations have been made to enhance capacity and move towards the development of an integrated and sustainable GHG inventory system.

The most important gaps have been identified and appropriate improvement proposals have been made. The gaps cover activity data collection, capacity-building, the development of a sustainable GHG inventory system, institutional arrangements, methods and data documentation (including quality assurance and quality control (QA/QC) procedures, archiving, Key Category Analysis (KCA) and an inventory improvement plan).

KCA was performed for the 2015 inventory results. Excluding LULUCF emissions and removals, two emission sources accounted for more than 80 per cent of GHG emissions on a $CO_2e$ basis. The most significant emission sources are both related to agriculture, and in particular, to livestock. $N_2O$ emissions from agricultural soils accounted for 47.5 per cent of emissions, while enteric fermentation accounted for 33.6 per cent. The major contributor to $N_2O$ emissions from agricultural soils is manure that has been applied or left on agricultural land. In total, 11 IPCC source categories have been identified in this INC (from highest to lowest), which comprise 99 per cent of GHG emissions in South Sudan.

Estimates of emissions and removals of GHG presented in this inventory have uncertainty for several reasons, including the lack of precise activity data and incomplete knowledge of processes that cause such emissions or removals. The “Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories” recognizes that while uncertainty cannot

be completely eliminated from estimates, the main objective should be to ensure their accuracy when producing them.

Attempts were made to ensure that estimates of GHG emissions and removals included in this inventory were unbiased, in accordance with the recommendations. Estimate precision varied depending on each sector's available data, as well as the resources that could be investigated for determining emission factors that suited South Sudan's circumstances. Efforts were made to ensure that the best activity data and emission factors available were used for emissions and removals identified in the KCA as the most important overall.

For most sectors, it was not possible to conduct a detailed uncertainty analysis due to inadequate information. Nevertheless, a general evaluation of inventory precision was carried out based on the judgment and knowledge of inventory specialists. The objective was to identify sources of emissions and removals that could use additional resources in the future to reduce the level of overall uncertainty. The precision associated with activity data and emission factors, as well as emission removal estimates, is expressed as ± a given percentage based on a 95 per cent confidence interval limit.

When considering both activity data and emission factors, estimates of LULUCF sources and sinks associated with forest lands have the highest level of uncertainty. The combined uncertainty as a percentage of total national emissions in 2015 was 76 per cent. The next highest source of emissions is also related to LULUCF, specifically the conversion of forest land to grassland, for which combined uncertainty was 38 per cent of total national emissions in 2015.

## Programmes with measures to facilitate adequate adaptation to climate change

South Sudan faces several development challenges due to decades of political instability, poverty and persistent food insecurity, all of which are exacerbated by climate change. With around half its population living below the national poverty line, a weak economy and the ongoing political conflict, South Sudan ranks among the world's most fragile states. Despite having one of Africa's richest agricultural areas with fertile soils and abundant water, frequent flooding, conflict and the displacement of millions of people have drastically reduced the country's food production, which has left an estimated 7.5 million people facing food insecurity. Climate change in South Sudan is manifested through erratic onset and duration of rains, delayed and shorter rainy seasons, less rainfall in some areas leading to decreased water table levels and the southward expansion of the desert.

The country has distinct climatic areas, which are influenced by the annual movements of the Intertropical Convergence Zone. The climate ranges from hot and dry in the south-east near the border with Kenya and north-east near the border with Sudan and temperate in the southern highlands.

Data show that there tends to be low levels of rainfall in the north-east and south-east areas, and high rainfall throughout the south-west. The area along the border with the Central African

Republic, the Democratic Republic of the Congo and Uganda receives the most rainfall throughout the year. Despite these patterns, there is considerable variation in rainfall from year to year, and also from location to location. South Sudan's climate is semi-humid, with annual rainfall ranging from 200 mm in the south-east (Eastern Equatoria) to 1,200–2,200 mm in the forest area of Western Equatoria and the Equatoria highlands. In the northern states, rainfall varies between 700 and 1,300 mm.

Over the past decades, South Sudan's temperature has increased considerably compared with other regions in East Africa. Significant warming has been observed over the past 30 years, particularly in South Sudan's central and southern regions, which are among the world's most rapidly warming locations, with station temperatures in the country rising as much as 0.4°C per decade. An annual mean temperature increase of 1.3°C per century between 1951 and 2000 has been reported in South Sudan. Since the 1970s, the global warming signal has become much more detectable, revealing that much of South Sudan was more than 2°C warmer on average in the 2000s than the 1970s.

In South Sudan, rains have declined by 10–20 per cent, while the variability in the amount and onset of rainfall has increased each year, meaning that less of the country has been receiving adequate rainfall needed for livestock and farming.

All projections agree that South Sudan will become warmer by 2060, with lower temperature increases occurring in the south. These warming projections range from 1.5°C to 3.1°C during August to between 1.1°C and 2.1°C during January. While there is no consensus among projections on the future change in rainfall, the current increased variability, in terms of onset, duration and total amount, is likely to continue. Rainfall variability is high in the semi-arid northern and eastern parts of the country. Changes in climatic patterns, both long-term and seasonal, have a detrimental effect on people's livelihoods, including those that depend on climate-sensitive income, such as seasonal and daily agricultural labour, rain-fed crop sales and fishing.

The expected climate change is likely to lead to more droughts and floods, which are increasingly becoming more severe. These changes will affect agriculture and natural resources, which are the main livelihood sources of more than 80 per cent of the population. Unless communities adapt, climate change will reduce agriculture production, increase food insecurity and generally hinder South Sudan's socioeconomic development. It has already been reported that around 56 per cent of the country's population is vulnerable to drought and flood shocks.

As a result of the expected warmer and drier weather, increase in droughts and erratic rainfall, and worsening floods, existing household vulnerabilities will intensify, causing households to exceed their current coping strategies, limiting poor people's capacities to maintain sustainable livelihoods. The changing climate is likely having a negative impact on South Sudan's agriculture (farming, livestock and fisheries), hydrology and water resources, and forestry, among many other economic sectors. Such impacts are also expected to affect the country's seven different livelihood zones in South Sudan in different ways to those detailed in this INC.

As the world's newest country, South Sudan has one of the weakest and most underdeveloped economies. Socioeconomic development and other non-climatic factors in South Sudan, such as a fragile economy, internal conflicts, agriculture-dependant livelihoods, population growth, limited

education, poverty and weak institutions, significantly impact the country's vulnerability to climate change. Although climatic factors are the main drivers of climate change, natural ecosystem conditions, human activities and low adaptive capacity in South Sudan will further aggravate its impacts. Fragile land and water resources, resource management and poor land-use practices are key factors that will influence climate change. Due to South Sudan's lack of diversified sources of income, food insecurity, political conflicts, high poverty rates, poor infrastructure and limited government capacity to manage fragile natural resources and cope with climate change variability, the country has a limited capacity to adapt to impacts, which will worsen the situation.

In order to adapt adequately to climate change, this report proposes that systems and structures, including international climate policy obligations and relevant policy, legal and institutional frameworks, be established to ensure that adaptation measures are suitably coordinated. In its NAPA, the Government of South Sudan has identified the country's adaptation priorities, for which it is now necessary to begin building implementation pillars for climate action. The Government and its development partners have launched and planned several climate change initiatives, which need to be strengthened. This INC has identified such initiatives being implemented in the seven livelihood zones and presents the following recommendations with respect to climate change adaptation:

- formulate and implement climate change adaptation policies, legislation, strategies and plans
- establish clear mechanisms to address climate change adaptation in sectoral policies and regulations
- build the capacity of relevant institutions to work on climate change issues
- mainstream traditional adaptation measures and coping strategies in national planning
- mobilize international climate funding for adaptation in South Sudan
- harness the support of NGOs and civil society in adaptation work.

This INC also proposes specific sector-based recommendations for agriculture, hydrology and water resources, and forestry and environment sectors, as summarized in the table below.

| Category | Recommended measures | Priority geographical location |
|---|---|---|
| **Policy and legal framework** | Formulate and implement climate change adaptation policies, legislation, strategies and plans. These include fast tracking the implementation of NAPA, the Comprehensive Agriculture Master Plan, the Agriculture Development Master Plan, the Irrigation Development Master Plan and other climate change policies and plans needed for adaptation. | National |
| | Establish clear mechanisms to address climate change adaptation in sectoral policies and regulations. These may include specific adaptation provisions for climate change resilience in policies and laws, such as in electricity, agriculture, energy, forestry, tourism, livestock and fisheries sectors. | National |

| Category | Recommended measures | Priority geographical location |
|---|---|---|
| **Institutional framework** | Build the capacity of relevant institutions to work on climate change issues. This should include enhancing the transfer and sharing of climate change knowledge and capacity across all sectors, strengthening policy-level awareness, institutionalizing climate change in relevant institutions, and establishing climate change units and departments in government ministries and agencies. | National |
| | Mainstream climate change adaptation in planning and budgeting at the national, state and county levels. | National |
| | Mainstream traditional adaptation measures in national planning to enhance resilience. | National |
| | Mobilize climate funding in South Sudan for adaptation purposes from international public and private sources, domestic public and private sources and carbon finance. At the local level, this may also include establishing county adaptation funds. | National |
| | Harness the support of NGOs and civil society in implementing climate change policies, strategies and plans. | National |
| **Agricultural sector** | Diversify sources of income and livelihoods to reduce the impacts of climate change on agricultural production and to enhance households' ability to absorb shock. | Zones with low levels of diversification, such as the Ironstone Plateau Zone and Hills and Mountains Zone |
| | Improve access to better agricultural inputs (e.g. drought-tolerant, early-maturing, disease-resistant and adapted to local agroecological zones improved seed varieties) and techniques through extension-services support. | High-potential agricultural areas in all zones |
| | Establish and build the capacity of early warning systems and design response strategies. | National, with priority given to drought and flood-prone areas |
| | Improve access to markets and value chain development. | Agropastoralist and agriculture areas with limited access to markets, such in the Green Belt Zone, Ironstone Plateau Zone and Hills and Mountains Zone |
| | Promote traditional conflict management systems to mitigate resource-based conflicts. | National, with priority given to conflict-prone areas, such as the Pastoral and Arid Zones, and Western and Eastern Flood Zones |

| Category | Recommended measures | Priority geographical location |
|---|---|---|
| | Encourage traditional crop and livestock production mechanisms to enable communities to adapt to climate change impacts. | National |
| | Promote sustainable land management practices, such as climate-smart agriculture, conservation agriculture and holistic planned grazing. | National |
| | Enhance people's knowledge and technical skills to increase their adaptive capacity to climate change impacts. | National |
| | Facilitate people's access to formal credit and financial systems to stimulate socioeconomic development and enhance households' capacity to climate change impacts. | National |
| | Promote the development of informal social grass-roots networks to enhance people's ability to cope with climate change shocks. | National |
| | Strengthen the Government's capacity to achieve fishery production potential through the developing infrastructure and providing fish seed (fingerlings) and equipment. | Fish-producing areas around the Nile and Sobat Rivers and in the Western and Eastern Flood Plains, as well as other areas with potential for aquaculture development, such as Central Equatoria, Eastern Equatoria, Western Equatoria, Northern Bahr el Ghazal, Western Bahr el Ghazal and Warrap State |
| | Establish and/or strengthen appropriate fishery policies, regulations and institutions to improve fish production. | National |
| | Promote traditional fishing regulations, such as fishing restrictions that allow for the replenishment and maintenance of ecological balance in the Sudd Wetland. | All fishing areas |
| | Promote the use of improved fishing gears and preservation techniques to improve fishery productivity in South Sudan. | All fishing areas |
| | Support the commercialization of fishery and develop the requisite capacity to improve fish production. | All fishing areas |

| Category | Recommended measures | Priority geographical location |
|---|---|---|
| **Hydrology and water resources** | Build institutional capacity in water resource management, planning and governance at the national, county and state levels. | National |
| | Promote sustainable and equitable access to water mechanisms to offset climate induced changes. | National |
| | Protect and restore important watersheds so that they continue to contribute to ecosystem sustainability and resilience against climate change shocks. | All zones, with priority given to the Hills and Mountains Zone and other forested water catchment areas |
| | Promote and support technologies for water and soil conservation that are resilient to climate change. | National, with priority given to flood-prone areas |
| **Forestry and the environment** | Promote measures that protect biodiversity and increase ecosystem resilience. These include expanding protected areas, scaling up biodiversity conservation projects and strengthening resilient and sustainable management of important ecosystems. | All areas rich in biodiversity |
| | Promote and support landscape restoration and ecosystem-based adaptation. This includes applying principles for wetland use and promoting projects aimed at maintaining genetic diversity. | National, with priority given to areas rich in biodiversity |
| | Promote energy-saving technologies, such as improved charcoal stoves, biogas and solar-powered systems. | National |
| | Promote community-based natural resource management approaches. | National |

## Programmes with measures to mitigate climate change

Articles 4.1 and 12.1 of the UNFCCC commit Parties to develop national and, where appropriate, regional programmes and measures that will mitigate human-induced climate change. Such measures may either reduce the increase in GHG emissions (abatement) or increase terrestrial storage of carbon (sequestration). All measures must comply with the applicable national and international agreements, policies and legislation.

South Sudan views climate change mitigation as a means to sustainable development. For the country, undertaking mitigation analysis also facilitates the implementation of mitigation projects, strengthening of institutional and human capacities and the prioritization and evaluation of social, economic and environmental programmes.

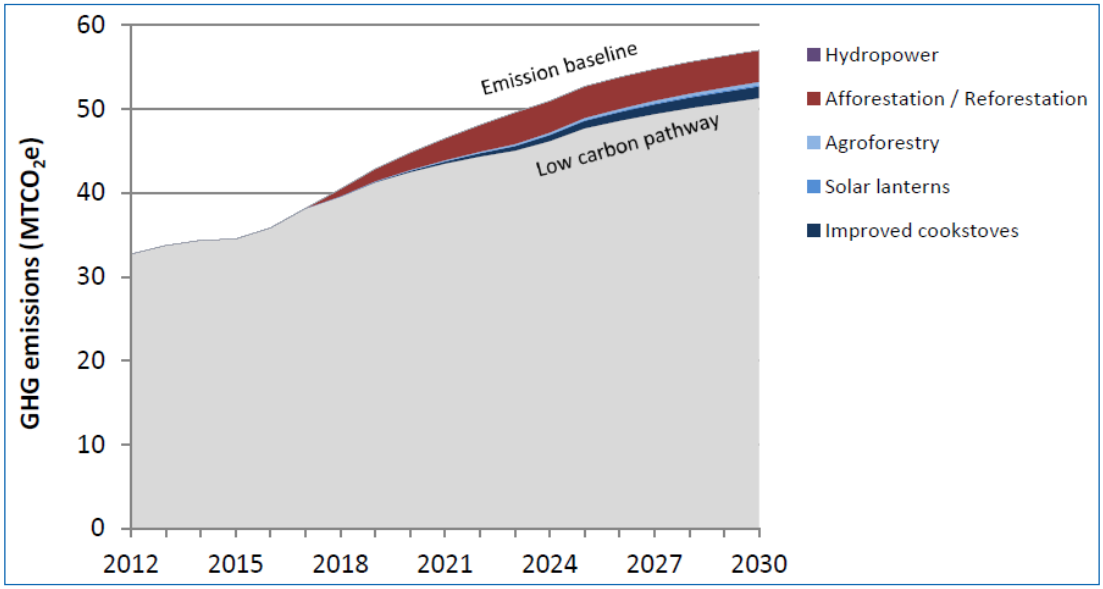
For the analysis, a baseline business-as-usual emissions trajectory was produced and development scenarios were analysed, though this was completed with limited information on the Government's future plans and a lack of historical data, and will therefore require improvements in the future as better information becomes available.

Despite the absence of adequate data, the analysis applied both a bottom-up assessment of mitigation opportunities and a top-down economy-wide economic, energy and emissions model. The analysis provides the evidence base for prioritizing low-carbon development opportunities and, ultimately, for developing investment proposals to attract international climate funding through various strategies, such as Nationally Appropriate Mitigation Actions (NAMAs) and the Reducing Emissions from Deforestation and Forest Degradation (REDD+) programme.

The projected investment costs for the priority mitigation measures was not carried out due to a lack of data.

Figure 5 summarizes the mitigation scenarios identified in the INC.

**Figure 5: Composite abatement potential for the five options in $MtCO_2e$ (2012–2030)**




A total of five mitigation options (improved biomass cookstoves, solar lanterns, agroforestry, afforestation/reforestation and hydropower) were modelled. Two of the options focus on energy demand, one focuses on energy production and the remaining two are related to LULUCF and agriculture. The composite emission abatement potential of these five options' low-carbon development opportunities for 2012–2030 is shown in the figure above. The biggest GHG emission reduction potential is within the forestry sector, followed by energy demand (improved cookstoves).

The total GHG abatement rises to 203,000 $tCO_2e$ per year in 2030 for a total emission reduction of 689,000 $tCO_2e$ in the 2018–2030 period.

## Other information considered relevant for implementation of the Convention

Since gaining independence in 2011, South Sudan has made considerable effort to participate in the MEAs and has also joined global efforts to address environmental issues by becoming a Party to the three Rio Conventions. Even though legal policy frameworks on climate change are only just emerging in South Sudan, the Government has worked to address the issue in various policies, with a view to enabling the country to mitigate climate change and adapt to its impacts.

In its efforts to address climate change, the Government has collaborated with the GEF and UNEP to prepare its NAPA, NDC and INC, among others.

South Sudan has a federal government that comprises the national, state and local levels of government. The national government, 32 state governments and local governments, which include the county, payam, boma and town councils in each state, are the institutional structures mandated to implement climate change-related policies. These structures have roles and responsibilities assigned to them for forestry, biodiversity and ecosystem protection and management. Most of the institutions responsible for climate change are in the early stages of development.

Several institutional capacity constraints in South Sudan limit the Government's ability to reduce climate change vulnerability. Firstly, as a new country, many policies and strategies related to environmental management and agriculture are emerging, but they do not explicitly include climate variability and climate change. Secondly, there are inadequate institutional arrangements at the national, state and county levels for effective coordination, planning and implementation of climate change adaptation interventions. Finally, many of the institutions have been weakened by a lack of technical know-how and financial resources. As a result, very few programmes aimed at reducing vulnerability to climate change are being implemented. Furthermore, there is no budget line item for climate change adaptation and mitigation in South Sudan in many of the government ministries.

Although South Sudan has not conducted a Technology Needs Assessment (TNA), the Government has identified a number of technology needs in various key sectors. In addition, South Sudan's NAPA lists national priorities and adaptation projects for urgent and immediate climate change concerns, particularly in the areas of the environment, water resources, agriculture and disaster risk reduction, including policy and institutional frameworks, and includes guiding principles for such projects along with the necessary technology. In this INC, an analysis has been carried out on technology needs and its status in the economy's key sectors, with a focus on adaptation and mitigation.

Climate change-related research and systematic observations are at very early stages in South Sudan. The South Sudan Meteorological Service (SSMS), which was created in 2011, is responsible for weather forecasts. The SSMS has major institutional and technological challenges and is severely under-resourced to carry out its mandate. Government institutions, higher education institutions and private and civil-society research organizations carry out research in the country.

Although the South Sudanese telecommunications industry is still young in terms of development, there are opportunities to use it for disseminating weather and other climate-related information.

South Sudan needs to undertake numerous capacity-building efforts. Very useful research on climate change is being produced, in particular by CSOs, academic and research institutions, the private sector and individual researches, both inside and outside the country. Despite the production of this knowledge and information, there seems to be a general lack of knowledge-sharing, which is preventing measures from being implemented in the long-term and also hindering capacity-building initiatives within the country.

Given South Sudan's current economic circumstances, limited capacity and lack of climate technologies, it will only be able to implement its Intended Nationally Determined Contribution (INDC) if it receives capacity-building, financial and technical support from the international community. To achieve this, South Sudan's climate change mitigation and adaptation capacities will need ongoing development and strengthening.

In its INDC, South Sudan will encourage innovations in technologies which are suitable for tackling climate change at all levels, as well as the inclusion of climate change priorities in its development agenda. The Government has already identified several areas where technology transfer could benefit the country in its climate change adaptation and mitigation.

To carry out the Government's plans for addressing climate change, substantial and targeted education, training and public awareness are required.

# CHAPTER 1 NATIONAL CIRCUMSTANCES OF SOUTH SUDAN

## TABLE OF CONTENTS

## Introduction

This chapter outlines the national and regional development priorities, objectives and circumstances on the basis of which South Sudan will address climate change and its adverse impacts. These are important as they determine South Sudan's ability to mitigate and adapt to climate change, while also achieving the national development objectives.

The chapter first provides an overview of South Sudan's government structure, including a brief description of the country's geographic and climatic characteristics. This is the followed with information on the country's current situation and prospects and plans for its environmental, economic and social sectors, which details associated climate change impacts, vulnerabilities and risks. Brief reviews on sectoral contributions to greenhouse gas (GHG) emissions are also provided if significant and where data are available. The chapter finishes with information on South Sudan's environmental and climate change governance.

## Government profile

The Republic of Sudan gained independence in 1956, experiencing two phases of civil war from 1955–1972, which ended with the Addis Ababa Agreement (signed between the Government of Sudan and the Anyanya) and from 1983–2005, which brought about the Comprehensive Peace Agreement (CPA) between the Government and the Sudan People's Liberation Army/Movement (SPLA/M).

In January 2011, 98.8 per cent of South Sudanese voted for independence during a referendum on whether South Sudan should become independent, leading to the declaration of the Republic of South Sudan as a sovereign state on 9 July 2011 following a peaceful succession, as per the outcome of the CPA.

South Sudan is the world's newest nation and Africa's fifty-fifth country. As a new country, South Sudan has the challenge of dealing with a legacy of almost 50 years (1955–1972, 1983–2005 and 2013 to date) of conflict and continued instability, as well as huge development needs. Formal institutions are gradually being established and the Government is growing its limited capacity to formulate and implement policies and programmes. South Sudan has significant oil wealth, which if used effectively to drive development, could provide the basis for progress in the coming years.

After independence, the Government promulgated the Transitional Constitution of the Republic of South Sudan as the country's first constitution, which expects all levels of government in South Sudan to promote democratic principles, political pluralism underpinned by decentralization and devolution of political and economic powers, with the ultimate goal being national reconciliation, healing, harmony and peaceful co-existence.

South Sudan is a unitary State with a multiparty political system. The Government comprises a devolved three-tier system made up of the national government, 32 state governments and several local governments, with defined roles and responsibilities and a separation of powers between the executive, legislature and judiciary.

Under the Transitional Constitution, local governments are governed by Local Government Councils (LGCs), whose mandates, functions and powers are also provided for in the Interim Constitution of South Sudan (2005) and the Local Government Act (2009). LGCs are responsible for providing services to the public and regulating the affairs of their local areas through:

a) developmental functions to enhance the living conditions of people in their areas of jurisdiction
b) powers to regulate the local environment through planning, managing development, developing and enforcing bylaws
c) powers to raise revenue
d) powers to recruit, retain, manage and discharge staff
e) powers to cooperate with the national government, state governments, local authorities and other (legal) persons.

Local government is key to ensuring that the national government's plans and objectives are implemented and achieved at the local level.

In August 2011, South Sudan launched its South Sudan Development Plan (SSDP) 2011–2013, titled "Realising Freedom, Equality, Justice, Peace and Prosperity for All". The SSDP was originally designed for 2011–2013, but was later extended to 2016 in order to streamline its planning initiatives. The plan acted as a prelude for the South Sudan Vision for 2040 and established effective nation-building and peacebuilding as the key national development priorities for the country as a new state. By the end of the plan period, South Sudan was expected to be a peaceful, stable, viable and secure nation with a strong foundation in place for effective governance, economic prosperity and enhanced quality of life for all citizens.

Under the Transitional Constitution, the Government has overall responsibility for ensuring that national programmes are implemented to deliver developmental gains. The Government is also responsible for meeting its obligations under the United Nations Framework Convention on Climate Change (UNFCCC), which it ratified on 18 May 2014. Since climate change is crosscutting and multi-sectoral in nature, the national government is best placed to address it.

Between December 2013 and April 2016, the country experienced armed conflict, with fighting erupting again in mid-July, which continued into 2017, resulting in increased violence and insecurity throughout the country. Continued armed conflict has hindered South Sudan's economic activity and undermined potential developmental gains, which has reduced the country's capacity to respond to the impacts of climate change, thereby constraining economic growth and worsening the humanitarian situation.

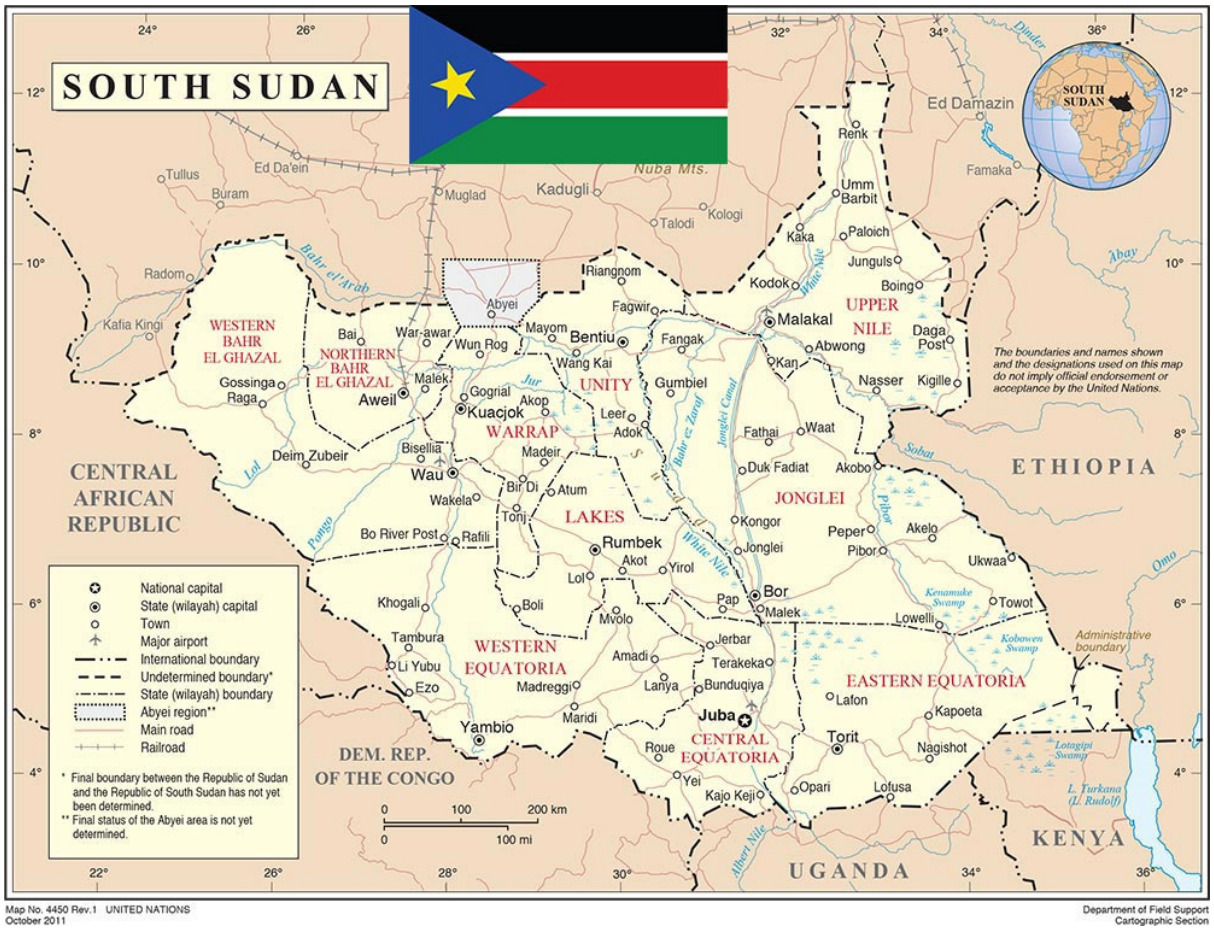
# Geographical profile

## Location

South Sudan is a landlocked country that lies between latitudes 3°N and 13° N and longitudes 24°E and 36°E. It is bordered by Ethiopia to the east, Kenya to the south-east, Uganda to the south, the Democratic Republic of the Congo to the south-west, the Central African Republic to the west and Sudan to the north (Figure 1.1).

The country's territory totals 644,329 km$^2$ and comprises tropical rainforest, swamplands and grasslands.[1] Its Nile catchment area receives water from the highlands of the Central African Republic, the Democratic Republic of the Congo, Ethiopia and Uganda, most of which drains into the Sudd Wetland, which is the world's largest swamp, and other smaller wetlands. The Sudd Wetland empties its waters into the confluence with the White Nile.

**Figure 1.1:** Map of South Sudan

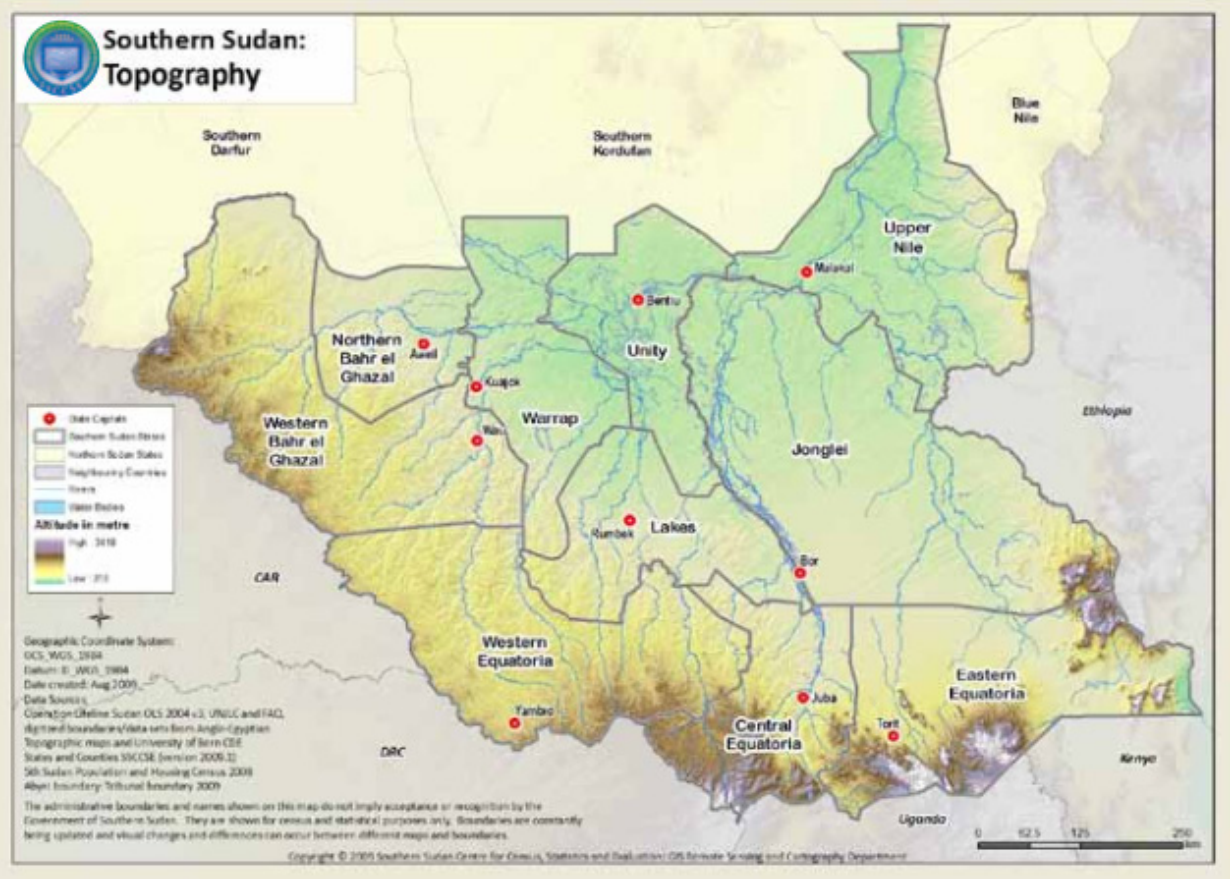



Source: United Nations, Map No. 4450 Rev 1, October 2011.

## Topography

South Sudan's has many plains and plateaus that are drained by the Nile and its numerous tributaries. The Nile River system runs from south to north across the entire length of the east-central part of South Sudan. The central part of the country has a clay plain where the Sudd Wetland covers around 100,000 km$^2$, comprising lakes, marshes and extensive floodplains. The Ironstone Plateau lies between the Nile Congo Watershed and the clay plain and has numerous inselbergs, which are isolated hills that rise abruptly from the plains. In the southern part of South Sudan are the Imatong Mountains, with peaks of more than 3,000 metres.

**Figure 1.2: Topographical map of South Sudan**




Source: South Sudan, National Bureau of Statistics, Statistical Yearbook for South Sudan 2010.

## Drainage and soils

The Nile River system is South Sudan's dominant physical feature, running the length of the country from south to north. The Mountain Nile, or Bahr el-Jebel, enters the country from the south through the rapids at Nimule on the border with Uganda. After its confluence with Bahr el Ghazal River from the west, the Mountain Nile becomes the White Nile further north along its course. The White Nile receives much of its waters from the Sobat River from the west, which flows from the Ethiopian Plateau to the Nile River near Malakal. Not all the drainage in the country reaches the Nile River; rivers in the south-west, for example, infrequently reach the Bahr el Ghazal system, instead draining into local swamps and marshlands.[2]

It is estimated that about 80 per cent of South Sudan's land is arable and suitable for growing a wide range of food and cash crops. High rainfall in the country also makes the land ideal for agricultural activities, though its agricultural system is poorly developed and there is a lack of irrigation systems. As such, the South Sudanese rely on rain-fed agriculture and livestock products for food. During the dry season from November to March, tall grasses that surround the grasslands are burned, releasing a lot of smoke and particulates into the atmosphere.

## Climatic profile

### Climate

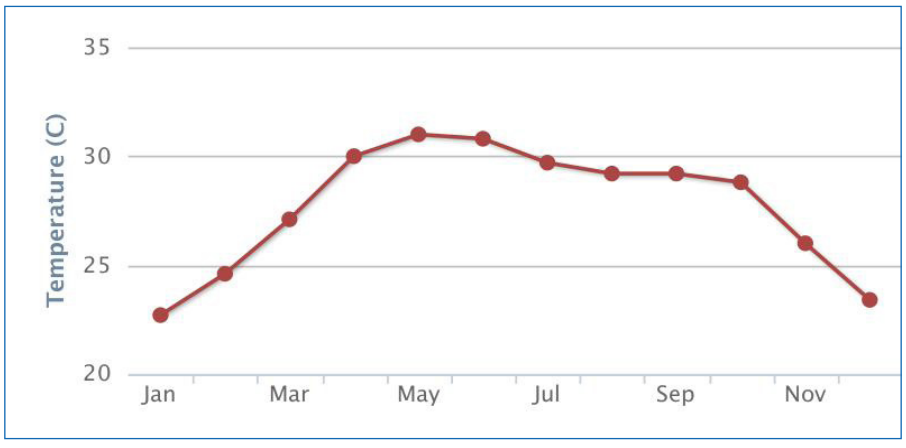
The country has distinct climatic areas, which are influenced by the annual movements of the Intertropical Convergence Zone. The climate ranges from hot and dry in the south-east near the border with Kenya and north-east near the border with Sudan to temperate in the southern highlands. The climate is semi-humid, with annual rainfall ranging from 200 mm in the south-east (Eastern Equatoria) to 1,200–2,200 mm in the forest area of Western Equatoria and the highland areas. In South Sudan's northern states, rainfall varies between 700 and 1,300 mm.

The rainfall pattern is seasonal, with its wet season lasting from April to October with a short dry spell in June, followed by its dry season from November to March.

### Temperature

South Sudan's temperature varies across locations. Average temperatures range between 18°C and 30°C, with the coldest temperatures experienced in elevated areas. The hottest month is generally March, whereas the coldest is August.

**Figure 1.3: Historical monthly average temperature for South Sudan for 1990–2012**




Source: World Bank Climate Change Knowledge Portal. Available at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCcode=SSD

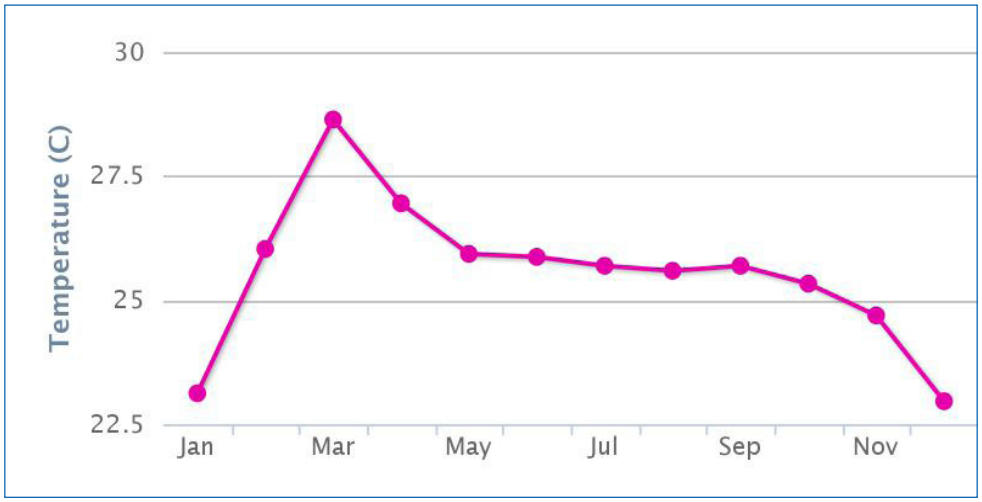
## Temperature projections

As a result of changing climatic conditions, South Sudan is experiencing substantially warmer and drier weather, the effects of which are leading to increased evapotranspiration and droughts.[3] Since 1980, rainfall levels have decreased, while air temperatures have rapidly increased. This warming, which is occurring at a rate two and a half times greater than the global average air temperature change, is making "normal" years effectively drier.[4]

General Circulation Models (GCMs) indicate that South Sudan's annual mean temperatures have risen since the 1960s. Over the past 30 years, South Sudan has been among the most rapidly warming locations on the globe, with temperatures increasing as much as 0.4°C per decade. The GCMs indicate that the mean annual temperature is projected to increase by $1^0$C by 2060 from 2020 values.[5]

In addition, the GCMs show that future predicted rainfall in South Sudan will increase in most seasons for the 2011–2030 period, which could have a severely impact the environment and household livelihoods.[6]

**Figure 1.4: Mean projected temperature for South Sudan for 2020–2039**




Source: World Bank Climate Change Knowledge Portal. Available at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisRegion=Africa&ThisCcode=SSD

GCM projections indicate that the following temperature trends are likely to occur in the future relative to the baseline period 1961–1990:

a) temperatures may increase by 0.6–1.7°C by 2030 and by 1.1–3.1°C by 2060
b) the country may become wetter, with increased rainfall intensity
c) the number of days and nights that are currently considered cold may decrease, becoming very rare.

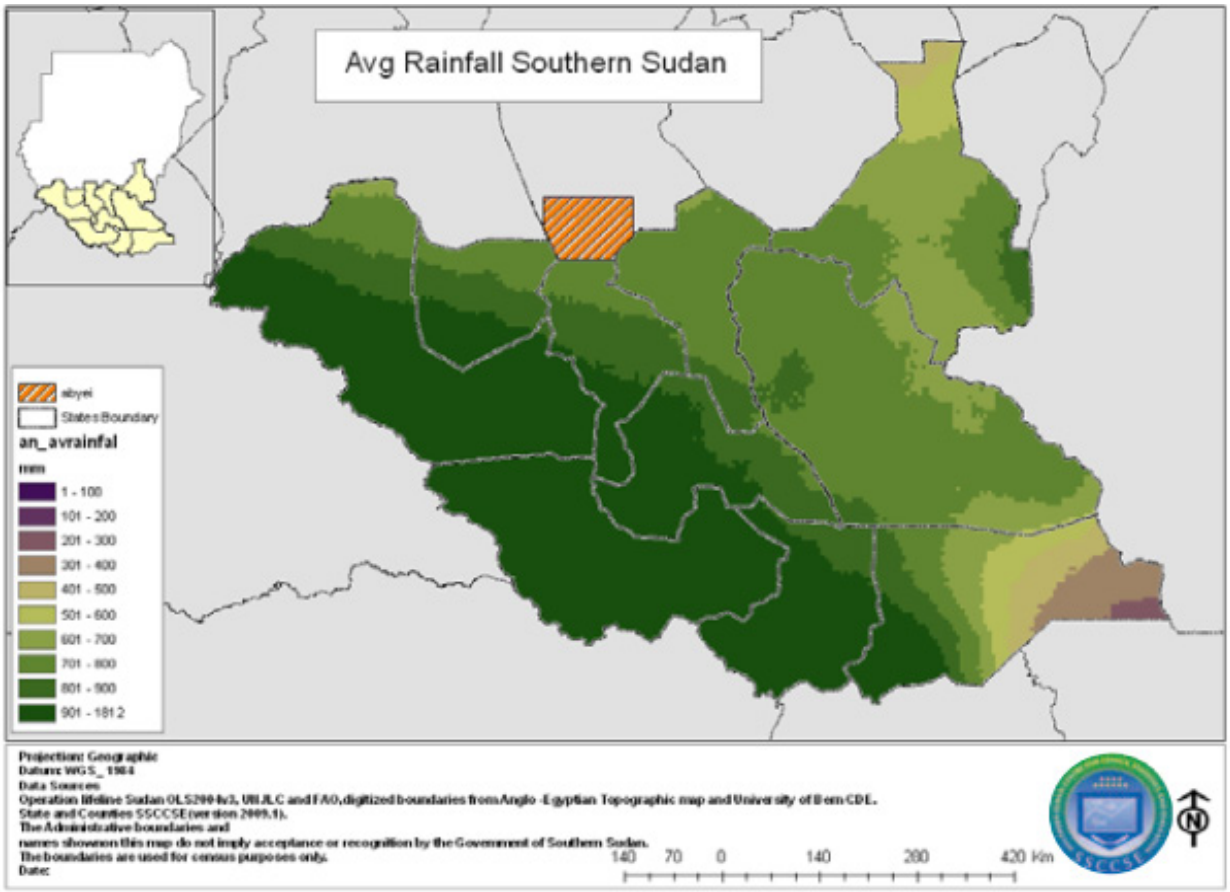
## Precipitation

Most of South Sudan experiences monsoons between June and September during its long rainy season, though the extreme south region tends only to experience two peaks during this period.[7] Annual rainfall in the country ranges from 200 mm to 2,200 mm.

Historical data show a low precipitation pattern in the north-east, with high precipitation in the south-west. The area along the border with the Central African Republic, the Democratic Republic of the Congo and Uganda receives the most rainfall throughout the year. However, the volume of rainfall varies greatly from year to year and also from location to location.

South Sudan receives most of its rain during the rainy season (June–September), which provides enough water across parts of the country for farming and livestock. The heavy rains that fall in August and September cause the Nile River and its tributaries to flood, though many parts of the country are prone to flooding during the wet season, including the states of Jonglei, Unity, Upper Nile, Warrap and Northern Bahr el Ghazal, as well as parts of Western and Eastern Equatoria.[8]

**Figure 1.5: Average rainfall in South Sudan**



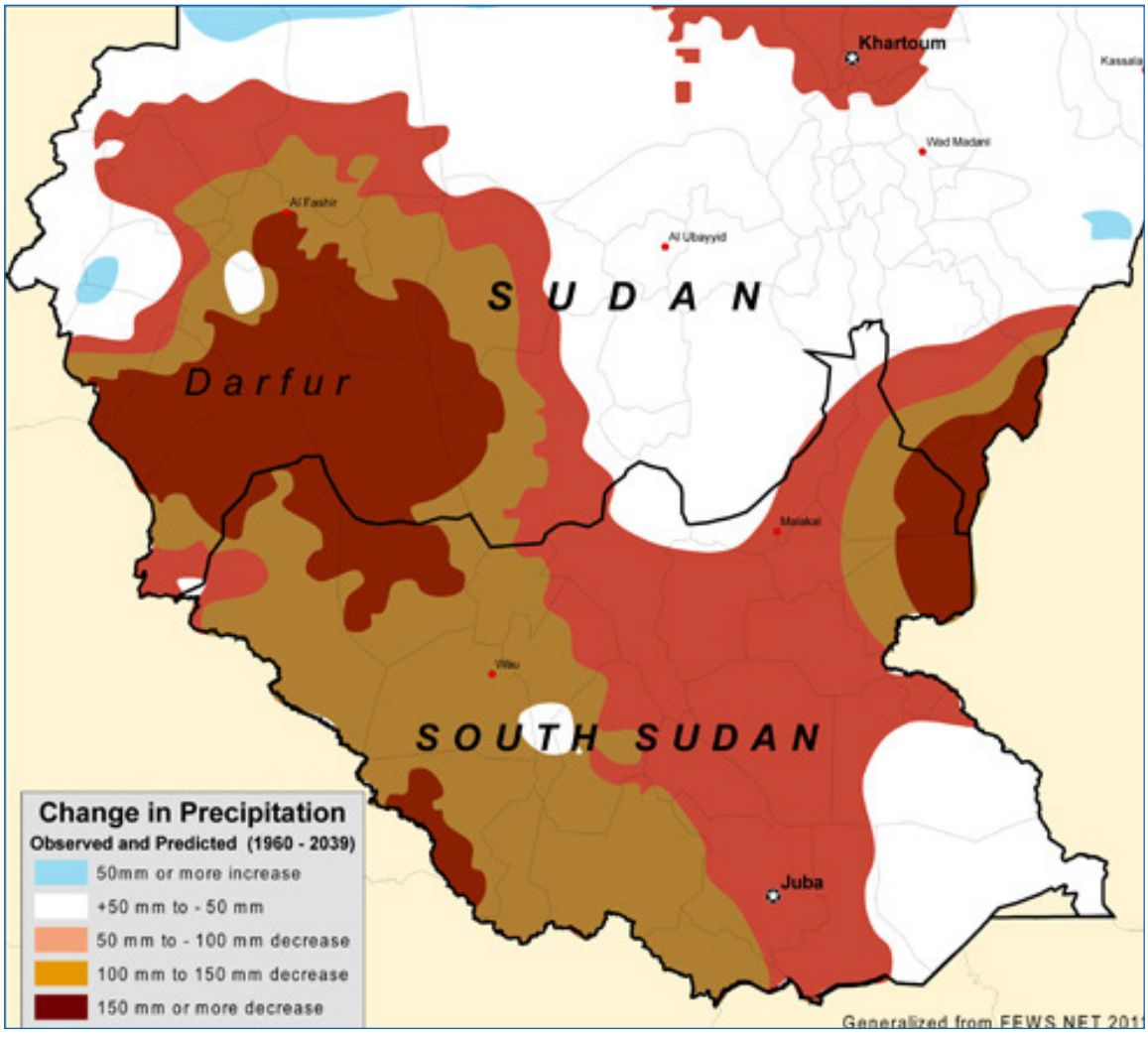

Source: South Sudan, National Bureau of Statistics, Statistical Yearbook for South Sudan 2010.

## Future precipitation characteristics

According to the Famine Early Warning Network (FEWS NET), much of South Sudan has experienced a 10–20 per cent decrease in long rains since the mid-1970s.[9] The area that received 500 mm or more of rain has reduced, resulting in rainfall deficits for populations in Upper Nile, Jonglei and Eastern Equatoria. In Upper Nile, the 500 mm band moved south by one degree, from approximately 1°N to 10°N.[10] If current rainfall trends continue, by 2025, the 500 mm rainfall band may move south into Western Bahr el Ghazal, Northern Bahr el Ghazal, Warrap, Unity, Lakes and Central Equatoria.[11]

In addition to the 30-year trend of declining precipitation, there is evidence that variability in the amount and onset of rainfall will increase from year to year (Figure 1.6).

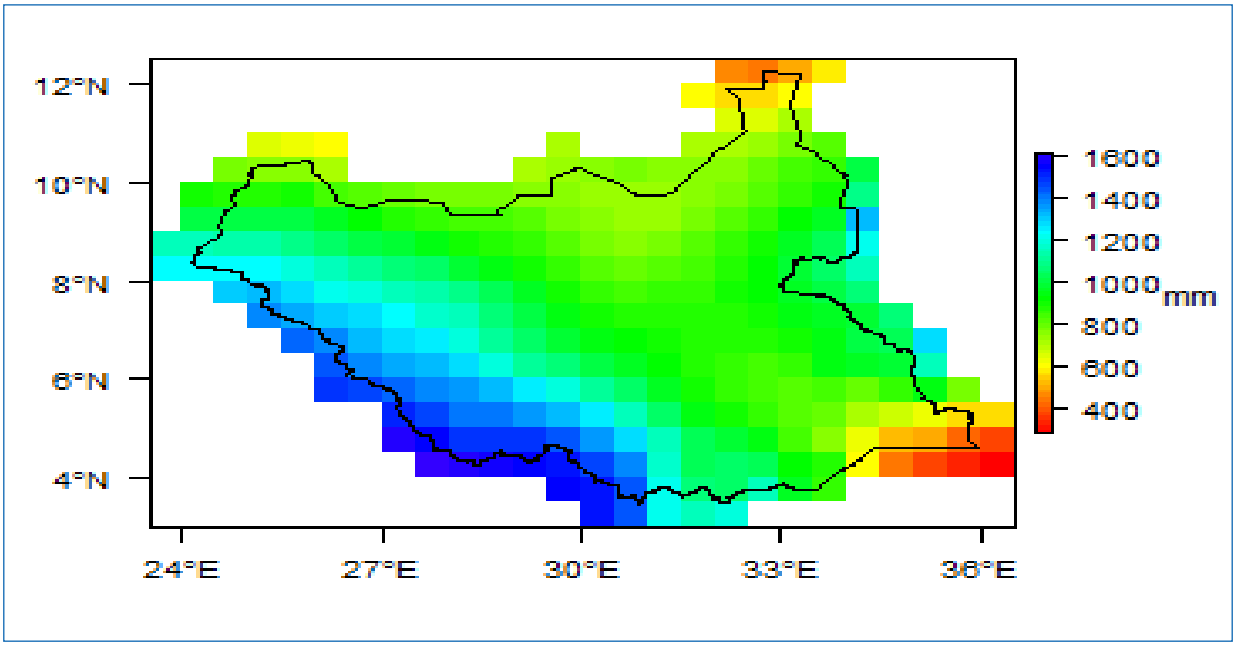
**Figure 1.6: Changes in precipitation, 1960–2039**




Source: Famine Early Warning Network, 2011

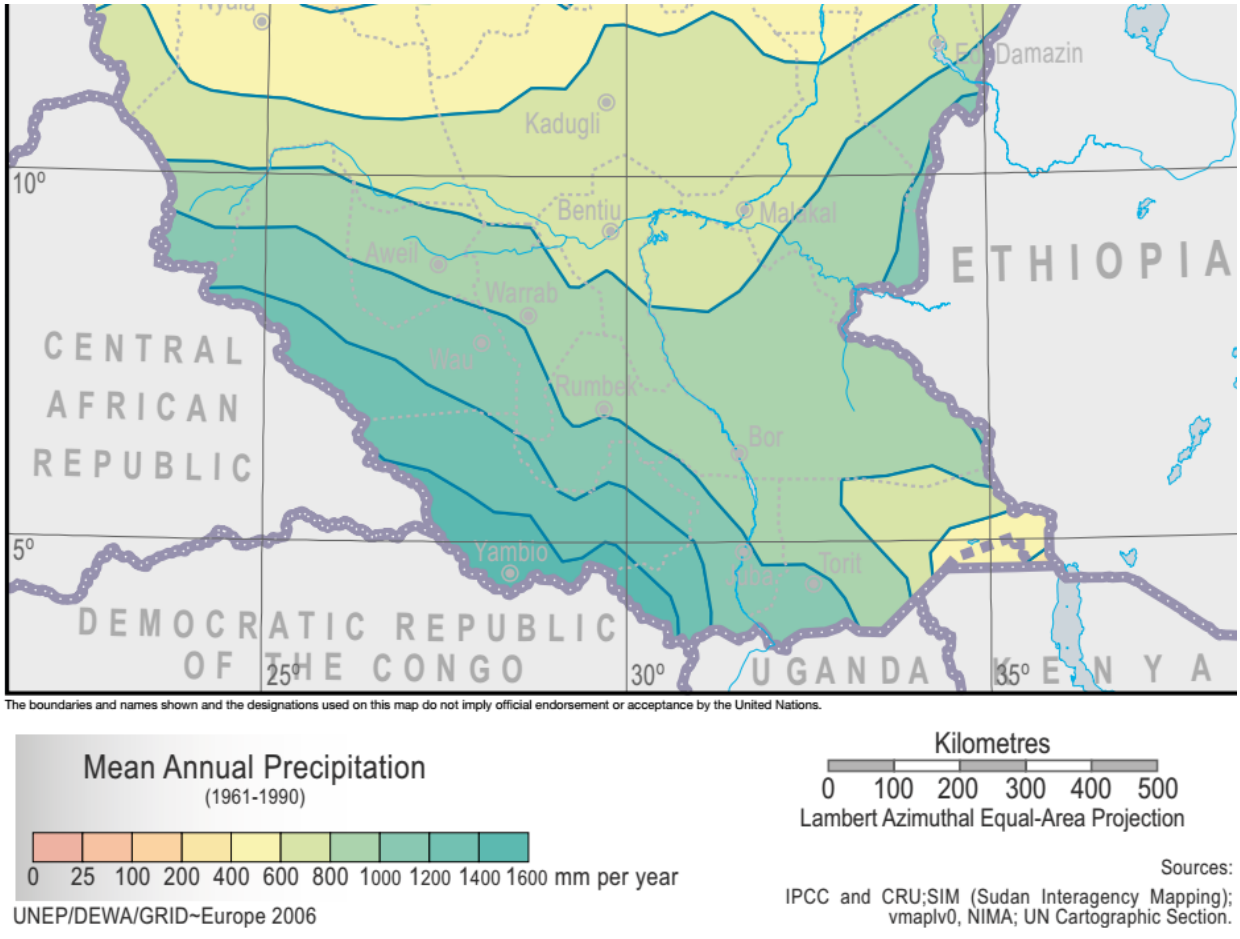
Due to changes in temperature, the resulting hotter and warmer climate will amplify the effects of droughts in South Sudan, with any observed warming of more than 1°C equivalent to a further decrease of 10–20 per cent in rainfall.[12] While this is will lead to reduced and variable rainfall, it may also cause more flooding as rains become more unpredictable and inconsistent in volume, a situation that is already being observed in several parts of the country.

**Figure 1.7:** Precipitation map of South Sudan



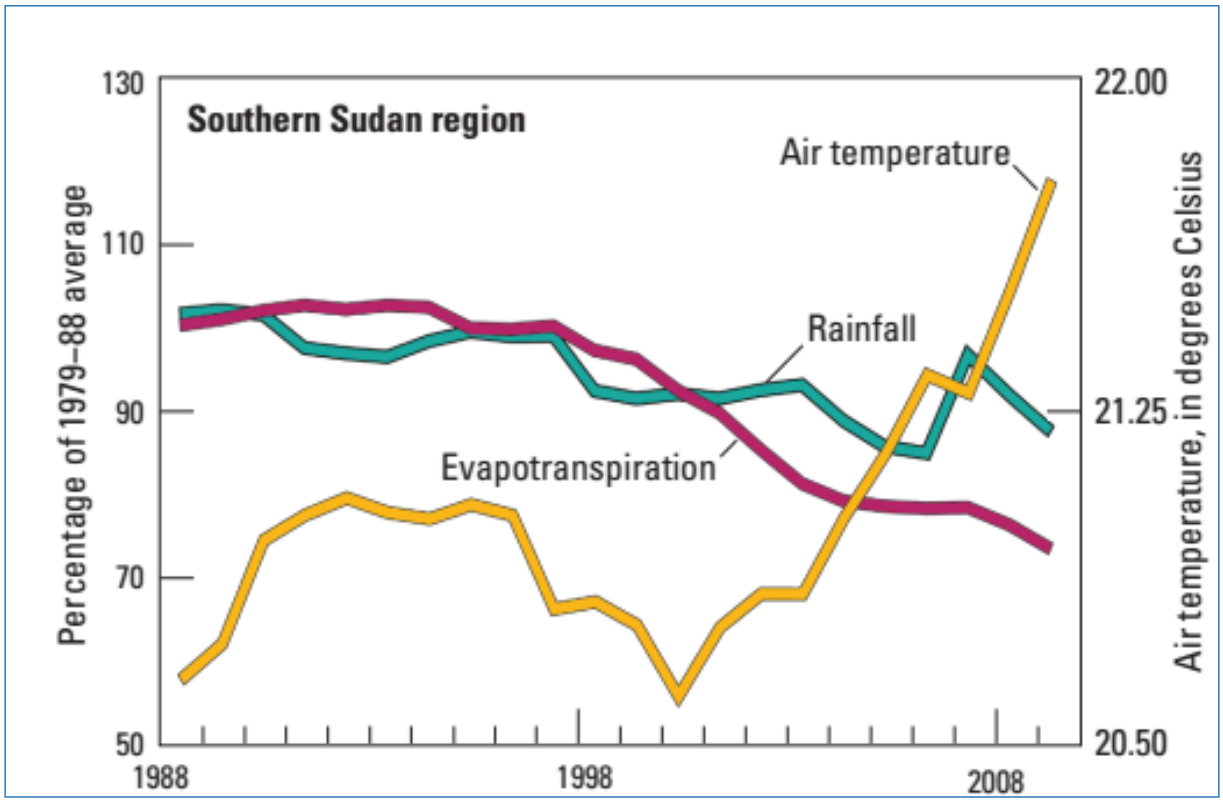

Source: Earthwise, British Geological Survey (BGS).
Available at: http://earthwise.bgs.ac.uk/index.php/Hydrogeology_of_South_Sudan

**Figure 1.8:** Precipitation zones of South Sudan




Source: United Nations Environment Programme (UNEP), 2007.

**Figure 1.9:** Changes in precipitation, 1988–2009




Source: Famine Early Warning Network, 2011.

Changing climatic conditions are affecting South Sudan's rainfall and temperature, in particular leading to erratic seasonal precipitation patterns which have a huge impact on the environment. Observed impacts in the country include:

- an increased incidence of droughts, with notable ones occurring in 1989, 1990, 1997, 1998, 2000, 2008–2009, 2010–2011 and 2014
- increased flooding in recent decades, occurring, for example, from 1962–1965 and 1978–1979, and in 1988, 1994, 1998, 1999, 2006,[13] 2013, 2014, 2015 and 2017
- increased occurrence of floods and droughts in the same season, with droughts happening earlier in the season around May/June and floods happening later around August/September
- more severe flooding which takes longer to recede, especially in the northern part of the country.

There are indications that the intensifying flooding and droughts are directly linked to climate change, which are greatly impacting the country.

- Between August and November 2013, floods affected around 150,000 people, destroying crops, property and infrastructure.
- The Government declared the country a disaster zone in October 2013, after seven of South Sudan's 10 states were heavily flooded.[14]
- Flooding from July to August 2014 resulted in deaths, displacement of more than 40,000 people, destruction of property and a widespread malaria epidemic.
- In September 2015, flooding displaced around 2,000–3,000 households.[15]

South Sudan is highly vulnerable to the impacts of climate change, especially since its population is highly dependent on climate-sensitive sectors (such as agriculture, which is mainly rain-fed) for their livelihoods and, most importantly, their food security. Climate change is not only expected to impact agriculture, but also the energy, tourism, water and health sectors.

## Population profile

The Sudan Fifth Population and Housing Census (2008) estimated the country's population at 8,260,490 million people (Figure 1.10). Current estimates from 2017 put the population at 13,123,385.[16]

**Figure 1.10: South Sudan population trends (2006–2016)**


Source: Trading Economics, 2018, South Sudan Population, https://tradingeconomics.com/south-sudan/population.

South Sudan is a very young country with two-thirds of its population under the age of 30 (Figure 1.11). The 2009 National Baseline Household Survey (NBHS) revealed that the country faces several human development challenges, related to the following:

- 51 per cent of the population is below the age of 18
- 72 per cent of the population is below the age of 30
- 83 per cent of the population is rural
- 27 per cent of the adult population aged 15 years and above is literate
- the literacy rate for men is 40 per cent compared with 16 per cent for women
- 51 per cent of the population live below the poverty line
- 78 per cent of households depend on crop farming or animal husbandry as their primary source of livelihood
- 55 per cent of the population has access to improved sources of drinking water.

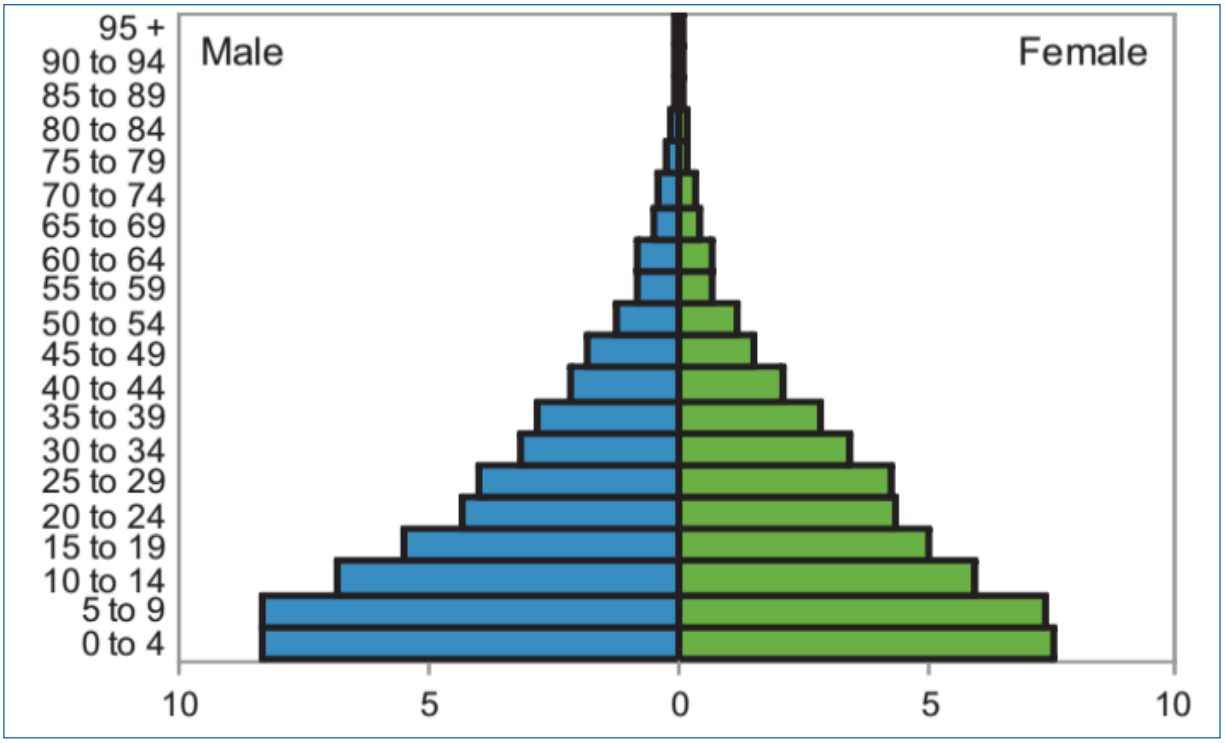
Fragile countries, resulting from political instability, conflict, climate change and natural disasters, continue to exhibit the lowest levels of human development. South Sudan is one such country. Most of the population live off farming, with smaller numbers depending more on animal husbandry.

The maternal mortality rate is one of the highest in the world for various reasons, including a shortage of health care workers, facilities and supplies, poor roads and a lack of transport, and cultural beliefs that prevent women from seeking obstetric care. Most women marry and start having children early, giving birth at home with assistance from traditional birth attendants, who are unable to handle complications. Educational attainment is extremely poor due to the lack of schools, qualified teachers and materials. Less than a third of the population is literate (a rate which is even lower among women) and half live below the poverty line. Teachers and students are also struggling with the switch from Arabic to English as the language of instruction. Many adults have not been able to receive an education because of war and displacement.

South Sudan has an infant mortality rate of 105 per 1,000 live births and a maternal mortality rate of 2,054 per 100,000 live births, and only 17 per cent of children are fully immunized. Around 38 per cent of the population has to walk for more than 30 minutes one way to collect drinking water and around 80 per cent of South Sudanese do not have access to any toilet facility.

According to the Sudan Fifth Population and Housing Census, 1.4 million people live in urban areas, while 6.9 million live in rural areas. Following the signing of the CPA in 2005, rapid changes occurred in South Sudan's demographic structure as large numbers of people returned to the region, leading to more households. However, since the outbreak of the 2013 conflict, it is estimated that around 2 million South Sudanese have fled, seeking refuge in neighbouring countries.[17]

**Figure 1.11: Population pyramid of South Sudan (2009)**

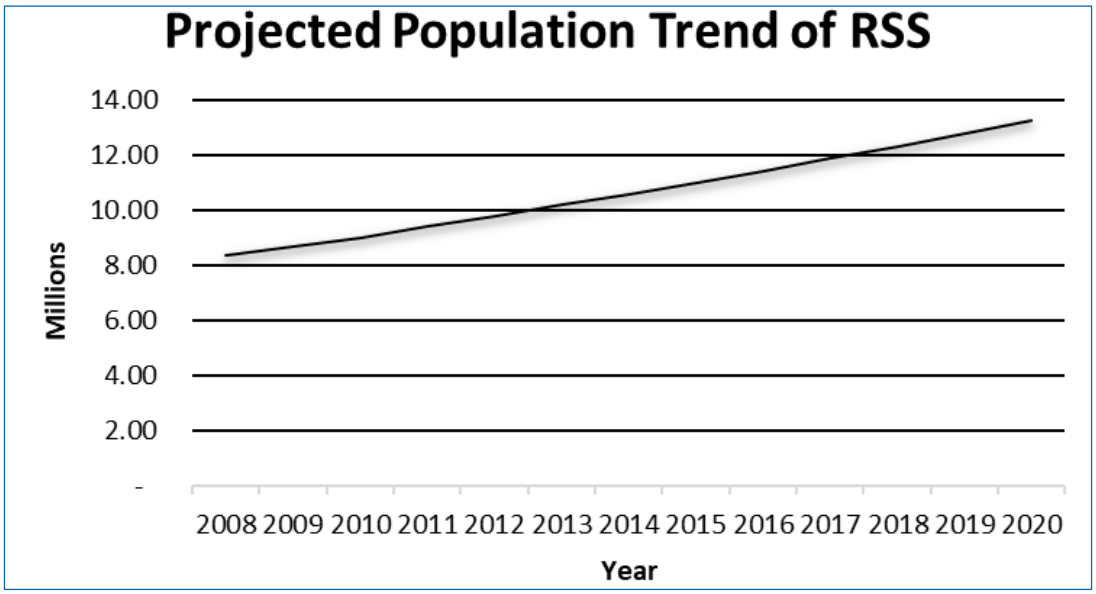



Source: Southern Sudan Centre for Census, Statistics and Evaluation, 2011.

South Sudan's population is growing at an annual rate of 2.8 per cent (World Bank, 2017), which is more than double the global population growth rate of around 1.2 per cent per year. An increasing number of South Sudanese are falling below the poverty line, as a result of the country's contracting economy, varying climate change, renewed political and civil conflicts and falling oil revenues.

Population trends indicate that the South Sudanese population is expected to increase until 2020, with an annual growth of roughly half a million people per year (Figure 1.12). The 2008 census reported a population density of 13 persons per square kilometre. Although this density is low compared with neighbouring counties, it is expected to increase, with the resultant pressure on natural resources causing substantial environmental degradation, particularly deforestation.

**Figure 1.12: Population trend, South Sudan, 2008–2020**




Source: South Sudan, National Bureau of Statistics, 2010.

The 2009 census established that the South Sudanese population is largely rural, with 83 per cent residing in rural areas. However, this varies widely between states, with 92 per cent of the population in Northern Bahr el Ghazal classified as rural compared with 57 per cent in Western Bahr el Ghazal. Urbanization is increasing in South Sudan: it is estimated that by 2020, the rural population will decrease to 74 per cent, with 26 per cent living in urban areas, which is expected to increase again by 2050 to 34 per cent.[18]

At present, just over half (51 per cent) of the population lives below the poverty line, which suggests that one out of every two South Sudanese is unable to obtain a minimum level of basic needs.[19] The Government's Millennium Development Goals Status Report estimated that 50.6 per cent of South Sudan's population live below the national poverty line, which was set as 72.9 Sudanese pound per person per month in 2009. The poverty rates are 55.4 per cent for the rural population and 24.4 per cent for the urban population. The 2008 census established that there is disparity between urban and rural areas, with 25 per cent of urban dwellers living below the poverty line.

# Cultural profile

## Ethnic groups

South Sudan is ethnically and culturally diverse, with 64 major ethnic groups which can be broadly categorized into the Nilotic, Nilo-Hamitic and the South-western Sudanese groups.

Nilotic people include the Dinka, Nuer, Shilluk (Chollo), Murle, Kachiopo, Jie, Anyuak, Acholi, Maban, Kuma, Lou (Jur), Bango, Bai, Gollo Endri, Forgee, Chod (Jur), Khara, Ngorgule, Forugi, Siri, Benga, Agar, Pakam, Gok, Ciec, Aliap, Hopi, Guere, Atuot, Apak, Lango, Pari, Otuho and Aja.

Nilo-Hamitic groups include the Bari, Mundari, Kakwa, Pojulu, Nyangwara, Kuku, Lotuka, Lokoya, Toposa, Buya, Lopit, Tennet and Didinga.

The South-western Sudanese groups include the Kresh, Balanda, Banda, Ndogo, Zande, Madi, Olubo, Murus, Mundu, Baka, Avukaya and Makaraka.

Each tribe has different social and livelihood systems, cultural traditions and a sense of identity, though some have similar systems depending on the level of interaction. This diversity presents both a unique opportunity for the country to enjoy the richness of various traditions, but also poses a threat to national unity and a collective sense of national identity.

Due to its numerous ethnic groups, South Sudan does not have one unifying national language. Instead, English is used as the national language and Arabic is used as a means of communication among those who studied in the language, with local Arabic, commonly known as Juba Arabic, used by those in major Equatorial towns.

Economic activities vary across the ethnic groups: some are mainly pastoralist (with limited crop growth), such as the Dinka and Nuer, while others, such as the Azande, are largely agrarian, but also keep goats and poultry and hunt on a subsistence level. The Mundari and Murle are agropastoralist, deriving their livelihoods from farming and cattle rearing. Cattle are typically a central part of their livelihoods and the local culture. Although some groups primarily rely upon livestock for their livelihoods, they also engage in planting (cultivation) and fishing activities during the dry season. The Toposa, Lotuka and Didinga ethnic groups also largely depend on cattle rearing and crop farming for their livelihoods.

These communities move with their cattle in the dry season (usually January to May) to wet areas (swamps in the rainy season, which become pasture in the dry season), where they set up temporary cattle camps. This provides the cattle with access to water and pastureland for part of the year. Fishing is usually best in the dry season, as water levels in rivers and pools decrease, making fish easier to catch. At the beginning of the rainy season (May/June), people return to their homesteads and sow fields.

South Sudanese communities greatly value animals, which are kept as a sign of wealth and prestige. Cattle are particularly valued, with households' wealth and power determined by the number of cattle they own. Households not only use cattle for agricultural activity, such as ploughing land, but also in rituals and as payment for bride prices. Given the importance of animals, any negative

impact on livestock population as a result of climate change will severely affect households. However, it should be noted that by keeping large herds of livestock, households are contributing significantly to GHG emissions.

Other ethnic groups in South Sudan, such as the Chollo, Anyuak, Maban, Zande, Kakwa, Bari, Lokoya and Pojulu are more agrarian and tend to keep goats, poultry and a few cattle compared with the major pastoral groups. These agrarian communities derive their livelihood primarily from fishing and agriculture. While they value livestock, they do not depend on it for food compared with other agropastoralist groups. In the dry season, livestock do not need to migrate long distances.

All 64 ethnic groups typically have stronger ties to their local tribal and religious organizations than to the national government. Competing tribal interests continue to make strong parochial demands on public appointments and resources. South Sudan's worsening economic conditions have limited the Government's ability to meet these demands. This has deepened existing perceptions of marginalization among less powerful ethnic groups, thereby placing further strain on the fragile network of political arrangements that bind South Sudan's society together. This in turn is impacting the environment in which these groups live, along with their use of natural resources. Due to the variability of climate change throughout the country, each group will be impacted differently.

## Conflicts, insecurity and climate change impacts

Between 1955 and 1972, Sudan experienced a first phase of civil war, which ended with the signing of the Addis Ababa Peace Accord between the Government of Sudan and the Anyanya. In 1983, a second phase of civil war began, which lasted until 2005 when the CPA was signed between the Government and the SPLA/M. In fulfilment of the CPA and following a referendum, the Republic of South Sudan gained independence from Sudan in July 2011, ending one of the longest civil wars on record. Despite the relative peace brought by independence, true peace in South Sudan has always been threatened by ongoing tensions with Sudan over oil revenues and land borders, armed groups, rebellions and inter-communal violence. As a result, the country has continued to experience frequent conflicts which have adversely impacted South Sudan's environment, people and natural resources.

In December 2013, two and half years after independence, armed conflict broke out between forces loyal to different government factions. This led to a humanitarian crisis, displacing millions of people and causing widespread food insecurity. The warring parties signed a peace agreement in August 2015, creating a Transitional Government of National Unity as part of the compromise. Renewed fighting erupted in mid-July 2016 between the two principle signatories, plunging the country back into conflict and causing increased violence and insecurity that still continues.

Flooding is now an annual occurrence in South Sudan and causes large swaths of pastureland and cropland to be submerged, resulting in food insecurity. Such flooding also acts as a source of conflict between communities: when pastoralists move their herds, they come into contact with other communities whose lands have not been flooded without having received proper permission for access, which often results in conflicts as each community tends to protect their pastureland or crops.

Another cause of tension is cattle raiding, which mostly occurs in the states of Eastern Equatoria, Unity, Warrap, Jonglei and Lakes, where cattle are seen as a sign of wealth, a source of pride, income and payment for bride prices. Cattle raiding is accompanied by bitter tribal revenge killings and conflicts over resources, especially grazing lands during dry periods, and boundaries, which has worsened with the presence of guns and ammunition.

In most conflicts, civilians have borne the brunt of the fighting, forcing them to flee their homes to areas they perceive as safe. As a result of the ongoing fighting, South Sudan's humanitarian situation continues to deteriorate, with that United Nations reporting that the country is facing the "worst levels of food insecurity in its history",[20] with 4.6 million people projected to face severe food insecurity during May and June 2014 and more than 4.1 million people in critical need of water sanitation and hygiene services. The wars and conflicts have also had a serious impact on natural resources, created an atmosphere of fear and uncertainty and hindered many agricultural activities, which is exacerbated by the lifestyles imposed on displaced or refugee households, as there are few opportunities to practice agriculture, livestock herding or afforestation.[21] Nomadic communities can no longer follow their tested and established adaptation strategies, including routes with livestock following floods and droughts, due to insecurity.

In November 2015, over 2.2 million people had been displaced, which was an increase of 200,000 since the beginning of 2015, with 1.6 million of these displaced internally, while over 616,000 people having fled to neighbouring countries. Severe food insecurity affected 4.6 million people in 2016 compared with 3.8 million people in 2015, and was expected to affect 7 million people in 2017.[22] The incidence of poverty has worsened from 44.7 per cent in 2011 to over 57 per cent in 2015.[23]

South Sudan is also currently burdened by considerable debt due to its increased military spending and revenue shortfalls caused by low oil prices and decreased production, partly as a result of the conflicts.

On 14 December 2016, the president announced the launch of a National Dialogue Initiative with the aim of protecting and preserving the unity of South Sudan's people, ending their suffering, restoring the economy and focusing on state and nation-building.

Without political peace and stability throughout the country, climate change is likely to significantly affect more South Sudanese, especially given the likelihood of its adverse impacts on the agricultural sector.

## Poverty

According to the World Bank,[24] poverty is a term used to describe a pronounced shortage in material needs and their availability, thereby defining an individual's welfare within a society. In South Sudan, poverty is measured and defined using the absolute poverty line based on consumption expenditure as a proxy for income.

According to the National Bureau of Statistics 2009 Poverty Survey, over 51 per cent of South Sudanese live below the poverty line. Extreme poverty affects people who reside in the countryside, where most are deprived of basic services, such as health and education. Most rural South Sudanese have limited access to assets that are essential in everyday life. Besides the

Government's diminished capacity to create income-generating opportunities for people, ongoing violence in the country continues to displace people, reducing the potential to earn livelihoods, pushing more people into poverty.[25]

Rising food prices have put many households in both urban and rural areas in a very difficult position, as they are unable to afford the minimum food basket. According to the Ministry of Finance and Economic Planning, the Central Bank has no reserves and the limited oil and non-oil revenues are spent on defence and security loans. Poverty has therefore worsened, rising from 44.7 per cent in 2011 to 65.9 per cent in 2015, with a parallel increase in the depth of poverty.

## Bush fires

Bush fires in South Sudan are caused for various reasons, such as:

- socioeconomic and ethno-cultural activities
- developmental purposes and community lifestyles.

Bush fires are sometimes started deliberately by burning fire lines to prevent the spread of larger fires, during slash and burn agriculture, for pasture renewal or during hunting. Other non-deliberate causes include cigarette butts, lightening, charcoal burning and honey harvesting.

According to Bayoumi,[26] grass burning starts 2–3 weeks after the end of the rains i.e. in November and then again in March, April or May. Wildfires are common in central, western and southern South Sudan and spread rapidly due to the strong north-easterly winds and flat terrain of these areas. Repeated fires occur when the hot dry weather continues and are exacerbated if the rains are delayed.

In the high-rainfall savannah ecosystems of southern South Sudan, fires kill certain species of trees, such as *Isoberlinia doka* and *Daniellia oliveri*, and reduce the growth of other species. Fires may also reduce gum yields from *Acacia senegal* by up to 50 per cent, which is a big economic loss. In an average year, fires affect about 70 per cent of open rangelands in South Sudan.[27]

The traditional system of constructing or maintaining forest fire lines (firebreaks) is implemented through an annual budgeted programme. Despite this, villages with wood and grass houses still fall victim to fire each year, due to insufficient funding of the programme and the limited fire service throughout the country.

Teak (*Tectona grandis*) firebreaks were used in southern South Sudan to protect fire-prone species. In traditional agricultural areas, extension workers guide community members and farmers to protect their villages and lands. At present, there is no method other than burning to clear forest land for cultivation, though the Forest Act (1989) prevents wasteful burning, obliging farmers to make use of cleared woody material (shrubs and trees), by converting it into useful products, such as charcoal.

The 1986 Forest Policy emphasizes the protection of forests against fire, while the Forest Act prohibits people from trespassing into reserved forests with their animals, as well as from carrying ignited material into forests and making fires for cooking or any other purpose in or near forests,

obliging people to help extinguish forest fires. Reducing the number of fires will help conserve the country's natural resources and will improve the growth of many tree species.[28] However, enforcing laws to ensure fires are reduced is a major challenge for the Government.

**Figure 1.13: Bush fire in Kapoeta East County, Eastern Equatoria, January 2014**

Source: Eye Radio, 2014.

## Natural resources profile

### Biodiversity

South Sudan is endowed with a wealth of biodiversity, which provides the country with great opportunity for socioeconomic development, as well as many biological resources that have considerable economic, social and intrinsic value.[29] Most South Sudanese depend on biological diversity for goods and services, either directly or indirectly, for their basic and development needs.

The country has a wide range of habitats, including lowland forest, montane forest, savannah woodland, savannah grassland, wetlands and floodplains, the Sudd Wetland and the semi-arid region in the north,[30] which support a very rich diversity of animal and plant species thanks to the fresh water and fertile soils provided by the White Nile and its tributaries.[31] Some of the country's endemic fauna species include the Nile lechwe, Hoogstraal's striped grass mouse, Nile sitatunga and the recently discovered climbing mouse *Dendromus ruppi*. South Sudan is also home to eland and is the only African country with both species: the common eland (*Taurotragus oryx*) and the giant eland (*Taurotragus derbianus*).[32]

Wildlife migrations occur in South Sudan across the eastern grassland savannahs and floodplains of Jonglei and Eastern Equatoria, which stretch into the neighbouring Gambela region of Ethiopia. The white-eared kob, tiang antelope, Mongalla gazelle and bohor reedbuck represent some of the greatest animal migrations and wildlife spectacles in the world, and are therefore an invaluable natural resource for South Sudan as they could be major tourist attractions in the future.[33]

The world's largest population of the shoebill and black crowned crane are found in the Sudd Wetland. Although South Sudan shares many of its fauna species with its southern and western neighbours, other species, such as the Nile lechwe and the white-eared kob, are endemic to South Sudan and Ethiopia.[34]

Reptiles endemic to the country include the Torit Gracile Blind Snake (*Letheobia toritensis*) and the Mount Kinyeti Chameleon. South Sudan also has native freshwater fish, including *Barbus tongaensis* and *Labeo tongaensis*. As regards plant species, the Imatong Central Forest Reserve is a major biodiversity hotspot, supporting over 2,000 vascular plant species and 500 bird species, and is one of the largest intact *Podocarpus* forests in Africa. Endemic flora and fauna of South Sudan includes *Barbus tongaensis, Chloroselastaposana* and *Lepidochrysops nigritia*.[35]

South Sudan's biodiversity, including its wildlife, is currently under threat, due to weak environmental regulation, poor development planning, fires that destroy forest resources and, most importantly, fragility, resulting from conflict, instability and security.

In the Fifth National Report to the Convention on Biological Diversity (CBD), submitted in 2015, the following were identified as direct threats to South Sudan's biodiversity:

- wildlife hunting, poaching and trafficking
- deforestation for biomass fuels and from illegal logging of hardwoods
- livestock and agricultural land expansion
- habitat fragmentation caused by road network expansions and the expansion of extractive industries (such as mineral mining and oil industry developments)
- adverse climate change impacts, including increasing desertification and delayed and shorter rainy seasons
- human-wildlife conflicts, especially with communities living near protected areas.

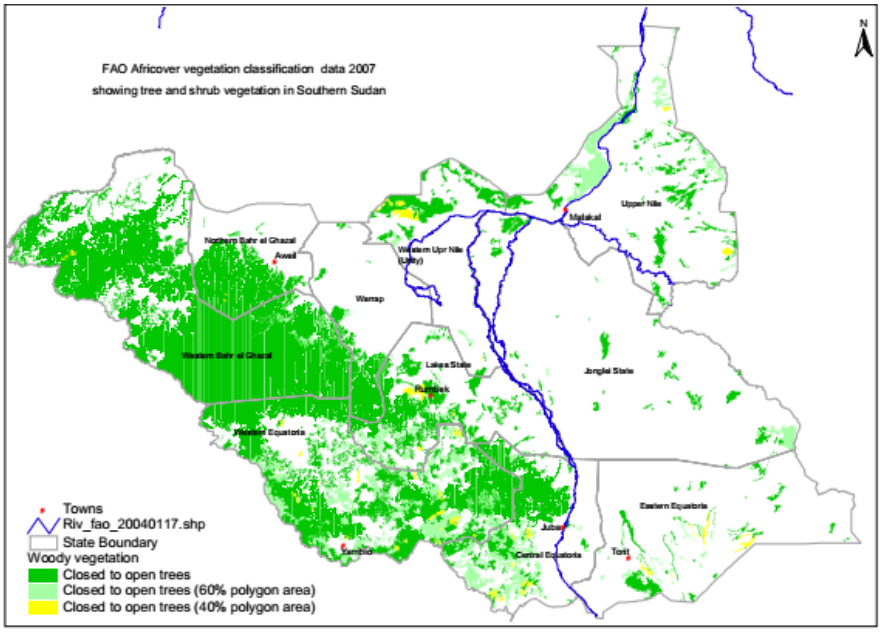
## Forestry

In the south of the country, extensive and diverse forest and woodland resources provide food, oils, medicines, timber and firewood for communities, as well as habitats for much of South Sudan's wildlife. Forest ecosystems are generally robust, yet in some areas they have been degraded by decades of uncontrolled fire, uncontrolled grazing and overcutting of more desirable species.[36]

It was estimated that by 2016, South Sudan's natural forests and woodlands covered an area of around 20.74 million hectares or approximately 33 per cent of the total land area.[37] These forests contain valuable commercial products, including cabinet-grade timber from trees such as mahogany, ebony and teak. In addition to direct benefits (income, food and fodder for wildlife and domesticated animals), South Sudan's forests provide many vital indirect benefits, such as environmental protection (shade, wind belts) and improved agricultural production (from increased soil fertility through mulching and nitrogen fixation).[38]

According to the Food and Agriculture Organization of the United Nations (FAO) Africover project, South Sudan has lost substantial forest cover, decreasing from 56.65 million hectares in 2007 (with 22.87 million hectares of closed to open trees and 33.78 million hectares of closed to open shrubs)[39] to 27.4 million hectares in 2016.

**Figure 1.14:** Map of forest areas in Sudan using Africover data




Source: United States Agency for International Development (USAID), 2007.

Forest resources are important for the country, which exports timber, especially teak,[40] and in particular the livelihoods of rural South Sudanese communities. In 2011, the forestry sector contributed US$395.4 million to the economy, which was approximately 0.7 per cent of gross domestic product (GDP).[41] These statistics may not include non-timber products, the most important of which is firewood, which is used by households for cooking and also provides a source of income, along with charcoal, for small-scale farmers, although this practice does contribute to environmental degradation. Many poor families use the forestry sector to sustain their livelihoods, particularly when crops fail or security deteriorates, through hunting and food gathering food for fruits, vegetables, mushrooms and honey. Commercially important non-food products, such as shea nuts, resins and gums, are also regularly collected and sold by farmers.[42]

The main threats to South Sudan's natural forests and woodlands include forest base degradation from wild fires, overgrazing and overcutting of trees during conflicts. According to a Ministry of Agriculture and Forestry report in 2006, the productivity of South Sudan's natural forests and woodlands is low and in decline, as many areas have shallow soils and face intermittent droughts, which limit tree growth. The lack of a strong national forestry management policy and regulations has also contributed to degradation and inefficiency in forestry development and exploitation.[43]

South Sudan's protected areas include wildlife, forest and Ramsar sites. The country has an extensive system of game reserves and national parks, some of which date back to the 1930s. In total, the country's protected sites cover 87,000 km$^2$ (13 per cent of its land surface). National parks are estimated to cover an area of 51,760 km$^2$, game reserves 34,110 km$^2$ and forest reserves 1,160 km$^2$. In addition to these protected areas, South Sudan also has one Ramsar site, the Sudd Wetland, recognized under the Ramsar Convention as a Wetland of International Importance.[44]

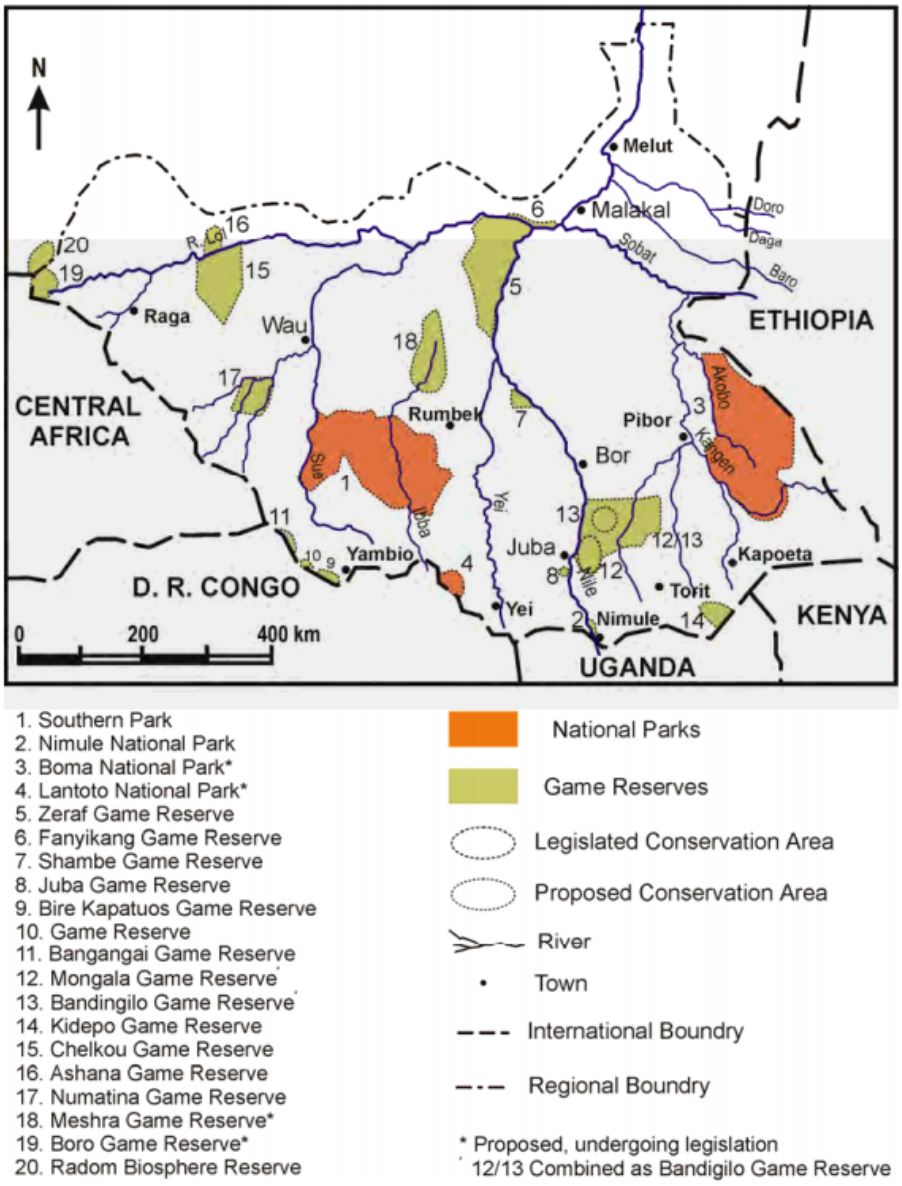
The current protected areas in South Sudan are listed in Table 1.1 below

**Table 1.1: Conservation areas in South Sudan**

| Game reserves | Area (ha) | Date established |
|---|---|---|
| Ashana | 90,000 | 1 Jan 1939 |
| Bangangai | 17,000 | 1 Jan 1939 |
| Bire Kapatuos | 500,000 | 1 Jan 1939 |
| Boro | 150,000 | Proposed |
| Chelkou | 550,000 | 1 Jan 1939 |
| Ez Zeraf | 800,000 | 1 Jan 1939 |
| Fanyikang | 48,000 | 1 Jan 1939 |
| Juba | 20,000 | 1 Jan 1939 |
| Kidepo | 120,000 | 1 Jan 1975 |
| Meshra | 450,000 | Proposed |
| Mbarizunga | 1,000 | 1 Jan 1939 |
| Mongalla | 7,500 | 1 Jan 1939 |
| Numatina | 210,000 | 1 Jan 1939 |
| **Total game reserve area** | **2,963,500** | |
| **National parks** | | |
| Bandingilo | 1,650,000 | 1 Jan 1992 |
| Boma | 2,280,000 | 1 Jan 1986 |
| Lantoto | 76,000 | Proposed |
| Nimule | 41,000 | 1 Jan 1954 |
| Shambe | 62,000 | 1 Jan 1985 |
| Southern | 2,300,000 | 1 Jan 1939 |
| **Total national park area** | **6,409,000** | |
| **Ramsar sites** | | |
| Sudd Wetland | 5,700,000 | 2006 |
| **Nature conservation areas** | | |
| Imatong Mountains | 100,000 | Proposed |
| Lake Ambadi | 150,000 | Proposed |
| Lake No | 100,000 | Proposed |
| **Total nature conservation areas** | **350,000** | |

Source: USAID, 2007 (data from World Database on Protected Areas, World Commission on Protected Areas (WCPA), 2006).

Map of South Sudan's protected areas




Source: USAID, 2007.

South Sudan faces many challenges in developing and sustainably managing its forestry sector, which include the following:

- **Deforestation and forest degradation**: South Sudanese forests are fragile ecosystems which suffer varying levels of degradation through uncontrolled fires, uncontrolled grazing and overharvesting. The level of degradation is high in all states and the International Centre for Research in Agroforestry (ICRAF), now known as the World Agroforestry Centre, concluded that between 1973 and 2006, South Sudan lost on average 2 per cent of its forests to deforestation every year.
- **Poor forest governance and a lack of agreement regarding ownership of forest resources**: Forests have always been exploited during war. At present, the Government is trying to restore order to the exploitation of forest resources throughout the country. However, illegal exploitation is still common and a lack of appropriate legislation is delaying such efforts.

- **Weak and inadequate coordination mechanisms between the national and state governments**: A lack of adequate coordination mechanisms between South Sudan's different government levels is hampering forest governance. For example, each state's Director General of Agriculture (who is responsible for forestry services) reports only to the Minister of Agriculture, without providing any information to the Director General of Forestry. Under this decentralized system of governance, there are gaps and overlaps among responsible officers at the national and individual state levels.
- **Forest fires**: These pose a significant threat to forest resources.
- **Charcoal and fuelwood**: These products make up approximately 96 per cent of the country's energy supply due to a lack of alternative energy sources, such as electricity, wind power, solar power and gas. Charcoal-making is therefore an attractive economic activity and more people becoming involved in its production, which is accelerating deforestation. There is also a growing demand for fuelwood and brick-making.
- **Linkages with land**: Administration and management of the forestry sector require coordination with the policies, laws and institutions governing the country's land. Under the 2009 Land Act, community lands can be designated, among other reasons, for forestry purposes. Land ownership in South Sudan is yet to be resolved and calls for a new common understanding between the Government, state and local governments, and communities, particularly as it relates to Central Forest Reserves (CFRs) and State Forest Reserves (SFRs).

## Water resources

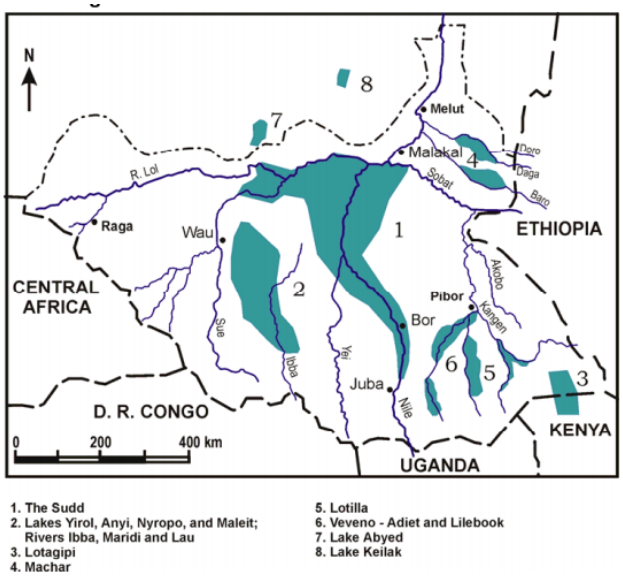
South Sudan has substantial water resources, though these are unevenly distributed throughout the country and vary considerably from year to year.

Water demand for domestic and productive uses has been growing rapidly over the years. This trend is expected to continue, placing even greater pressure on water availability. South Sudan's major surface-water resources are the Nile River (White Nile and Blue Nile), tributaries and aquifers. A large part of the country is covered by the Sudd Wetland, which is formed by the Baḥr el-Jebel and extends to its confluence with the White Nile. The Sudd Wetland comprises lakes, swamps, marshes and extensive floodplains that cover around 15 per cent of the country's total area and was declared a Ramsar site in 2006.

Other than the Sudd Wetland, there are many other wetland systems throughout South Sudan, some of which are quite extensive. Wetlands are only protected in South Sudan if they are part of national parks, game reserves or forest reserves, which leaves many of South Sudan's wetlands at risk.[45]

South Sudan's groundwater resources are found in the Umm Ruwaba formation, which is recharged by seasonal rainfall and river flooding. However, at present, the extent of the aquifer is unknown.[46]

**Figure 1.15:** Surface-water resources in South Sudan

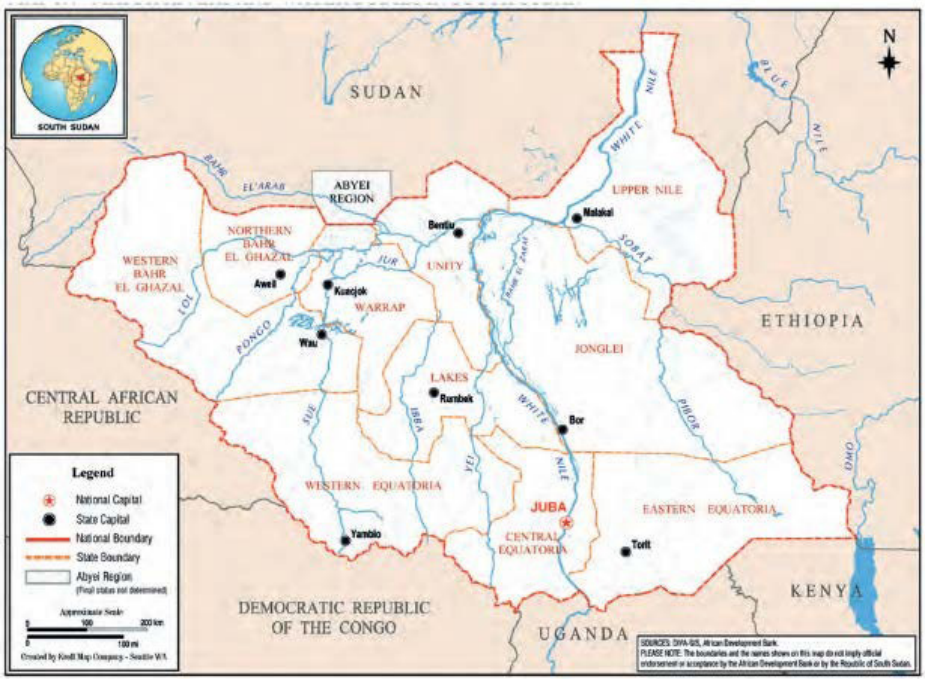



Source: USAID, 2007.

The surface-water drainage system in South Sudan follows the Nile River system. Most of South Sudan's water is carried by the Blue Nile. Three major South Sudanese tributaries meet and flow into the White Nile: the Bahr el Ghazal (comprising three sub-basins: Kiir, Lol and Jur), the Baḥr el-Jebel (comprising numerous tributaries such as Yei, Aswa and Kiit) and the Sobat River (comprising sub-basins such as Pibor and Baro-Akobo).

South Sudan's total renewable water resources are estimated at 49.5 $km^3$ per year, which translates to per capita availability of roughly 4,567 $m^3$ per year.[47] Most of the water used is externally generated from upstream countries. The share of water generated from rainfall is erratic and the country is prone to drought. In dry years, domestic water resources fall dramatically, dropping to 15 per cent of the annual average in severe cases. This hydrologic variability, coupled with the lack of investment in storage structures, has made South Sudan prone to periodic floods and droughts.[48]

**Figure 1.16: Rivers in South Sudan**




Source: African Development Bank (AfDB), 2013, South Sudan: An Infrastructure Action Plan. A Program for Sustained Strong Economic Growth.

Since the Nile originates in upstream countries (Burundi, Kenya, Rwanda and Uganda), any changes in these countries' water resources will impact the volume of water in the Nile, which in turn will affect South Sudan and the Sudd Wetland.

South Sudan is thought to have large aquifers throughout its territory, which are recharged by seasonal rainfall and river flooding, and in some cases, extend across international boundaries.[49] However, most of the country's underground water has high levels of salinity that exceed World Health Organization (WHO) potable water limits, especially in Jonglei and Unity, making it unsafe to drink.[50] There is also risk of groundwater becoming contaminated, due to oil exploration and extraction activities.

Despite the availability of abundant surface-water and groundwater resources, millions of South Sudanese lack access to improved water supply and sanitation services.[51] In fact, two out of three people do not have access to improved water services, while more than eight out of 10 people do not have access to improved sanitation services.[52] In addition, 98 per cent of households do not have drinking water on their premises or delivered by tankers or carts.[53] Water-related diseases such as diarrhoea, cholera and guinea worm are prevalent, due to poor hygiene awareness among citizens. South Sudan has the largest incidence of guinea worm in the world, which is transmitted through drinking contaminated and stagnant water.[54]

The Government has recognized the need to regulate and protect the country's water resources and in 2013 developed the Water Bill, which provides for the protection of water sources from pollution, erosion and any other adverse effects. The Government has also taken encouraging steps towards labelling the water supply and sanitation sector as an extremely high priority and a key entry point to its development objectives. Furthermore, it has classified the sector

as one of the top six expenditure priorities and has included it in all key strategic documents. In addition to developing a comprehensive development plan (SSDP 2011–2013), the Government has established key sectoral institutions and taken commendable strides to formulate and adopt a water policy and a water, sanitation and hygiene strategic framework. These instruments have generated a positive dynamic towards the sustainable development of the water sector, a necessary pre-requisite for alleviating poverty and spurring the country's economic growth.[55]

Climate change is likely to impact water availability in terms of quantity and quality, with the increasing frequency of floods and droughts expected to affect South Sudan's freshwater resources. Competition for water resources is expected to increase, resulting in conflicts between upstream and downstream users.

Since most households rely on surface water for their needs, climate change will have a severe impact on them and will reduce their resilience to natural hazards, such as droughts and floods.

## Economy, industry and services profile

### Economy

South Sudan is a least developed country (LDC) and the world's newest nation, which gained independence from Sudan in 2011. Although South Sudan has large base of natural resources other than oil, most of which are untapped, it remains relatively undeveloped and is characterized by a subsistence economy. Despite the nation's vast arable land, oil reserves, untapped water resources and large stocks of cattle and fisheries, the general lack of road infrastructure, market integration and investment in agriculture, coupled with years of conflict, has led to widespread economic challenges besides food and nutrition insecurity.

South Sudan's 2017 GDP was estimated at US$3.6 billion,[56] though as a new country, it has the dual challenge of dealing with a legacy of almost 50 years of conflict and instability, and huge developmental needs. Formal institutions are gradually being established and the Government is growing its limited capacity to formulate and implement policies and programmes. South Sudan has significant oil wealth, which if used effectively to drive development, could provide the basis for progress in the coming years. At present, South Sudan is the world's most oil-dependent nation, with the resource accounting for almost all its exports, around 60 per cent of its GDP and over 95 per cent of government revenues in previous fiscal years. It is estimated that as its oil reserves are depleted, production will gradually reduce to almost nothing by 2035. South Sudan's macroeconomic performance is deteriorating, due to the country's fragile situation and continuing low global oil prices. Economic growth fell by 0.2 per cent in 2015 and the country's current account deficits have sharply increased.

South Sudan's industry and infrastructure are severely underdeveloped and poverty is widespread, as a result of several decades of civil war with Sudan. Outside the oil sector, livelihoods are predominantly low productive, unpaid agriculture and pastoralist work, with roughly 85 per cent of the population engaged in non-wage work (78 per cent in agriculture), which accounts for around 15 per cent of the country's GDP. Markets are disorganized which has resulted in insecure

property rights and weak price signals. South Sudan has not yet developed an entrepreneurial culture, likely due to its limited development of the private sector.[57]

According to the National Bureau of Statistics, South Sudan's real GDP grew 0.3 per cent in 2016 compared with 5.1 per cent in 2015. Oil, public and non-oil private sectors are the three key contributors to the country's GDP growth. Over the 2008–2016 period, the country's economic performance has varied, especially since gaining independence in 2011 (Figures 1.17 and 1.18). Most of the variation has been directly linked to oil revenues (oil production and prices) and the escalation of armed conflict in the country. South Sudan's economy heavily depends on the oil sector; in the years before the oil shutdown, non-oil private sector growth averaged only 4 per cent.[58]

South Sudan's economic performance has continued to deteriorate over the years because of the civil war, the sharp fall in oil production and the collapse of global oil prices. Net oil revenues in 2015/16 were expected to be only 17 per cent of those of the previous year, which had an adverse impact on economic performance, with real GDP growth falling by 0.2 per cent in 2015.

**Figure 1.17: GDP of South Sudan (2008–2016)**


Source: Trading Economics, South Sudan GDP, https://tradingeconomics.com/south-sudan/gdp.

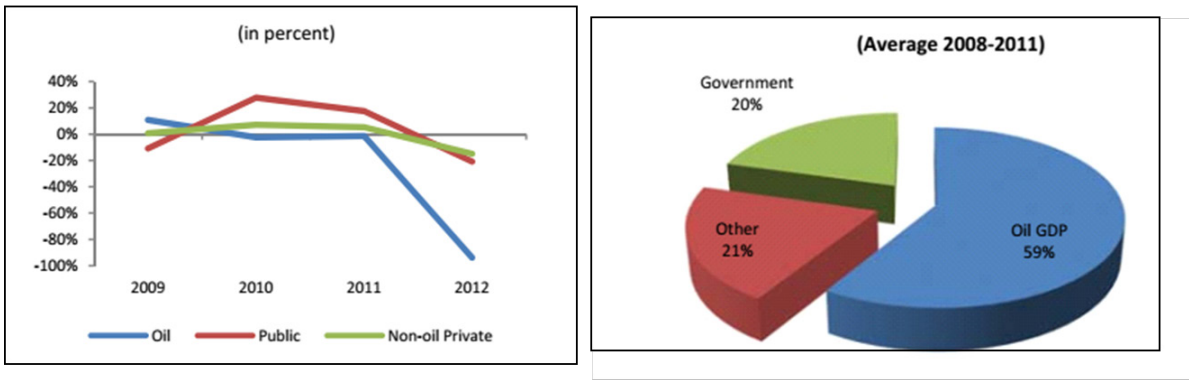
**Table 1.2: GDP growth rates (2009–2016)**

| Year | GDP growth rate (%) |
|---|---|
| 2009 | 5.0 |
| 2010 | 5.5 |
| 2011 | -4.6 |
| 2012 | -46.1 |
| 2013 | 13.1 |
| 2014* | 2.9 |
| 2015* | -0.2 |
| 2016* | -13.1 |

* These are World Bank estimates.

Source: South Sudan, National Bureau of Statistics, 2012.

**Figure 1.18:** GDP growth (2009–2012)




Note: In the non-oil sector, subsistence agriculture, forestry and fisheries account for 14.5 per cent; government services, 9.1 per cent; trade, hotels and restaurants, 5.9 per cent; manufacturing and mining, 3.6 per cent; transport and communication, 3 per cent; construction, 2.2 per cent and other services, 2 per cent.[59]

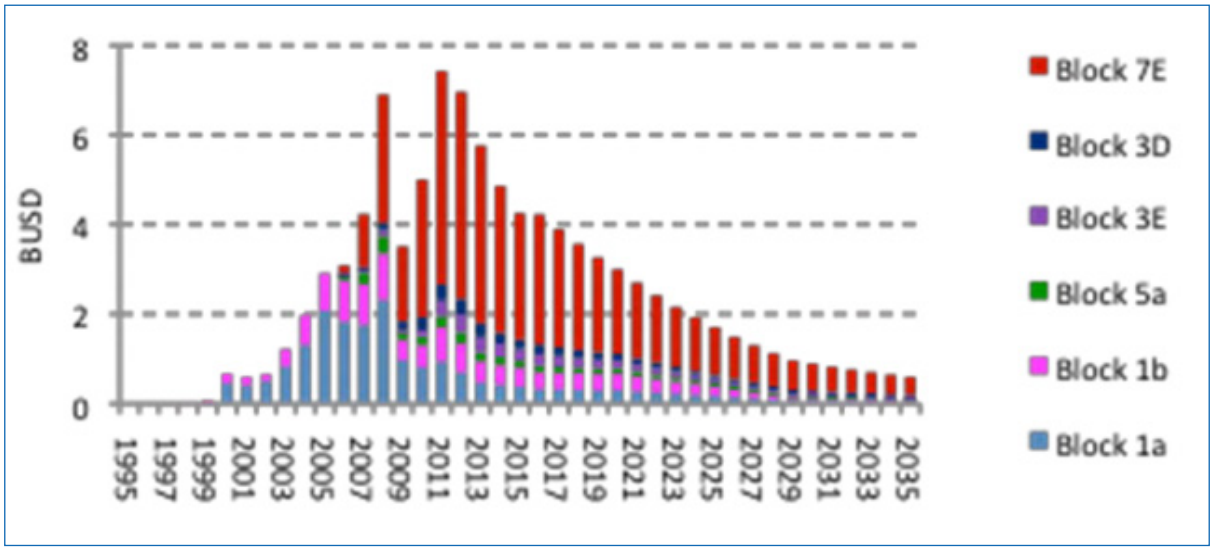
Source: World Bank, 2015.

In the years following the 2005 CPA up to 2011, South Sudan reported improved economic results. However, in January 2012, following a dispute with Sudan over transhipment fees, South Sudan suspended oil production for 15 months, which had a devastating impact on its GDP in 2012, causing it to decline by 48 per cent. After resuming its oil flows, South Sudan's economy rebounded strongly during the second half of 2013, despite the fact that production was 40 per cent lower than prior to the shutdown, with an average of 222,000 barrels produced per day. In 2013, GDP grew by almost 30 per cent. However, the outbreak of conflict in December 2013, combined with further reductions in oil production and exports, led to another significant fall in GDP in 2014, causing poverty and food insecurity to rise.

South Sudan continues to experience armed conflict, which hinders economic activity and undermines its development gains, therefore constraining economic growth and worsening the humanitarian situation. The current conflict has had a significant financial impact on the country with the 2015/16 GDP contracting by 6.3 per cent. Disruptions in oil production and below-average agriculture production means the economy is expected to contract further in financial year 2016/17, while fiscal and current account deficits will soar, leading to significant declines in domestic prices and the parallel market premium. Extreme poverty is now at 65.9 per cent.[60]

Declining oil prices and lower production have led to decreased export revenues (Figure 1.19). In 2017, oil production was expected to decrease to around 120,000 barrel per day, down from 165,000 barrels per day in 2014 and a peak of 350,000 barrels per day before independence in 2011. The decline in oil revenue has also had a negative impact on macrobudgetary indicators, which require austere fiscal adjustments. Relative food prices have increased and food shortages and hunger are the most alarming signal of the country's larger economic collapse. Annual inflation peaked at 79.5 per cent in May 2012 but declined rapidly thereafter to 1.7 per cent in 2014, before increasing again to 52.8 per cent in 2015, following the outbreak of violence in December 2013.

**Figure 1.19: Declining oil revenues**




Source: SSDP 2011–2013.

As a result, the Government has been unable to raise the resources required to finance peace-related activities. In fact, financing the normal 2015/16 budget, as approved by the assembly, was a daunting challenge. The fiscal budget and current account deficits have risen sharply, which has caused a huge decline in foreign reserves, an increase in domestic and external debts, depreciation of the parallel domestic currency exchange rate and acceleration in consumer inflation. For 2016, South Sudan's GDP was expected to have fallen drastically by 13.1 per cent. The country's economic prospects remain bleak and will depend on the successful implementation of the peace agreement, a significant recovery in global oil prices and the implementation of the economic and fiscal measures announced in September 2016.

South Sudan's economy is overly dependent on oil, which increases its fragility and vulnerability to external shocks. In order to end this over-reliance, the country needs to diversify its non-oil sectors, such as agriculture, mining, forestry and manufacturing, which potentially have greater regional linkages.[61] The long-term challenges include diversifying the formal economy, alleviating poverty, maintaining macroeconomic stability, improving tax collection and financial management, and improving the business environment within the context of a rapidly changing climate.

The country's economic performance, which is directly linked to oil revenues (oil production and prices) and escalation of armed conflict, has varied significantly since its independence. To strengthen its economy in the long term, South Sudan needs to end its over-reliance on oil and diversify its non-oil sectors, such as agriculture, mining, forestry and manufacturing, which potentially have greater regional linkages. The long-term challenges include diversifying the formal economy, alleviating poverty, maintaining macroeconomic stability, improving tax collection and financial management, and improving the business environment within the context of a rapidly changing climate.

The World Bank has identified South Sudan as having one of the most constraining business climates in the world.[62] Many South Sudanese depend on the public sector payroll in the absence of an appropriate environment for developing business activities. Many service jobs, especially

in Juba, are filled by expatriates from countries that are members of the Intergovernmental Authority on Development, due to lack of local capacity. Few South Sudanese are engaged in trade activities.[63]

In its report "Doing Business in Juba 2011", the International Finance Corporation (IFC) ranked Juba 159 out of 183 economies on the ease of doing business. A number of key challenges emerged from this survey, including human and institutional capacity constraints, major infrastructure gaps and overlapping legal and regulatory instruments. Several important laws are yet to be enacted. There is also a lack of clarity among federal, state and county jurisdictions over business licensing, taxes and customs. Although some progress was made in terms of drafting laws, addressing the infrastructure and institutional gaps will remain a major challenge.[64]

Private sector operations largely focus on trade financing. Due to difficulties related to the increased scarcity of hard currency and the depreciation of the South Sudanese pound, some of the largest banks are offering loans for a maximum 3 years, a period stipulated by law, which prohibits collateral being pledged for a longer period. Most corporate loans are 100 per cent cash collateralized, due to a lack of records on borrowers and the capacity to manage them.[65]

South Sudan's economy is fragile and nascent, and does not reflect its tremendous economic potential. Statistics show that the country needs to improve its trade balance, which currently favours regional trading partners and their imports, rather than exporting its own products. Informal traders dominate merchandise trade, both in terms of volume and value.[66]

South Sudan's trade policy and regulatory environment are still in the early stages of development. A few trade-related and investment laws have been enacted, such as on businesses registration, companies, arbitration and investment promotion. At present, South Sudan has no business regulations in place, such as standards and quality assurances, and lacks the human and institutional capacity to implement legislation, which are challenges the country will need to overcome.[67]

## Industry

South Sudan's industrial sector mostly comprises mining other extractive ventures, all of which are closely related to oil production. There are no major manufacturing or construction activities. South Sudan has abundant mineral wealth of unknown commercial quantities, including gold, uranium, diamonds, tungsten, mica and iron ore. The extractive sector is currently very small, accounting for less than 5 per cent of the country's GDP.[68] According to Southern Sudan Centre for Census, Statistics and Evaluation (SSCCSE) data (Table 1.3), there were only 295 registered businesses in the industrial sector in 2010, with 199 of these in manufacturing, 89 in construction and seven in water and waste management services. A large push in agriculture and infrastructure in the decade ahead will provide numerous possibilities for new investment in industrial activities, especially for the domestic market.

**Table 1.3: Number of registered businesses in state capitals in 2010**

| Type of business activity | Number | Percentage |
|---|---|---|
| Agriculture, forestry and fisheries | | |
| Mining and quarrying | 10 | 0.1 |
| Electricity, gas, steam and airconditioning | | |
| Manufacturing | 199 | 2.7 |
| Water supply, sewerage and waste management | 7 | 0.1 |
| Construction | 89 | 1.2 |
| Wholesale and retail trade | 5,116 | 69.8 |
| Transportation and storage | 45 | 0.6 |
| Accommodation and food services | 1,037 | 14.1 |
| Information and communications | 97 | 1.3 |
| Finance and insurance | 52 | 0.7 |
| Professional, scientific and technical services | 46 | 0.6 |
| Administrative and support services | 10 | 0.1 |
| Education | 31 | 0.4 |
| Health and social services | 361 | 4.9 |
| Arts, entertainment and recreation | 22 | 0.3 |
| Other services | 211 | 2.9 |
| **Total** | **7,333** | **100.0** |

Source: African Development Bank (AfDB), 2013.

In order to diversify away from its reliance on oil for economic development, South Sudan has put forward the development of non-petroleum mineral resources as an alternative. Certain mineral resources have been identified in a number of locations, though the extent of total reserves and recoverable reserves is not yet known. Such minerals include:

- Gold: Artisanal gold mining is carried out in Kapoeta and has been halted in Wonduruba and Luri due to insecurity.
- Diamonds: These have been found in Numatina in Western Bahr el Ghazal, close to the border with the Central African Republic.
- Iron ore: The Ironstone Plateau, which stretches across the states of Northern Bahr el Ghazal, Western Bahr el Ghazal, Western Equatoria, Warrap and Lakes has substantial iron ore deposits that could lead to the development of the smelting industry.
- Limestone: There are substantial limestone deposits in Eastern and Western Equatoria.

The construction industry has also been identified as an opportunity for bringing about a successful transition to the proposed high growth scenario in the next decade, which will require a substantial increase in the level of investment in the country. The high growth scenario envisages a situation where the annual non-oil GDP growth rate is raised to around 8–9 per cent throughout the decade in order to shift the economy's dependency away from oil revenues.

## Manufacturing

Manufacturing activities in South Sudan are limited. It is estimated that the subsector accounted for about 2 per cent of GDP or 6 per cent of non-oil GDP in 2010 (Table 1.4). Since there are few important manufacturers in South Sudan, most of the country's manufactured goods are imported from neighbouring countries.[69] Efforts are under way revive several agro-processing industries that operated in the region before the outbreak of civil war some 30 years ago. These include:

- saw mills, fruit canning and a brewery in Wau, Western Bahr el Ghazal
- the kenaf project for manufacturing and packaging hessian cloth in Tonj, Warrap[i]
- the Nzara agroindustrial complex in Western Equatoria
- a Mongalla cotton spinning and weaving factory in Central Equatoria
- paper-making using papyrus that grows in the Sudd Wetland and swamps of Warrap Unity, Upper Nile, Jonglei and Lakes
- the shea butter project in Greater Bahr el Ghazal region
- palm oil processing in Western Equatoria.

**Table 1.4: GDP by industrial origin, 2010 (Sudan pound in millions, current prices)**

| Sector | Value | Share (%) |
|---|---|---|
| Petroleum value added | 18,963 | 59.7 |
| **Non-oil GDP** | | |
| Agriculture, forestry and fisheries | 4,604 | 14.5 |
| Manufacturing and mining | 723 | 2.3 |
| Construction | 444 | 1.4 |
| Transport and communications | 604 | 1.9 |
| Trade, hotels, tourism | 1,033 | 3.3 |
| **Other services** | | |
| Government services | 4,855 | 15.3 |
| Other private services | 542 | 1.7 |
| Subtotal | 5,398 | 17.0 |
| **Total non-oil GDP** | **12,805** | **40.3** |
| **Total GDP** | **31,768** | **100.0** |

Source: AfDB, 2013.

Most firms and businesses in South Sudan face a number of major constraints that adversely affect their competitiveness with imports and their future ability to export. These include acute power shortages and high costs of running generators, high labour costs, lack of ready access to foreign exchange, poor transport infrastructure, difficulty in securing credit facilities and high rental costs for office space. Due to the low level of industrial activities in South Sudan, the sector is expected to have very low contribution to the national GHG emission.

[i] Kenaf is a close relative to cotton and okra.

## Services

### Transport

Current transport conditions are a major barrier to South Sudan's economic and social activity. Reliable and efficient road, rail, air and water transport infrastructure enables goods and services to be moved and delivered more efficiently, while also ensuring national and regional integration. This in turn boosts trade within the country and across borders, promotes economic development, helps alleviate poverty and create wealth, and achieve the objectives of Vision 2040 and beyond.

In South Sudan, the transport sector includes:

- Road transport: South Sudan has a number of main gravel roads from Juba, which include roads to towns located south-west of Juba, as well as a road to the border with Uganda. There is also a gravel all-weather road east of Juba that that reaches the border with Kenya, where it joins an all-weather Kenyan road to Lodwar, which connects it to the Kenyan road system. However, improvements to these roads from Juba have been impacted by the country's civil wars, due to extensive mining and the destruction of bridges. Several of the country's roads have seriously deteriorated due to a lack of maintenance, leaving some areas inaccessible by road during the rainy season. On the border with Kenya and Uganda, there is only one main road as part of the regional road network. The road connecting Juba with East Africa is the most travelled and is the only road network that is generally in good or fair condition. Highways in South Sudan are almost entirely unpaved. Rehabilitation work is under way and the first paved highway between the Juba and Nimule at the border with Uganda has opened.
- Water transport: The White Nile extends from Lake Victoria to Khartoum for almost 3,700 km. It enters South Sudan at Nimule, flows to Juba and Bor and through the vast swamps of the Sudd Wetland, passing major towns such as Malakal, Renk and Kosti. Between Juba, Renk and the border with Sudan, the White Nile is navigable, stretching 1,300 km. River transport services and ports are underdeveloped and commercial vessels are old. The Bahr el Ghazal River is one of the White Nile's tributaries. It is navigable all year round along its main route from where it joins the White Nile to Meshra Achol and for more than half of the year to Wau. The Sobat River, another tributary, is navigable between Malakal and Abwong all year round. The section from Abwong to Nasir, Akobo and Pibor is navigable for more than half of the year. The Sobat area and most of the flood-prone areas of the Upper Nile region depend on river transport from June to October. Commercial river transport services are fairly regular along the White Nile's "Southern Reach" route, which stretches from Kosti to Juba (1,436 km), through Renk, Malakal, Shambe, Diam Diam, Bor and Mongalla. There are seven main river ports in South Sudan located in Renk, Malakal, Shambe, Diam Diam, Bor, Mongalla and Juba.
- Rail transport: South Sudan has a total 248 km of narrow-gauge, single-track railroad line in the country. This is the country's only line, stretching from Babonosa (north Sudan) to Wau, most of which was mined and badly destroyed during the Second Sudanese Civil War (1983–2005). Despite its full rehabilitation in 2008 with United Nations funds, the line is still currently out of use.
- Air transport: South Sudan has one heliport and about 85 airports (as at 2013), of which only three have paved runways. The busiest and most developed airport in South Sudan is Juba International Airport, which has regular international connections to regional international airports, while also acting as the home base of some local privately-owned airlines. Other cities with international airports in South Sudan include Malakal, which has international

flights to Addis Ababa and Khartoum, Wau, which has a weekly service to Khartoum, and Rumbek, which also has weekly flights to Khartoum. Local private airlines also serve Nimule and Akobo, which have unpaved airstrips. There are several smaller airports throughout South Sudan, the majority of which are little more than dirt airstrips. Most of the airports are used for local air transport by humanitarian services and small private airlines operating within the country. Juba International Airport handles all aircraft sizes unlike the other airports, which are limited by the type and length of their runways.

- Pipeline transport: A single pipeline leads north from South Sudan's oil fields Sudan's only seaport, Port Sudan, which is used to export crude oil.

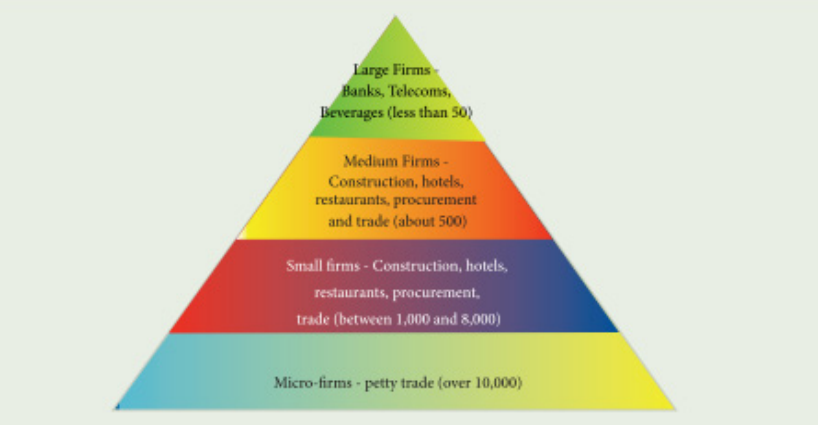
While South Sudan's transport infrastructure is vulnerable to the impacts of climate change, especially heavy rains and floods, it is also a significant and growing contributor of GHG emissions that lead to climate change. The development of an efficient, effective and climate-resilient transport sector is therefore crucial for South Sudan in order to lower its overall cost of doing business and to increase its competitiveness.

## Trade

South Sudan's private sector is predominantly informal. The national rate of employment stands at 11.5 per cent (10.8 per cent for men and 12.2 per cent for women). Most of the population is engaged in non-wage activities that are part of the informal and/or subsistence economy.[70] In 2012, it was estimated that up to 80 per cent of non-oil economic activity takes place in the informal sector, which has grown exponentially since 2005. In South Sudan, most trading is done through barter trade. As a result, little is known about its informal economy, though it is assumed to be better developed than its formal economy, relatively agile and therefore resilient to the waves of crisis affecting the country.[71] Although South Sudan's informal sector is not as well established as the informal sectors in the rest of the subregion, its comparative advantage lies in how the different parts of the network are linked. Informal traders and entrepreneurs maintain links with the informal sectors of neighbouring countries, forming "translocal" networks, which give South Sudan's informal economy greater resilience to economic shocks. Informal businesses span a range of activities, from gold mining to trading. Pro-poor growth requires developing a better understanding of the informal economy's existing dynamics, along with its key challenges and the steps needed to promote its formalization.[72]

Nearly all formal businesses in South Sudan are small and medium-sized enterprises (SMEs). Formal SMEs dominate most sectors of South Sudan's economy, including the retail and wholesale trade, construction, hotels and restaurants, and transport and communication sectors (Figure 1.20).[73]

**Figure 1.20: Number of business activities and their size**




Source: AfDB, 2013.

According to the African Development Bank Group (AfDB), anecdotal evidence estimates that South Sudan's SMEs constitute over 80 per cent of the total number of businesses in the country. SMEs play a crucial role in poverty eradication, particularly in terms of employment and income generation. Due to the limited access to finance in South Sudan, the majority of formal and informal business owners finance their start-up capital using their own savings. This indicates that financial intermediation is low and provides little funding for development finance, which is instead largely provided by commercial banks. According to the SSDP 2011–2013, financial intermediation is generally weak, with only 10 per cent of credit as a percentage of GDP directed to the private sector, compared with 14–30 per cent for neighbouring countries.[74]

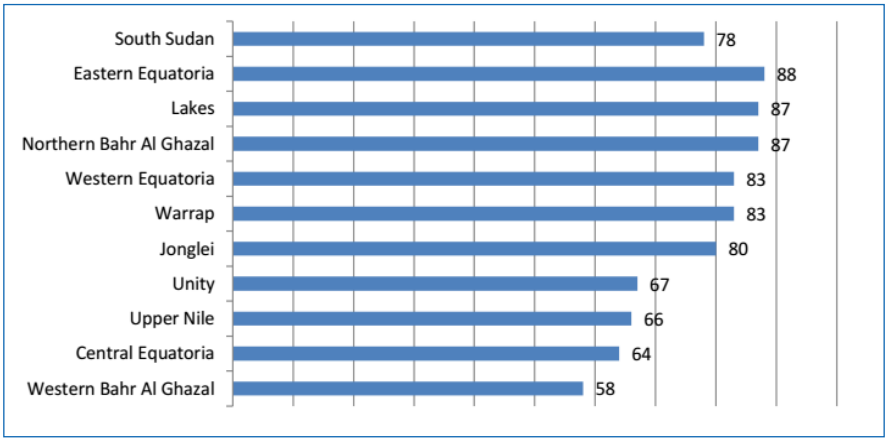
## Agriculture profile

South Sudan is endowed with immense natural resources, including fertile land, abundant water resources, extensive hardwood forests, large amounts of fresh water and minerals, and a wide variety of livestock, as well as native flora and fauna. These have made South Sudan suitable for a wide range of agricultural and natural resource-based production activities.[75] At present, the region supports 10–20 million cattle.

South Sudan has a total land area of 644,329 $km^2$, of which 90 per cent is considered suitable for agriculture, with 50 per cent being prime agricultural land. Despite having over 30 million ha of arable land, only 5 per cent is currently in use.

South Sudan is a predominantly agricultural economy, with 78 per cent of all households owning or using land for agricultural activity. There is wide variation between states in terms of agriculture. For example, in Western Bahr el Ghazal, 58 per cent of households are engaged in agriculture compared with 88 per cent of households in Eastern Equatoria. Agriculture is even practised in urban areas, albeit at a smaller scale, with 29 per cent of households engaging in activities compared with 86 per cent in rural areas.[76]

**Figure 1.21:** Agricultural households by state (%)




Source: National Baseline Household Survey (NBHS), 2009.

Since the signing of the CPA in 2005, agricultural development has been viewed as an alternative driver of growth. This will not only allow South Sudan to diversify its economy away from its oil dependency in the medium term, but also to directly reduce poverty and food insecurity of its citizens. The SSDP 2011–2013 emphasizes the country's need to diversify its economy. Given the importance of its agricultural sector, with almost 80 per cent of the population engaged in smallholder agriculture, farming, livestock rearing and fishing, the strategy underscores the need to focus on the sector's growth.[77]

## Crop husbandry

South Sudan has diverse soil and climatic conditions which favour the growth of various crops such as sorghum, maize, finger millet, rice, groundnuts, cassava, sesame, beans, fruits and vegetables, as well as coffee, tea, cotton and sugar cane, which the country also produces.[78] In general, cereal crop yields are lower than in the neighbouring countries due to several factors that reduce national production.

A 2013 AfDB study on South Sudan's competitiveness and cross border trade with neighbouring countries study established the following challenges:

- hydro-meteorological hazards, particularly the delayed and erratic rains and long dry spells, which led to crop failures throughout South Sudan
- insecurity associated with cattle raiding, intra-group and ethnic conflicts, and military and militia activities have resulted in significant displacements of households, which is directly impacting agricultural production due to the loss of assets and inability of farmers to cultivate their fields
- inadequate agricultural extension services, limited access to appropriate seeds and planting materials and continuous use of rudimentary farming tools have significantly led to low yields, averaging around 0.65 tons per hectare
- migration of youth to urban areas in search of alternative sources of livelihoods is causing labour shortages in the agricultural sector, resulting in lower cereal yields
- high pre- and post-harvest losses (up to 40 per cent) caused by pests and diseases, a lack of post-harvest machinery and equipment for harvesting, handling, packaging, processing, storage and cooling, and limited transportation facilities

- limited access to credit facilities to acquire modern agricultural equipment and machinery, which in turn negatively affects value added activities and the efficiency of the farm operations
- poor road infrastructure, which makes it difficult to access markets.

The Ministry of Agriculture and Food Security has identified a Green Belt Zone with fertile soils, stretching from Central Equatoria to Eastern Equatoria, as the most suitable area for medium and large-scale commercial agriculture. This zone also receives eight months of rain and has two planning seasons. Although these conditions mean that there is great potential for irrigation agriculture, at present, this farming system is only practised as part of the Aweil Rice Scheme, due to the closure of irrigation systems in northern Upper Nile as a result of their state of disrepair.

Currently, the food requirement for South Sudan's population is estimated at 1.04 million tons of cereal per annum. The country's cereal production can potentially reach a maximum of 2.5 million tons, but only if 96 per cent of unused farmland is brought under cultivation. This would potentially produce a surplus of 1.5 million tons for export to regional markets. However, increased productivity in the agricultural sector requires an increased level of mechanization and improved inputs (seeds, fertilizers, etc.), provision of new agricultural techniques and varieties.

## Livestock

South Sudan has one of the largest livestock populations in Africa, with a variety that includes cattle, goats, sheep and chickens. The country has potential to invest in cattle rearing, dairy products, poultry products, meat processing, fishery and cattle feed development.[79] Climate change poses a serious threat to livestock, as well as the livelihoods of pastoralist communities, due to the loss of pasture lands and reduced access to water resources. This has further resulted in armed conflicts among the pastoralist communities that have claimed many lives, demonstrating that climate change is also responsible for national security issues.[80]

South Sudan is considered to have the sixth largest livestock herd in Africa and the highest per capita livestock holding on the continent, contributing to around 15 per cent of the country's GDP. In addition, around 65 per cent of households in South Sudan own livestock.

Cattle is the most important source of red meat, supplying 65 per cent of meat needs and accounting for US$409 million or 13.57 per cent of the overall contribution of livestock to the economy.[81]

In South Sudan, cattle are much more than a source of food, signifying status and wealth and serving as the main livelihood asset for pastoralist communities. Livestock are sold for cash, slaughtered for cultural practices, bartered for grain, used as payment for penalties and given for dowry. The dislocation of massive numbers of livestock into areas outside their normal domains is causing dramatic rises in disease outbreaks and livestock deaths, which poses a grave threat to the livelihoods and food security of pastoralist communities across the country.

Women usually have a primary role regarding the nutritional status of their household, especially their children. The loss of cattle and decline in milk production due to disease implies that household coping strategies are being affected, impacting on overall household well-being and, in particular, nutrition. Lack of access to livestock increases the risk of malnutrition in pastoralist

groups, particularly in children and lactating women, who rely on milk and blood as an essential part of their diet. This drop in production and lack of access is also likely to reduce women's income from milk sales, which benefit and contribute to household food security and well-being.[82]

Livestock populations in South Sudan are based on estimates from the Ministry of Livestock and Fisheries, which have been adopted as the official livestock figures since 2009.

**Table 1.5: Livestock distribution in South Sudan states**

| State | Cattle | Sheep | Goats | Total |
|---|---|---|---|---|
| Central Equatoria | 878,434 | 1,153,283 | 1,265,977 | 3,297,694 |
| Eastern Equatoria | 888,278 | 1,132,541 | 1,025,297 | 3,046,116 |
| Western Equatoria | 675,091 | 1,153,283 | 1,169,705 | 2,998,079 |
| Jonglei | 1,464,671 | 1,207,214 | 1,400,758 | 4,072,643 |
| Unity | 1,180,422 | 1,754,816 | 1,487,402 | 4,422,640 |
| Upper Nile | 983,027 | 439,741 | 640,209 | 2,062,977 |
| Lakes | 1,310,703 | 1,464,421 | 1,232,282 | 4,007,406 |
| Warrap | 1,527,837 | 1,369,005 | 1,290,045 | 4,186,887 |
| Western Bahr el Ghazal | 1,247,536 | 1,120,095 | 1,265,977 | 3,633,608 |
| Northern Bahr el Ghazal | 1,579,160 | 1,630,361 | 1,285,231 | 4,494,752 |
| **Total** | **11,735,159** | **12,424,760** | **12,062,883** | **36,222,802** |

Source: Intergovernmental Authority on Development (IGAD), 2016.

South Sudan's livestock sector contributes to GHG emissions through enteric emissions and manure decomposition.

Growth rates in South Sudan's agricultural sector are linked to flood and drought events, with past negative growth indices generally associated with extreme weather events. Emerging and projected changes in climatic patterns, including increased variability of seasonal rains, have a direct influence on the sector's productivity.

South Sudan's population are highly dependent on climate-sensitive sectors for their livelihoods, such as agriculture (mainly rain-red) and pastoralism (livestock rearing), which are also interdependent, thus making them highly vulnerable to climate change impacts.[83]

## Energy profile

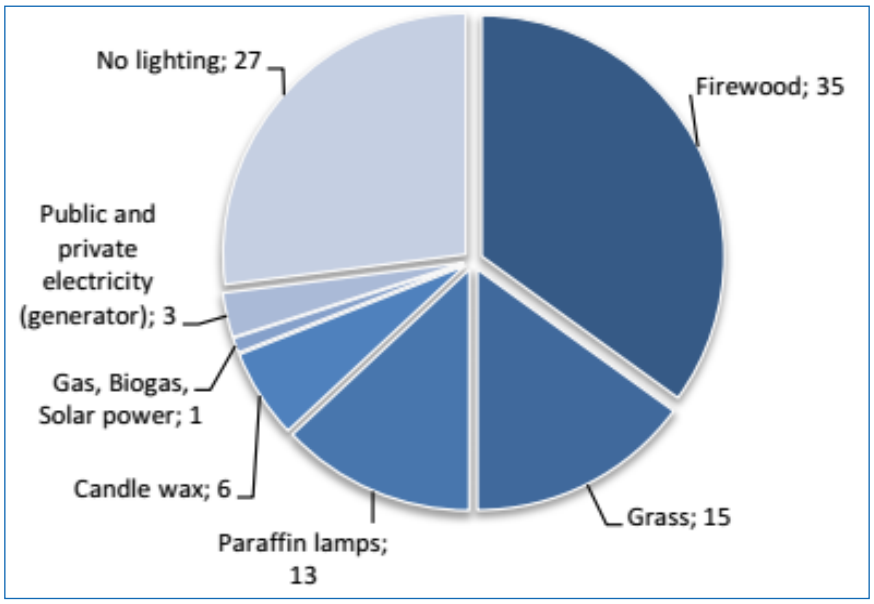
Energy production is crucial for South Sudan's economy and its population's standard of living. The SSDP 2011-2013 has identified energy as a key factor that will drive the country's economic growth.

Households in South Sudan predominantly use biomass to meet their energy needs, which involves burning charcoal, wood, grass, cow dung and agricultural residues. According to the 2012 NBHS, over 96 per cent of the population use firewood or charcoal as their primary fuel for cooking.[84] Firewood (35 per cent), grass (15 per cent) and paraffin lamps (13 per cent) are the most used sources for lighting, while 27 per cent of the population has no source of lighting at all (Figure 1.22). Only 3 per cent of the total population has access to electricity. Those who have electricity mainly reside in Juba, with the remaining few residing in the towns of Wau, Kapoeta and Malakal.[85] Costly diesel generators are mostly used to produce the electricity in Juba, as the generators that should supply the grid are not functioning.

South Sudan needs to gradually shift from biomass energy to modern energy in order to:

- promote socioeconomic development
- minimize forest degradation, which is a source of GHG emissions
- reduce the hardship and health hazards involved in household activities to improve people's quality of life.

**Figure 1.22: Main source of energy for lighting in South Sudan (%)**




Source: NHBS, 2009.

Since the country's independence, oil products consumed in South Sudan are imported via Mombasa Port through Kampala, as no products are traded between the Sudanese and South Sudanese capitals of Khartoum and Juba. The Ministry of Electricity and Dams, which was established after independence, has drafted a national electricity policy that prioritizes the use of domestic energy resources, mainly crude oil and hydropower, to supply power to industries and households.[86]

Short-term actions prioritized by the Government include implementing the required policy, institutional, legal and regulatory frameworks to create foundations that will enable the power sector to operate and attract investment from development partners and the private sector.

In 2013, the installed electricity generation capacity for the country was 30 MW, of which about 22 MW was operational. The total number of customers connected to the network was estimated at 22,000 and annual per capita electricity consumption stood at 1–3 kWh, which is the lowest rate compared with those of neighbouring countries. The average per capita electricity consumption in sub-Saharan Africa is around 80 kWh. The current demand for electricity is estimated at 300 MW, which is expected to rise to over 1,400 MW by 2030.[87]

The present power supply provided by South Sudan Electricity Corporation (SSEC) is limited to three state capitals (Juba, Malakal and Wau) and the town of Renk. The state capitals are supplied from diesel power generators (installed capacity of 23.8 MW), while Renk is supplied from Sudanese imports. Although South Sudan is interconnected with Sudan to import 40 MVA (about 32 MW) of power, imports are limited to roughly 3 MW (supplied to Renk), since the commercial agricultural development projects envisaged around Renk have not been completed and/or the network has not been extended to supply other major load centres.

Outside the SSEC supply area, the towns of Yei, Maridi and Kapoeta are supplied with electricity from diesel power plants funded by the United States Agency for International Development (USAID) that are run by local cooperatives. The installed capacities of the diesel generators in these towns are 1.2 MW, 0.8 MW and 0.8 MW, respectively, and the corresponding customer numbers are 1,100, 250 and 85. Since the cooperatives have to recover the full costs of the power supply, their tariffs are more than double the average SSEC tariffs in the towns, at around US$0.53/kWh compared with US$0.22/kWh. These high tariffs have become a barrier to connecting a significant number of household customers.[88]

## Future prospects for electricity

In recognition of the critical role that electricity plays in South Sudan's economy, the Government has adopted the South Sudan National Electricity Policy (SSNEP) Paper (May 2007), which outlines the framework for developing and operationalizing the electricity supply industry. The paper specifically defines the Government's priorities and development strategies for the sector, as well as relationships and scope for public-private partnerships. The policy provisions have been addressed in the draft Electricity Bill, which is be enacted soon.[89]

The proposed action plan for the electric power sector has six key components for the decade ahead:

- undertake a major programme to expand the country's generation capacity from the current 30 MW to around 580 MW by 2025 in order to meet the current and projected power demand
- expand the national transmission and distribution grid to link all 10 state capitals and to connect South Sudan with the grids of Ethiopia, Kenya and Uganda
- increase urban households' access to electricity from the current 5 per cent to 75 per cent by 2025

- complete a major restructuring of the SSEC and convert it into a fully fledged and financially sound state enterprise with the capacity to enter into take-or-pay contracts with private electric power suppliers
- strengthen the enabling environment for private investment in power generation and attract private investors to operate as independent power producers within South Sudan
- strengthen the existing regulatory arrangements for the electric power sector.

Even with this expansion programme, the average consumption of electricity in South Sudan is only expected to increase from a current low of 1–3 kWh to about 40 kWh per person per year by 2020. The reason that electricity consumption is expected to remain low is because of the high costs of extending the national grid to reach the large numbers of sparsely populated rural households and remote areas. The action plan therefore calls for a substantial expansion of off-grid arrangements to supply energy to these rural households.

The Government has identified a number of projects to boost generation capacity. In the medium term, the Ministry of Electricity and Dams is planning to:

- import 50–100 MW of power from Ethiopian hydropower plants
- develop the Fula Rapids 40 MW hydro project
- develop the Thar Jath 200–300 MW crude oil-fired power project
- develop the Sue 15 MW mini hydro project
- import power from Sudan by extending the transmission line from Renk to Malakal.

Long-term plans include developing the Bedden 540 MW hydro project and the Grand Fula 890 MW hydro project. To maximize the effectiveness of such generation projects, investments will also be needed in transmission and distribution projects.

## Oil products

Though there are plans to build refineries in the future, South Sudan imports fuel for its power generators and transport sector, which is likely to remain the situation for 3–5 years until its refineries are operational. South Sudan's current demand for heavy fuel oil (HFO), gas oil (diesel), gasoline (petrol) and kerosene (jet-A1) is around 25–30 million litres per month, which is roughly 4,000–5,000 barrels per day. The demand for oil products is expected to double in the next two years according to growth projections for industries such as roads, oil exploration and production, and agricultural schemes.[90]

South Sudan is investing in its own refineries and pipelines to avoid dependency on Sudan. The first South Sudanese refinery in Melut, in Upper Nile State, will aim to refine 10,000 barrels a day of the Thar blend and will mainly cater for domestic needs. The refinery was expected to be commissioned by the end of July 2013, but it has been delayed for various reasons, including political conflict, shutdowns of wells leading to reduced oil production and a lack of electricity. A second refinery in Bentiu, in Unity State, will refine the Nile blend, which is a better quality oil. The Cabinet has also approved a third refinery in Akon, which will refine the Thar blend, though it is yet to be launched.[91]

### Renewable energy and biomass

South Sudan has a large amount of renewable energy resources, which include biomass supplies, hydropower, solar, wind and agricultural residues. Biomass energy sources in South Sudan include woody biomass, charcoal and crop residues. Woody biomass (fuelwood) is the main source of energy for cooking, while charcoal is mostly used by urban population.

South Sudan has high potential for renewable energies to generate electricity through small-scale and large-scale hydropower, solar photovoltaic systems, wind, biomass, geothermal energy and waste-to-energy. However, due to the low access rate to modern energy services such as electricity and gas, most of the population relies on biomass fuels as their primary energy source for cooking and lighting, which is making households largely dependent on wood fuel.

The country has a solar potential of approximately 6.9 GJ/$m^2$/year. Solar power is ideal for rural electrification through the use of LEDs and it is estimated that around 45,000 households have some form of solar-derived energy service for lighting and powering household appliances.

There is also potential for wind energy, mostly in southern regions of the country, where the wind power density ranges from 285–380W/$m^2$, as well as geothermal energy thanks to the country's geographical location, although this potential has not yet been determined.

South Sudan also has huge hydropower potential, which is estimated at a total 4,860 MW, with an annual production of 24,132 GWh. Small hydro also offers a significant potential, as the country has more than 200 suitable sites for in-stream turbines. Small hydro capacity potential was estimated at 58.68 MW in 2009.

## Health profile

South Sudan's health profile is documented by the its 2010 Household Health Survey, which was carried out by the National Bureau of Statistics and the Ministry of Health. The survey reports that South Sudan has an under-five mortality rate of 108 deaths per 1,000 live births, an estimated child mortality rate of 32 deaths per 1,000 children aged 1 year, and an estimated infant mortality rate of 79 deaths per 1,000 live births.[92]

One in four children (28 per cent) under 5 years is moderately or severely underweight and 12 per cent are classified as severely underweight, which is due to a poor diet resulting from a lack of food.

The health sector is likely to be impacted negatively by climate change. For example, rising temperatures and erratic rainfall may lead to an increased spread of various diseases, such as malaria due to an increase in mosquito breeding habitats. However, most families in South Sudan have mosquito nets, with more than half (52 per cent) owning at least one mosquito net and 34 per cent specifically owning at least one long-lasting insecticidal net (LLIN). In order to reduce malaria-related negative health impacts among its people, the Government must implement measures aimed at eliminating malaria vectors during the rainy season, ensuring that such measures are not harmful to the environment.

Nearly 69 per cent of household members in South Sudan are using improved sources of drinking water. However, most households (89 per cent) do not treat their water, exposing a large percentage of the population to waterborne diseases. Due to changing rainfall patterns, more people will be impacted by droughts and flooding.

Since the environment, water, health and sanitation sectors are interconnected, any climate change-related impacts in the environment and water sectors will also affect the health and sanitation sectors. Actions targeting these sectors should therefore take a holistic approach to avoid mal-adaptation.

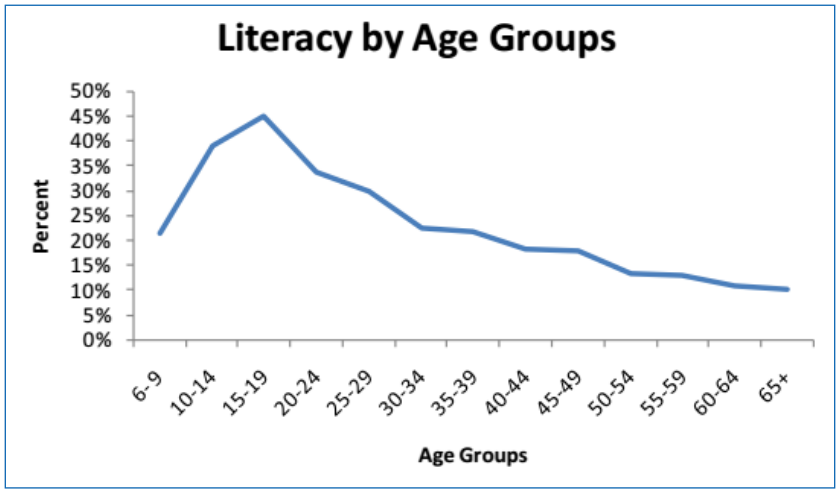
## Education profile

The South Sudanese education sector is not as developed as other neighbouring countries and faces several challenges. These include a shrinking national education budget, low teacher remuneration, an inadequate number of qualified teachers and other human resource limitations, inadequate physical facilities and school infrastructure, and gaps between policy formulation and implementation.

The Government developed the "General Education Strategic Plan (GESP) 2012–2017", which established a framework for developing the education sector for the period up to 2017. Through its strategic goals, the GESP laid the foundation of a dynamic education sector, responding to nation's needs.[93]

According to the 2009 National Baseline Household Survey (NBHS), only 27 per cent of adults aged 15 and older are literate (Figure 1.23).[94] However, the 15–24 age group has a higher literacy rate at 40 per cent and is the group that will drive the country's economy in terms of human capital in the future.

**Figure 1.23: Literacy by age groups**




Source: NBHS, 2009.

The GESP is founded on international education goals and principles, specifically, the universal human right to education. As such, the GESP embraces the goals and objectives of the Education for All (EFA) declaration, acknowledging that the 2015 was not feasible for the country because

of its inherent problems. South Sudan has set 2022 as its target for achieving the EFA objectives and the Sustainable Development Goals (SDGs). These educational rights are embedded in the Transitional Constitution, which guarantees free and compulsory education at the primary level.[95]

South Sudan has improved its school enrolment rate, which was at 72 per cent for primary schools in 2009.[96]

The future of South Sudan's education sector beyond 2015 is promising. The Ministry of Science and Technology, now the Ministry of General Education, is being restructured so that it can ensure quality education for national development in a more system-oriented manner. This will increase access to the education sector and will also improve its quality. The GESP 2012–2017 has set the following seven strategic goals to guide the education sector in achieving EFA:

- to increase access to general education and promote equity
- to improve the quality of general education
- to promote adult literacy to significantly reduce adult illiteracy in the country
- to build institutional and human capacity at the three levels of government to facilitate implementation of education reforms
- to increase funding for general education to support implementation of the Action Plan
- to promote partnership working among stakeholders throughout the country
- to monitor and evaluate the implementation of the GESP.[97]

## Institutional profile

South Sudan's long conflicts destroyed its little infrastructure and governance structures, which has made the new country one of the least developed countries in Africa and, as a result, highly vulnerable to climate change.[98] The fact that the country's population is dependent on climate-sensitive natural resources for livelihoods makes increases this vulnerability to climate change and the associated socioeconomic losses and damages. At present, South Sudan has limited institutional and technical capacity, and appropriate technologies and financial resources to support the implementation of interventions for adaptation to climate change.[99]

Article 41 of the Transitional Constitution highlights the importance of South Sudan's environment to the lives of its citizens, stating that "every person or community shall have the right to a clean and healthy environment" and "shall have the right to have the environment protected for the benefit of present and future generations, through appropriate legislative action and other measures that:

- prevent pollution and ecological degradation;
- promote conservation; and
- secure ecologically sustainable development and use of natural resources while promoting rational economic and social development so as to protect genetic stability and bio-diversity."[100]

Through the Ministry of Environment and Forestry, the Government of South Sudan has developed an Environment Policy Framework and Environmental Bill, which will regulate the exploitation of natural resources and all forms of socioeconomic development in the country. When operationalized, these will address the drivers of economic degradation and help mitigate climate change, while ushering the country towards environmentally sustainable development.[101]

To respond to the negative impacts of climate change, the Ministry of Environment and Forestry, along with other line ministries and civil society stakeholders, with the support of UNEP, developed a National Adaptation Programme of Actions (NAPA) in 2015, which forms the basis for the country's adaptation to new realities brought about by climate change.[102]

In the SSDP 2011–2013, protection of the environment during rapid economic, agricultural and urban growth was identified as a key policy area, which the Government has a responsibility to include in legislation and address when developing and implementing policies. The plan also emphasized that agencies would continue to take into account Environmental Impact Assessments (EIAs) that were relevant to their mandates and activities. Furthermore, it empowered the National Legislative Assembly to enact environmental policy and laws for sustainable natural resource management. In the SSDP 2011-2013, the Government of South Sudan committed to accede to and ratify applicable and beneficial multilateral environmental treaties, conventions and agreements. Lastly, the plan promoted inclusive participation, access to information and good governance in sustainable natural resources management and environmental protection.

## National policies and legislation

The Government has established some relevant legislation and policies to ensure the sustainability of South Sudan's natural resources. Relevant national policies and legislation that contain measures to mainstream climate change are shown in Table 1.6.

**Table 1.6: Key national policies and legislation**

| Policies | Measures to mainstream climate change |
|---|---|
| | SOCIOECONOMIC PROFILE<br><br>The SSDP has emphasized the importance of promoting private sector-led economic growth and delivering basic services in order to reduce poverty among the population. However, poverty can only be reduced if relative peace and security is maintained in the long term throughout South Sudan. The renewed conflict since 2013 is undermining development gains achieved following independence and is worsening the humanitarian situation. Without conflict resolution and a framework for peace and security, the country's longer-term development and prosperity are at risk.<br><br>In order to address poverty and improve the livelihoods of the South Sudanese, the SSDP aims to address the key nation-building, state-building and peacebuilding objectives of a new nation recovering from conflict and wishing to move onto a fast-track development path. Insecurity has been identified as major concern and has numerous causes, including political disagreements, clashes between communities over cattle and access to grazing land, breakdown of cultural values and norms, the availability of arms and the lack of economic opportunities. The consequences of insecurity include large numbers of displaced persons, continuing food insecurity, disruption to social services and increased poverty, all of which have a negative impact on the environment.<br><br>South Sudan's poverty and inequality exposes its people to climate risk hazards, leaving them vulnerable to climate change. According to the Intergovernmental Panel on Climate Change (IPCC), poverty and inequality are the most salient conditions that shape climate-related vulnerability. Poverty affects livelihood options and creates conditions where people have few assets to buffer extreme events. Climate change is an additional burden to the poor. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Transitional Constitution of the Republic of South Sudan, 2011** | The Transitional Constitution commits all levels of government in South Sudan to ensuring sustainable development as a way of protecting the environment for the benefit of both present and future generations, through reasonable legislative action and other measures.<br><br>Articles 41 (1), (2) and (3) give every person and community the right to a clean and healthy environment, stating that every individual is obligated to protect the environment for the benefit of present and future generations. It also states that every person has the right to have the environment protected through appropriate legislative action and other measures that:<br>• prevent pollution and ecological degradation<br>• promote conservation<br>• secure ecologically sustainable development and use of natural resources while promoting rational economic and social development so as to protect genetic stability and biodiversity.<br><br>Article 166 of the Transitional Constitution also recognizes and validates customary laws in the local government system, which therefore play a role in South Sudan's management and utilization of land, natural resources, ownership and management. |
| **Draft National Environment Policy, 2013** | The draft policy states that the country's wealth of biodiversity is the foundation for South Sudan's socioeconomic development. Most South Sudanese directly or indirectly depend on biological diversity for goods and services for their basic needs and development. South Sudan has a lot of biological resources that are of considerable economic, social and intrinsic value.<br><br>The goal of this policy is to ensure the protection, conservation and sustainable use of South Sudan's natural resources without compromising the tenets of intergenerational equity. This includes maintaining the balance between the environment and development needs through using natural resources in a sustainable manner, increasing public awareness of the importance of environmental protection and providing the basis for formulating biodiversity and ecosystem protection and management policies, laws and guidelines.<br><br>On conserving biological diversity, the policy calls for the development and implementation of a national strategy and biodiversity action plan. It also urges the country to: |

| Policies | Measures to mainstream climate change |
|---|---|
| | • promote coordination, cooperation and participation of all relevant stakeholders in conservation and sustainable use of biodiversity across all sectors of the economy<br>• encourage a green economy initiative to move towards a low-carbon and resource-efficient economy, as well as promote carbon sequestration<br>• promote national integrated approaches for conservation and sustainable use of biodiversity and protection of aquatic ecosystems and life<br>• implement the multilateral environmental agreements (MEAs) related to biodiversity<br>• support communication, education and public awareness programmes on the importance and benefits of conserving biodiversity to citizens and their livelihoods<br>• share the benefits of biodiversity conservation and sustainable use of resources with local communities and stakeholders<br>• discourage the introduction of invasive and alien species and properly manage and control such species where present to avoid adverse impacts on local environments<br>• promote ex situ conservation of biodiversity<br>• encourage conservation and cultivation of herbal, medicinal and economic plants.<br><br>The policy also provides for the establishment of an autonomous South Sudan National Environmental Management Authority (NEMA), which will monitor all public institutions, private companies and individuals to ensure their compliance with the stipulated environmental laws and regulations.<br><br>The policy calls for the development of a national strategy and mechanisms for climate change adaptation and mitigation, as well as a national climate change policy. It encourages the formulation and enactment of laws that maintain and preserve ecological functions, forest integrity, biological diversity and the conservation of water and soil resources of fragile ecosystems, while promoting passive and non-invasive forest management activities as alternative sources for income generation (livelihood improvement), such as honey, gum and silk harvesting. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Environmental Protection Bill, 2013** | The bill aims to protect South Sudan's environment and promote ecologically sustainable development that improves quality of life. It grants the right to a decent environment to every person and the concomitant right to bring about action to enforce that right if it is threatened as a result of an activity or an omission.<br><br>The bill empowers the Ministry of Environment and Forestry to supervise and coordinate all matters relating to the environment and to act as the lead government institution responsible for implementing all policies rated to the environment, including biodiversity. This includes taking stock of the country's natural resources and their utilization and conservation, examining land-use patterns to determine their impact on the quality and quantity of natural resources and carrying out surveys that will assist in the proper management and conservation of the environment.<br><br>The bill also provides for the preparation of a national environmental action plan and the designation of Environmentally Sensitive Areas (ESAs), which protect actual or prospective habitats of any environmentally sensitive species that needs protecting under the Government's international obligations as per the MEAs.<br><br>Section 66 of the bill provides for freedom to access environmental information, which will facilitate education and public awareness on biodiversity. The bill is therefore key to addressing pollution prevention, control and waste management, which is currently a major source of biodiversity loss and ecosystem degradation, particularly by the oil and extractive industries. |
| **Wildlife Conservation and Protected Areas Bill, 2015** | The bill aims to regulate wildlife conservation, the establishment and management of protected areas and the sustainable management and conservation of South Sudan's natural heritage and wildlife for the benefit of its citizens. It also allows local communities around protected areas to manage wildlife in collaboration with the South Sudan Wildlife Service (SSWS) and permits other organizations to manage any protected area on behalf of the Government. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Draft Wildlife Bill, 2013** | The bill aims to establish an autonomous SSWS as proposed by the Transitional Constitution. The SSWS will be responsible for coordinating with other relevant authorities on all issues affecting wildlife management, including issues of security, infrastructure, private investment and land-use planning. The SSWS will coordinate and cooperate with local communities and will facilitate their participation in wildlife management in their areas, including overseeing the appropriate allocation of rights and responsibilities.<br><br>The draft Wildlife Bill also increases the number of wildlife offences, as well as explicitly providing for the crime of wildlife trafficking. These include illegal hunting and the capture and trafficking of animals on the protected list. The bill also provides for the protection of wetlands to ensure these are better managed and protected. Furthermore, the bill outlaws the allocation of tourism concession agreements for protected areas that have not developed general management plans. |
| **Forest Policy, 2014** | The policy lays down a clear institutional and governance framework for forests at all levels across the country. It recognizes the importance of forests for commerce, communities and conservation and sets forth a series of implementation and institutional measures. It also introduces strict measures to protect the permanent forest estate and prevent changes in forest boundaries without legislative approval. The policy provides clarity on ownership and management responsibilities for forest reserves throughout South Sudan, for example, the national government is to take ownership of all previous Central Forest Reserves (CFRs) and ensure their effective management and protection as national forest reserves (NFRs). In addition, the Ministry of Environment and Forestry is to delineate other forests as NFRs in order to achieve the country's development goal of 20 per cent of land area being covered by forests.<br><br>The policy provides for the establishment of the South Sudan Forest Commission (SSFC), whose primary role is to provide regulations and operational standards for a vibrant forest sector, as well as to carry out administration and implementation of NFRs. The primary role of state governments will be to implement forestry programmes and plans on State Forest Reserves (SFRs), though they may also assist in the administration of forests managed by sub-state authorities and private individuals. In addition, the SSFC will enter into partnerships with state governments, communities and the private sector to implement national and state forest plans.<br><br>The policy also strengthens provisions and guiding principles on forest product regulation, utilization and marketing, and gives consideration to the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) as a new opportunity for financing forest management and strengthening both local forest benefits and resources for conservation. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Forest Bill, 2009** | The Forest Bill aims to operationalize the Forest Policy, covering all matters concerned with forests, woodlands and forest reserves in South Sudan. The bill provides for a governance structure for all forests in the country, national sustainable forest management standards, certification systems and schemes and private and voluntary standards, as well as procedures and decision-making processes and complaint and appeal mechanisms.<br><br>The bill establishes the SSFC as business-oriented, semi-autonomous body. The SSFC will have regulatory and administrative responsibilities related to the management of forests on public and private lands. It also makes provisions for effective forest protection, penalties for illegal forest activities and institutions needed for the sustainable management of forests. Furthermore, the bill permits the arming of the SSFC's disciplined force to carry out its functions.<br><br>The bill also establishes a National Forest Fund (NFF), which is to be managed semi- autonomously and used to support forestry research and education and protection of forest biodiversity and heritage. It devolves forest management by making provisions for structured community participation in forest associations and for effective protection by armed forest guards. The enactment of the bill will ensure that the existing shortcomings in the current forest regime are addressed and more significantly will firmly establish the SSFC. Finally, to address the question of locus standi, the bill provides for any citizen or resident of South Sudan to petition the court for remedy if the bill's provisions are being violated as a result of government agencies failing to undertake biodiversity and ecosystems conservation actions. |
| **Water Bill, 2013** | The bill aims to provide mechanisms that protect water sources from pollution, erosion and any other adverse effects by creating protected zones within a catchment draining either into or above water facilities that are part of a water supply, or any catchment, lake, reservoir, aquifer, wetland, spring or any other source of water (section 34). The bill aims to develop procedures for prioritizing the allocation of water resources for different social, economic and environmental uses, efficiency, system reliability and environmental sustainability principles. It also aims to conserve available water resources, manage water quality and prevent pollution of groundwater and surface water, as well as manage floods and droughts, mitigate water-related disasters and establish appropriate management structures, including mechanisms for intersectoral coordination and stakeholder participation. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Petroleum Act, 2012** | The oil industry and its associated activities in South Sudan are a major concern, due to their negative impact on the environment, natural resources, biodiversity and local community livelihoods. Oil exploration is carried out mainly in the central floodplains of Jonglei, Lakes and Upper Nile, which are also endowed with vast natural resources, including forests, livestock, wildlife and aquatic resources.<br><br>The Petroleum Act provides for Social and Environmental Impact Assessments (SEIA) to be undertaken by the oil contractor or licensee in compliance with international standards to determine any present environmental and social damage and establish the costs of repair and compensation. It obligates the sector to take necessary measures to ensure that their activities do not negatively harm the environment. |
| **Mining Act, 2012** | The act provides a framework for the management of the mining sector, in accordance with international standards, including licensing, environmental protection guidelines and the use of technology, to ensure as much mineral resources as possible are recovered from the ground. It also provides for community development agreements for mining licences and environmental and social provisions. |
| **Agricultural Sector Policy Framework, 2012–2017** | The Agricultural Sector Policy Framework for 2012–2017 aims to strengthen measures to mitigate the adverse impacts of climate change in the medium and long-term.<br><br>The Ministry of Agriculture and Food Security, in collaboration with the Ministry of Environment and Forestry, is developing a NAPA to identify priority activities that respond to South Sudan's immediate climate change adaptation needs and to formulate a national climate change strategy. The Ministry of Agriculture and Food Security has also outlined a green agriculture policy (adopting agricultural practices that minimize environmental pollution and promote agroforestry practices) and has mainstreamed gender in agricultural activities.<br><br>The framework also provides for the protection of plants, seed management and the development of a plant genetic resources conservation programme and a biosafety framework. Biosafety regulations seek to reduce and eliminate the potential risks resulting from genetically modified organisms (GMOs). The Ministry of Agriculture and Food Security will use these measures to ensure the conservation and protection of South Sudan's genetic resources from GMOs.<br><br>The Ministry of Agriculture and Food Security is mandated by the policy framework to develop a sustainable programme for the conservation and judicious utilization of plant genetic resources to enhance agricultural development. This will include promoting in situ and community conservation and management of plant genetic resources, as well as creating awareness on plant genetic resources. It will also establish a plant genetic resource centre for indigenous plants. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Ministry of Animal Resources and Fisheries Policy Framework and Strategic Plan, 2012–2016** | The policy and framework aim to promote best animal husbandry practices to reduce environmental degradation, as well as the sustainable management of rangelands and pastures through integrated range management practices. Some of the policy's strategic objectives include improving the utilization and conservation of rangelands and water resources by mapping livestock migratory routes and grazing areas, and establishing water catchments. Other activities include developing mechanisms for drought preparedness and undertaking efforts to institutionalize community involvement in natural resources management. |
| **Draft Policy Framework for the Minerals and Mining Sector, 2013** | The policy and framework provide for the management of South Sudan's fishery resources so as to maximize production, avoid overfishing and prevent the destruction of wetlands, while promoting their conservation. One specific objective of the policy is to maintain healthy environments and ecosystems by adopting measures to prevent environmental damage to aquatic systems through pollution and environmental degradation, ensuring that compulsory SEIA are undertaken for all developments that affect fisheries, including large-scale aquaculture developments, and to observe all international treaties and protocols on the environment and biodiversity. |
| **Mining Policy, 2012** | The Mining Policy recognizes the need to ensure that mining operations are conducted in a socially and environmentally responsible manner by minimizing any harmful impacts and that the interests of local communities are fully considered and protected. |
| **Food Security Policy, 2012** | South Sudan's Food Security Policy recognizes natural disasters as threats to food security, including droughts, floods, pests and diseases, attributing the cause of these disasters to climate change. It also points out that poor land management and insufficient application of fertilizers exacerbate these disasters. The policy counts the lack of technologies for food preparation, preservation and storage as one of the main problems.<br><br>To address these climate change-related challenges, the policy statement on climate change is aimed at enhancing policy measures that are meant to mitigate the adverse effects of climate change in the medium and long-term.<br><br>Some of the main objectives to overcome climate change adverse impacts include:<br>• understanding the likely impacts of climate change on the resilience of key crops, agroforestry tree species and livestock in the different agroecological zones<br>• enhancing the adaptive capacity of communities in drought and flood-prone areas<br>• supporting measures aimed at protecting vulnerable communities against climate change-related diseases and pest outbreaks. |

| Policies | Measures to mainstream climate change |
|---|---|
| | The policy proposes the following strategies for implementation:<br>• collaborate with the Ministry of Environment and Forestry to identify priority activities that respond to their immediate needs to adapt to climate change<br>• support and promote the development of intensive and diversified crops adapted to extreme climate risks<br>• map and intensify research on crops and livestock most adapted to changing climatic conditions in different agroecological zones<br>• advocate for strengthening of agrometeorological services<br>• promote land conservation and its proper utilization based on applicable instruments such as Environmental Impact Assessments (EIAs), audits and land-use plans<br>• develop appropriate technology and extension methods aimed at improving and maintaining soil fertility<br>• prevent water, soil and air pollution from agrochemicals. |
| **Draft Land Policy, 2011** | Legal and policy frameworks on land in South Sudan include the 2009 Land Act, the 2011 Transitional Constitution and the draft Land Policy. The Land Act and the Transitional Constitution stipulate that the people of South Sudan own the land, while the Government regulates its usage. However, subterranean natural resources should be owned, regulated and managed by the Government of South Sudan. The Land Act divides the land into private, public and communal lands. The laws also require the Government to enter into consultation with communities if land is needed for investment before making and signing an agreement with a land-owning community on behalf of a company that wants the land. The proposed Land Policy's goal is to promote land tenure security, listing the benefits of this as peacebuilding, economic development and national unity. |
| **Energy Policy, 2012** | Mitigation measures in the energy sector focus on designing energy policies that reduce the GHG emissions and provide long-term resilience as adaptation measures do not usually provide long-term solutions. Most mitigation measures attempt to advance renewable energy technologies as alternatives to fossil fuels. |
| **National Electricity Sector Policy** | The National Electricity Sector Policy sets the basis for selecting energy technology options and prioritization on least economic cost and highest economic benefit. The policy does not mention climate change and does not contain any mechanisms for mitigation and adaptation, with adaptation mechanisms in this sense referring to those that enable energy infrastructure and people to remain resilient to climate change induced floods and extreme weather events, such as storms. |
| **International Environmental Treaties and Conventions** | South Sudan has ratified and is implementing several international environmental conventions. The country has acceded to the United Nations Framework Convention on Climate Change (UNFCCC), the United Nations Convention on Biodiversity (CBD) and the United Nations Convention to Combat Desertification (UNCCD). However, the country has not yet ratified the Kyoto Protocol to the UNFCCC. |

| Policies | Measures to mainstream climate change |
|---|---|
| **Comprehensive Agricultural Master Plan, 2015–2040** | This plan's framework aims to end hunger, achieve food security, improve nutrition and promote sustainable agriculture in terms of crop husbandry, animal husbandry, forestry management, fisheries development, water resources, irrigation management and electricity and dams. Each subsector has goals, objectives, strategies and activities to be implemented in phases, starting with short, medium and long-term activities to be carried out within the specified period. |

## Lead government institutions for climate change

Table 1.7 lists the lead institutions and their responsibilities for climate change at the time of preparing this INC.

**Table 1.7: Lead institutions and responsibilities with regard to climate change**

| Ministry/agency | Description |
|---|---|
| **Ministry of Environment and Forestry** | The Ministry of Environment and Forestry is the lead institution for environment, forestry and biodiversity protection in South Sudan. It is tasked with developing a policy and regulatory framework on the environment and forestry. The Ministry has established various directorates, whose main functions are to ensure the sustainable management of South Sudan's environment and forests.<br><br>The Directorate of Climate Change and Meteorology develops and implements programmes to address climate change issues and coordinates the implementation of South Sudan's obligations under the UNFCCC.<br><br>The National Environment Policy in place stresses that the institutional framework for implementation should reflect the country's federal character and establishes environmental governance institutions at the national, state and local levels of government. The institutional structures and mandates for implementing the policy comprise the national government, state governments and local governments, which includes the county, payam, boma and town councils in the states. These structures are all assigned roles and responsibilities for forestry, biodiversity and ecosystem protection and management. Importantly, the National Environment Policy calls for strengthening of the local community's role in environmental management. Community responsibilities include establishing community-based organizations (CBOs), which are expected to play a pivotal role in advocating for the sustainable management of biodiversity and ecosystems through mobilizing and sensitizing local people, supporting local group participation in biodiversity management, and ensuring that the concerns of the underprivileged are integrated into national development plans. |

| Ministry/agency | Description |
|---|---|
| | The Directorate of Forestry is responsible for managing forests and protecting the country's forestry resources and sanctuaries for forestry biodiversity, through establishing a system that delineates various types of natural woody vegetation as required for biodiversity conservation.<br><br>As the lead agency for the environment, the Ministry is expected to monitor and ensure compliance with country's environmental laws, including:<br>• the Investment Promotion Act of 2009, which provides for the promotion and facilitation of investment in the country<br>• the proposed Environment Act.<br>• The Ministry is also responsible for ensuring the establishment of the proposed NEMA. |
| **Ministry of Wildlife Conservation and Tourism** | The Ministry's mandate is to manage protected areas, which are areas of land or water specifically protected to maintain their biological diversity and natural and associated cultural resources. These areas are managed through legal or other effective means, including national parks and game reserves. The wildlife and forestry departments manage and oversee most of the country's protected area system.<br><br>The Ministry of Wildlife Conservation and Tourism is the lead agency for protecting, conserving and managing wildlife resources in South Sudan through the Wildlife Service. The service's core mandate under the Transitional Constitution is to protect the country's wildlife and preserve and conserve the natural flora and fauna habitats. All protected areas and the wild animals therein remain the property of Government on behalf of the people. |
| **South Sudan Wildlife Service** | The Wildlife Service's mandate under the Wildlife Service Act of 2011 is to:<br>• conserve, manage and administer national parks, wildlife reserves or other protected areas in accordance with the law and in a manner that is consistent with the agricultural and pastoral activities of nearby settled communities<br>• develop, in collaboration with other competent authorities, tourism based on wildlife which contributes to social and economic welfare of South Sudan and the communities nearby the national parks or game reserves<br>• combat illegal hunting, trade in protected animals and trophies, by detecting, apprehending and prosecuting illegal hunters, poachers or illicit traders of animal trophies<br>• conduct research and monitor wildlife resources with a view to their optimization, preservation, conservation, management and protection<br>• promote education and the dissemination of information about wildlife resources in South Sudan<br>• undertake any administrative and technical tasks to ensure that the SSWS is sustainably managed<br>• perform any other function or duty assigned by law. |

| Ministry/agency | Description |
|---|---|
| **Ministry of Agriculture and Food Security** | The Ministry is responsible for increasing agricultural productivity in order to improve food security, contribute to economic growth and environmental sustainability, and facilitate and encourage equitable and sustainable development towards improved livelihood through awareness-raising, mobilization, capacity-building and the direct involvement of rural communities in their own development.<br><br>South Sudan has a wealth of diverse genetic resources that are important for maintaining an efficient and sustainable farming industry. These allow for the development of varieties and breeds to cope with new demand and climate changes. The Ministry observes that genetic diversity has been maintained in South Sudan through the long tradition of conserving seeds.<br><br>The Ministry is also mandated to develop and implement policies, objectives and strategies to develop forestry within South Sudan's agricultural sector. |
| **Ministry for Electricity and Dams** | The mandate of the Ministry for Electricity and Dams is electricity generation. Electricity is generated from both renewable and non-renewable sources. The Ministry has developed an energy policy to guide its work, although the Energy Act has not been published, as the bill is yet to be approved by parliament.<br><br>The South Sudan Electricity Corporation (SSEC) as an implementing body of the Ministry of Electricity and Dams that has been mandated to execute the Ministry's policies, strategies and plans for availability, accessibility and affordability of electricity by customers. |
| **Ministry of Water Resources and Irrigation** | South Sudan has abundant water resource which can be used for electricity generation, irrigation and household consumption. The Ministry of Water Resources and Irrigation manages water resources according to the following principles:<br>• water is commonly owned by all riparian people<br>• water is an economic and social good<br>• the criteria for optimal allocation are to include social equity, economic efficiency, system reliability and environmental sustainability<br>• water resources planning and development is to be undertaken at the lowest appropriate administrative level with the active participation of water users and stakeholders.<br><br>Effective water resources management requires an integrated approach. The relevant ministry policy documents that impact on biodiversity and ecosystems include:<br>• the 2007 Water Policy<br>• the 2013 Water Bill<br>• the 2011 Water, Sanitation and Hygiene (WASH) Sector Strategic Framework.<br><br>The WASH Sector Strategic Framework outlines optimized water allocation measures on an equitable and sustainable basis. One of the identified strategies is monitoring the social and environmental impacts of water resources management and also generating and adapting complementary knowledge. This is to be done within the environmental and social management framework. |

| Ministry/agency | Description |
|---|---|
| | The Ministry is also developing the Irrigation Development Master Plan and Water Resources Utilization and Development Master Plan, which when approved, will assist in guiding the Ministry to carry out its mandate.<br><br>The Irrigation Development Master Plan, which is a subset of the Comprehensive Agricultural Development Master Plan, has proposed and classified irrigation schemes into three categories: large, medium and small. Each scheme proposed also varies due to their differing climatic zones and will therefore grow crops which are suited to each specific agroecological zone. Emergency schemes have also been proposed for around Juba and other urban areas. |
| **Ministry of Livestock and Fisheries** | South Sudan has a large animal population which support the livelihoods of the numerous households. Most of the population practice pastoralism, with minimal animal production on a commercial scale. As a result of the huge animal numbers and changing climate, overgrazing, recurrent droughts and depletion of forest cover are decimating the country's rangelands and pastureland. Climate change will inevitably continue to negatively impact the sector in the future and citizens must therefore learn to mitigate, cope with and adapt to its effects.<br><br>The Ministry's Directorate of Veterinary Services is responsible for drafting and enforcing laws governing the control and eradication of livestock diseases and the safety of food of animal origin. This includes safeguarding public health by tracking animal diseases transmissible to humans as well as controlling domestic animal diseases.<br><br>The Ministry has developed a policy framework and strategic plan for 2012–2016 to guide its operation.<br><br>As regards fisheries, the Ministry has developed the Fisheries Policy for South Sudan 2012–2016, which provides for a framework for managing the country's fishery resources. |
| **Ministry of Petroleum** | The Ministry's main mandate is oil exploration, which is largely carried out in the central floodplains of Jonglei, Lakes and Upper Nile. These states are also home to vast natural resources, including forests, livestock, wildlife and aquatic resources. If not well managed, oil exploration can seriously impact the environment and climate at large. Extractive companies clear vast amounts of land for exploration, without providing adequate mitigation measures to compensate for the destruction.<br><br>The Ministry has developed the Petroleum Bill to guide the sector. |

Source: South Sudan's Fifth National Report to the Convention on Biological Diversity.

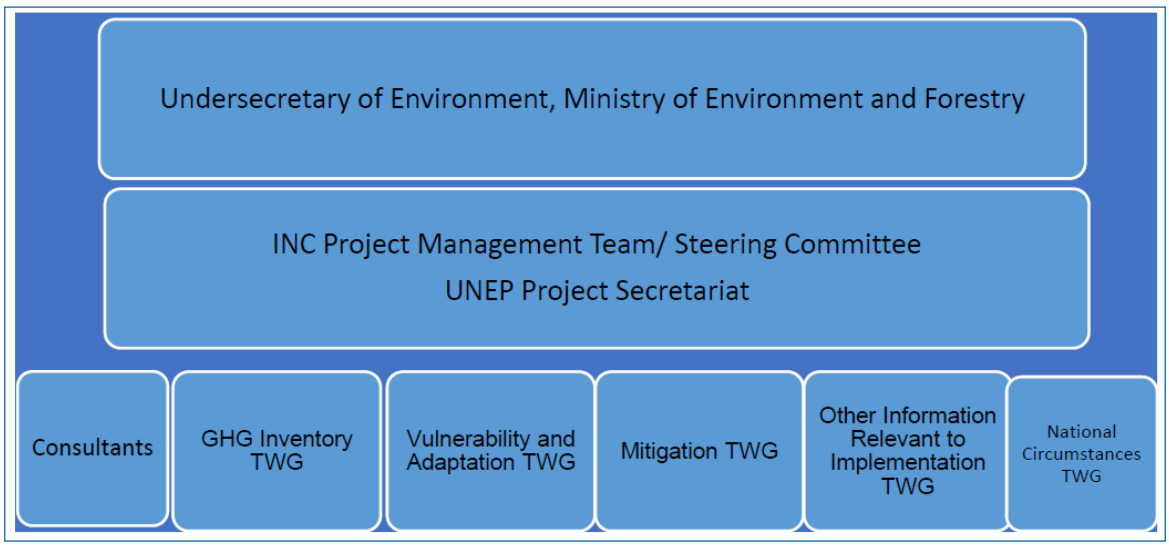
The work carried out for this Initial National Communication (INC) has built on the work completed under the NAPA, National Report to the CBD, medium-term South Sudan Development Plan (SSDP) 2011–2013and South Sudan's Vision 2040.

## South Sudan's ongoing responses to climate change

The Government of South Sudan is implementing many interventions that have a direct and/or indirect relevance to climate change adaptation and mitigation. These measures aim to help the country meet its own development agenda while improving the welfare of its citizens, particularly in terms of:

- **Agriculture**: South Sudan has developed a Comprehensive Agricultural Development Master Plan, which aims to guide how agriculture is carried out. The plan not only targets agriculture, but also covers fisheries, livestock, irrigation, forestry, energy and other related sectors. The plan is a holistic, strategic framework for eradicating poverty through multi-sectoral interventions that will enable people to improve their livelihoods gradually and sustainably. It is an outcome-focused set of principles upon which sectoral and intersectoral policies and investment plans can be developed at both the national and state government levels.
- **Livestock and pastoralism**: South Sudan is helping farmers to adopt modern livestock farming practices and is also raising their awareness about optimal livestock numbers, as well as practices that expose them to livestock diseases and cattle raiding, which are being discouraged. Early warning systems for droughts and floods and vaccination campaigns are also being planned under the Comprehensive Agricultural Development Master Plan.
- **Water resources**: The Ministry of Water Resources and Irrigation is developing an Irrigation Development Master Plan and Water Resources Utilization and Development Master Plan to guide water use. Irrigation schemes have been zoned and planned and appropriate crop-growing zones have been delineated.
- **Electricity**: The Ministry of Energy and Dams has identified hydroelectric potential and proposed dams and their respective capacities. The Government and investors have the opportunity to form partnerships to invest in these dams. Environmental and social impact guidelines for energy projects have been developed to ensure energy projects are developed sustainably.
- **Forestry**: Guidelines on utilizing forest resources and the Forest Bill (2014) have been developed. Households are being encouraged to use efficient cookstoves and need to reduce forest fires and deforestation activities. While charcoal burning is not illegal, exports of the resource are discouraged to reduce its demand. South Sudan has also developed a REDD+ preparedness plan to help protect its forest resources.

**Figure 1.24: Structure for INC preparation**



The Project Management Team (PMT) comprises a Project Coordinator and Project Steering Committee chaired by the Undersecretary of the Ministry of Environment and Forestry. The PMT works in collaboration with the UNEP Project Secretariat. The consultants are responsible for compiling the relevant data for the chapters in coordination with the thematic working groups (TWGs), which reviewed and approved the consultants' work. The five TWGs involved key sector stakeholders and experts from other government ministries and the University of Juba. The TWGs also acted as advisory groups, helping consultants to access information, as well as providing inputs and carrying out reviews and analyses of their work and results.

## Conclusion

National Communications (NCs) are important for predicting, monitoring and evaluating a Party's contribution to attaining the objective of the UNFCCC and also for reducing the adverse of climate change on its people and economy. This chapter has provided a description of national and regional development priorities, objectives and circumstances, on the basis of which South Sudan will address climate change and its adverse effects. These are important as they determine South Sudan's ability to mitigate and adapt to climate change, while at the same time achieving the country's development objectives.

The information also indicates any associated climate change impacts, vulnerabilities and risks and includes brief reviews of a sector's contribution to GHG emissions if significant and where data are available. Lastly, the chapter details South Sudan's environmental and climate change governance.

The preparation of this chapter on South Sudan's national circumstances revealed weaknesses related to vulnerability and adaptation assessment. The collection and analysis of data must therefore occur on an ongoing basis to support the preparation of future NCs. In is also necessary to review South Sudan's climate change governance structure and to strengthen the capacity of institutions directly involved in collecting such data, as well as those developing climate change strategies. In order to improve the preparation of its NCs as an enabling activity for accessing climate funding from the Global Environment Facility (GEF) and other international sources, South Sudan must build its capacity, which is currently a serious issue for the country.

# CHAPTER 2 SOUTH SUDAN NATIONAL GREENHOUSE GAS INVENTORY

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## Introduction

In accordance with article 4, paragraph 1 (a) of the UNFCCC, all Parties to the Convention are requested to "Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties". National inventories are to be communicated to the COP through its secretariat.

In 2003, Sudan submitted its INC which included the South Sudan region, as it had not yet gained independence. However, since then, no inventory for South Sudan has been separately prepared or submitted. Non-Annex I Parties (developing countries) are required to submit their INC within three years of entering the Convention or when they have financial resources available in accordance with article 4, paragraph 3. The sixteenth session of the Conference of the Parties (COP 16) decided that non-Annex I Parties should submit their NCs to the COP every four years or in accordance with any further decisions on this frequency to be adopted in the future. As an LDC, South Sudan is permitted to estimate its national GHG inventory years at its discretion.

This inventory reports GHG emissions and removals by sinks for the base year 2015, as well as for the years between 2011 and 2015. This represents the time period since independence and the years for which there are recent data available to estimate emissions per sector. Some inventory data are also reported for 2016, though emissions have not been estimated for this year as there were insufficient data available to do so accurately.

This report provides a description of the appropriate methodologies used and an analysis and interpretation of the data generated on anthropogenic GHG emissions and sinks per sector for South Sudan. The GHG inventory was conducted for each of the following sectors: energy, industrial processes, agriculture, land use, land-use change and forestry (LULUCF) and waste. No information on solvent and other product use has been provided in this report due to the insufficient data available and the very low contribution of this sector to overall GHG emissions. The GHGs included are: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$) and partial hydrofluorocarbons (HFCs) not covered by the Montreal Protocol. Indirect GHGs, including non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), nitrogen oxides (NOx) and sulphur dioxide ($SO_2$) are also reported, as these have an important influence on chemical reactions in the atmosphere.

The "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" (Volumes 1, 2 and 3) and the "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" were used as the primary basis for undertaking the necessary calculations on GHG emissions and removals. The use of these IPCC guidelines for all years fulfils the objective of the UNFCCC COP to use comparable methodologies. The "2006 IPCC Guidelines for National Greenhouse Gas Inventories" was also drawn upon for instances in which the emission estimates could be significantly improved. In accordance with the guidelines, $CO_2$ emissions from international bunkers and burning of biomass are not included in the national totals, but are reported separately as memo items in the inventory.

Emissions were calculated using the UNFCCC Greenhouse Gas Inventory Software for non-Annex I Parties (NAIIS) (version 1.3.2). For verification and transparency purposes, the completed relevant IPCC worksheets for all sectors and the summary report sheets used to prepare South Sudan's inventory report have been provided in the appendices. Complete documentation of methods, activity data, emission factors and references of all data sources are provided in individual sector reports. This level of documentation helps ensure the transparency of this inventory and will support the preparation of future inventories.

## Summary of greenhouse gas emissions and removals

Overall GHG emissions in South Sudan increased slightly between 2012 and 2015. In three years, total emissions are 5 per cent higher, which is equivalent to an annual increase of 1.8 per cent. Despite an overall decline in domestic fuel consumption, increased activity in the oil and gas sector is driving the increase in emissions, with overall production and emissions from the sector rising by more than 400 per cent in the same time frame.

This section provides an overall summary of South Sudan's GHG emissions between 2012 and 2015. GHG emissions are expressed as carbon dioxide equivalent ($CO_2e$) by IPCC sectors. $CO_2e$ is calculated based on global warming potentials (GWP) from the "IPCC Fourth Assessment Report", as indicated in Table 2.1.

**Table 2.1: Global warming potentials of GHGs identified in South Sudan**

| Gas | 100-year GWP |
|---|---|
| Carbon dioxide ($CO_2$) | 1 |
| Methane ($CH_4$) | 21 |
| Nitrous oxide ($N_2O$) | 310 |
| HFC-134a | 1,300 |
| HFC-404a | 3,260 |
| HFC-407c | 1,610 |
| HFC-410a | 1,725 |

Note: Since the publication of the "Revised 1996 IPCC Guidelines", new GWP have been estimated based on improved research. However, national inventories of non-Annex I Parties reported to the UNFCCC are currently still prepared using the GWP indicated above.

Total $CO_2e$ emissions for 2015 are estimated to be 33.5 megatons of carbon dioxide equivalent ($MtCO_2e$), excluding LULUCF contributions. This is an increase of 2.0 $MtCO_2e$ (6 per cent) from 2012 emissions. With LULUCF sector $CO_2e$ emissions, the total rises by 2.0 $MtCO_2e$ (2 per cent) to 36.3 $MtCO_2e$ for 2015.

Figures 2.1 and 2.2 indicate the relative contribution of the four main GHGs ($CO_2$, $CH_4$, $N_2O$ and HFCs) to the total emissions for each of the inventory years (2012, 2013, 2014 and 2015).

**Figure 2.1:** Total GHG emissions, excluding LULUCF (GgCO2e), 2012–2015

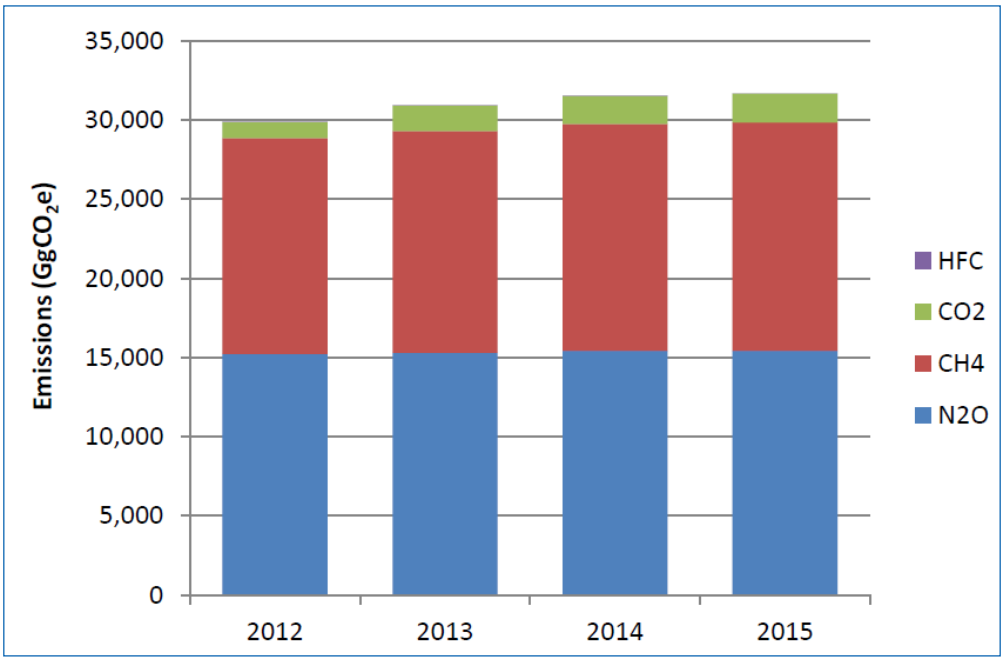
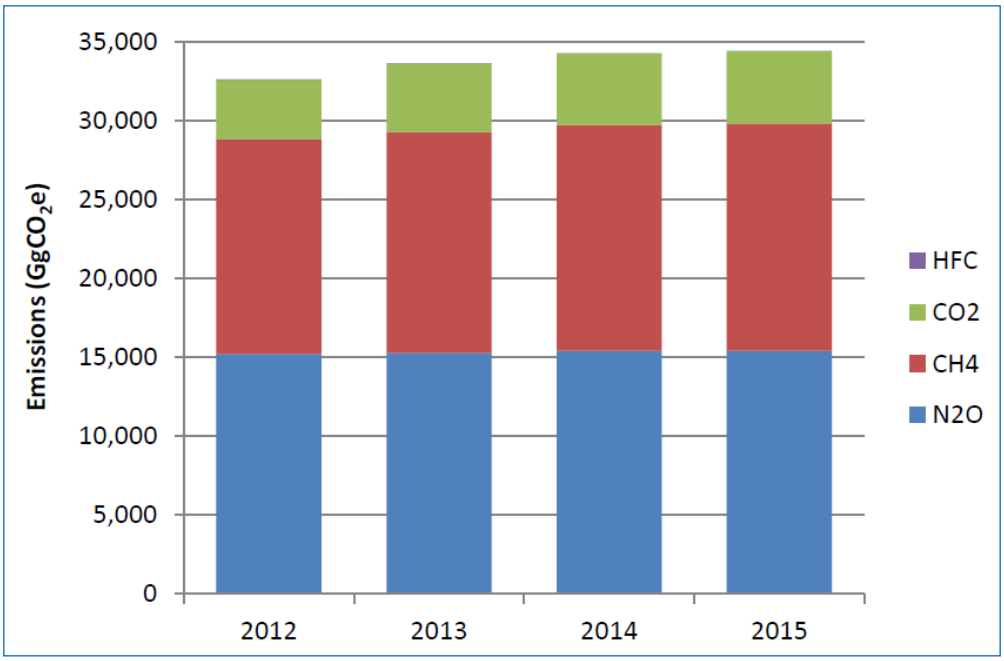



**Figure 2.2:** Total GHG emissions, including LULUCF (GgCO2e), 2012–2015




Trends in total $CO_2e$ emissions for each IPCC category, excluding the LULUCF sector, for the complete period (2012–2015) are shown in Figure 2.3. Figure 2.4 identifies the emissions profile with the LULUCF sector included.

Figure 2.3: GHG emissions, excluding LULUCF (MtCO2e), 2012–2015

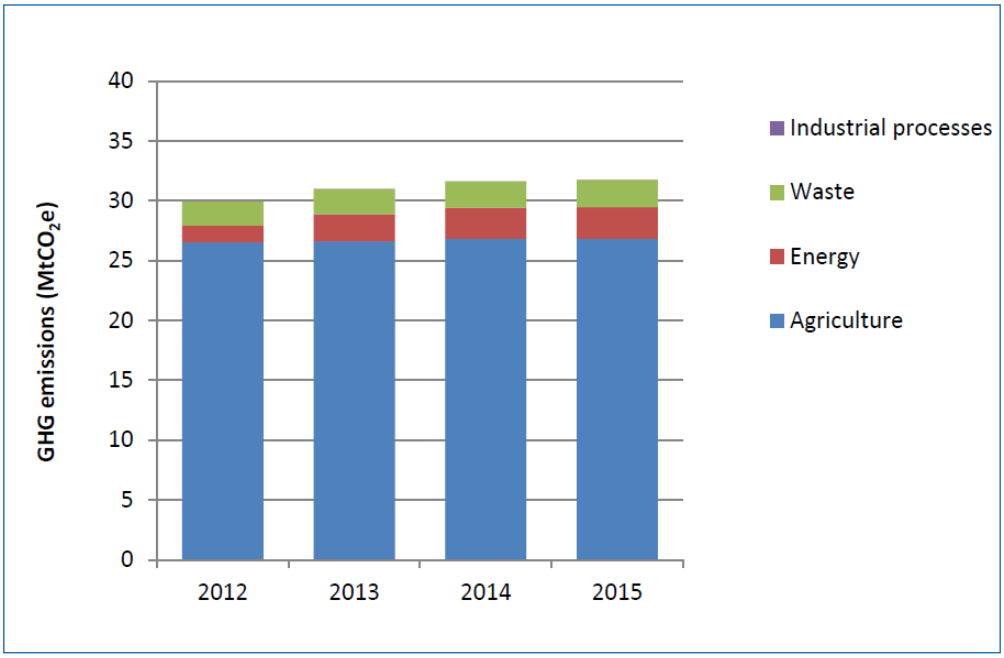
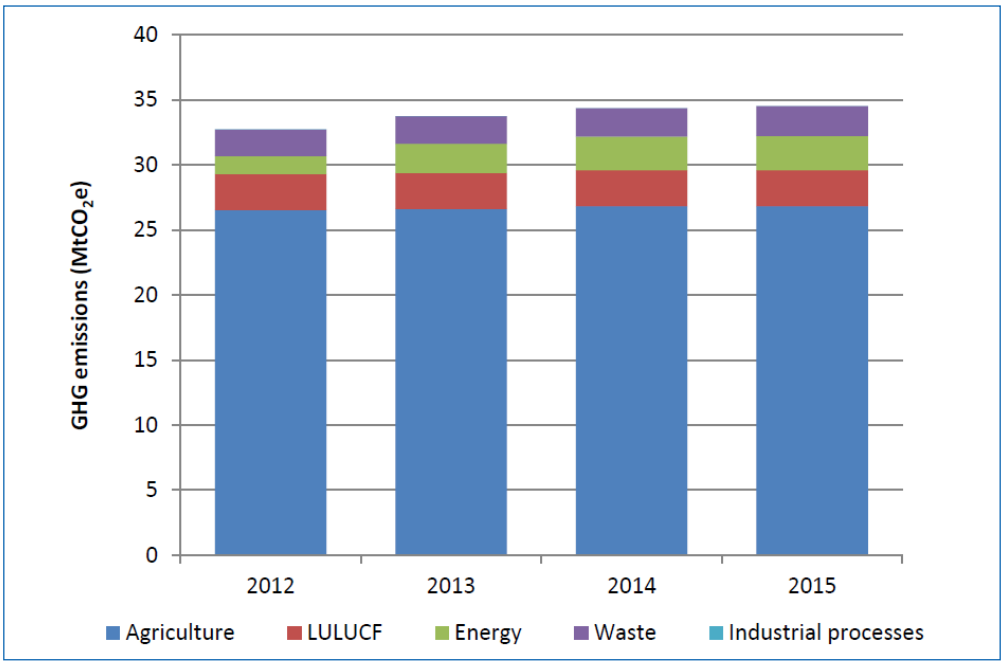
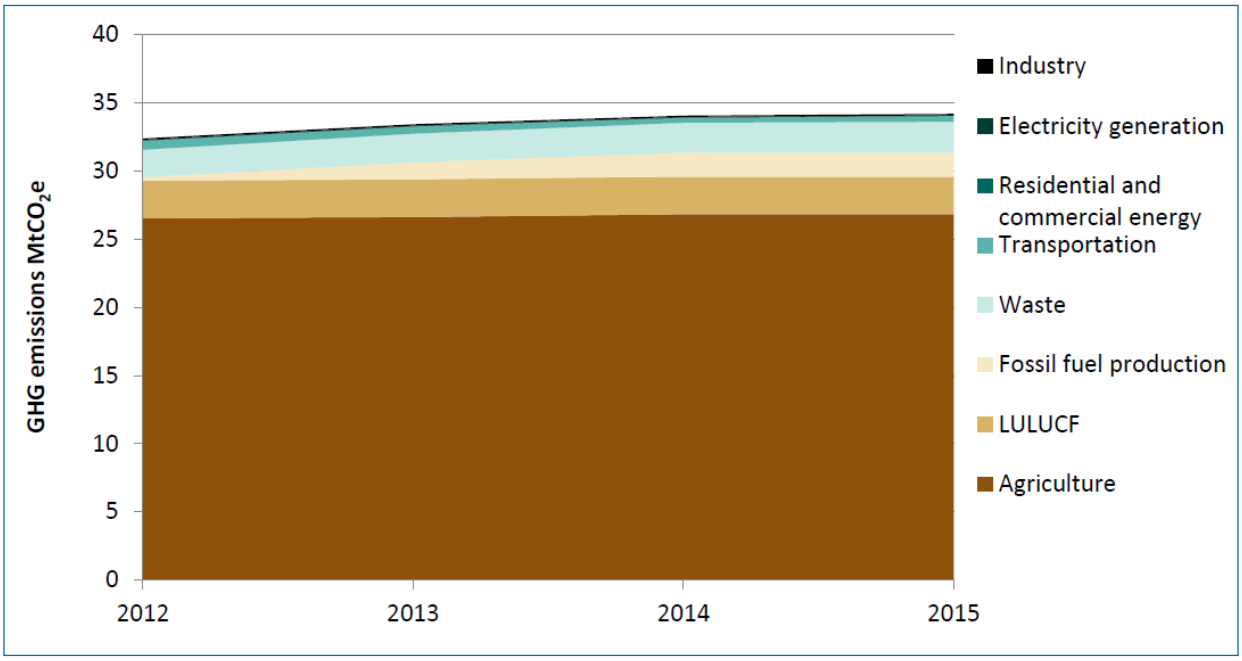



Figure 2.4: GHG emissions, including LULUCF (MtCO2e), 2012–2015




Note: Industrial process emissions are so small that they are not visible in the chart.

Figure 2.5: GHG emission trends in $MtCO_2e$, including LULUCF (2012–2015)




Trends in total $CO_2e$ emissions for each IPCC category for the complete period (2012–2015) are shown in Figure 2.5, including the LULUCF sector.

## Greenhouse gas emissions by sector

### Energy sector

Although South Sudan engages in primary fossil fuel production, it does not have an active refinery to manufacture crude oil into secondary petroleum products. Almost all crude oil production is exported, with exception of minor quantities, which are consumed by oil and gas industries for self-use.

Fossil fuels used in all other sectors (residential, commercial, transport and others) are imported. Demand for fossil fuels in South Sudan is much higher than the available supply, which can be sporadic with frequent fuel shortages. As a result, average annual supply from imports varies significantly.

The estimated national consumption of fossil and biomass fuels is provided in Table 2.2. Data on fossil fuel imports were collected from the Ministry of Finance and Economic Planning and included monthly weight and monetary import values over several years. However, while these data are the best official sources of information available, there are a number of problems. For example, there are clear cases where monetary and weight units have been reported incorrectly or where they simply do not align, with the price per unit of fuel proving unreasonable. While some effort was made to correct obvious errors in the data, reliance was placed on other import data sources in order to improve and verify the data. Other sources indicated the typical monthly imports, based on storage capacity. Estimates of biomass consumption were based on various

different studies and are consistent with those published in the South Sudan Comprehensive Agricultural Development Master Plan.

**Table 2.2: Domestic energy balance of fuels (terajoules) (2012–2016)**

| | Type | Fuel | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| | | | | 42,830 | | | |
| Primary fossil fuels | Production[1] | Crude oil | 48,780 | 251,049 | 351,593 | 347,337 | 326,268 |
| | Used for self-consumption | Crude oil | 2,439 | 12,552 | 17,580 | 17,367 | 16,313 |
| | Exported | Crude oil | 46,341 | 238,497 | 334,013 | 329,970 | 309,954 |
| | Production[1] | Natural gas | 0.26 | 1.28 | 1.88 | 2.01 | 1.82 |
| | Used for self-consumption | Natural gas | 0.26 | 1.28 | 1.88 | 2.01 | 1.82 |
| Secondary fossil fuels | Consumption (imported)[2] | Diesel oil | 8,377 | 6,766 | 4,833 | 5,477 | 6,444 |
| | | Gasoline | 2,668 | 2,155 | 1,539 | 1,744 | 2,052 |
| | | Jet kerosene | 407 | 360 | 308 | 348 | 410 |
| | | Liquid petroleum gas | 484 | 435 | 365 | 414 | 487 |
| Biomass fuels | Production and total domestic consumption[3] | Fuelwood | 22,631 | 23,383 | 24,122 | 24,857 | 25,586 |
| | | Charcoal | 7,098 | 7,410 | 7,728 | 8,055 | 8,391 |
| | | Agricultural residues | 5,051 | 5,219 | 5,384 | 5,548 | 5,711 |
| International bunker fuel | | Jet kerosene | 814 | 731 | 614 | 696 | 819 |

Notes: Crude oil self-consumption for production is estimated at 5 per cent of total crude oil production. All natural gas is assumed to be used for self-consumption.

Jet kerosene values have been adjusted to include requirements for the United Nations Humanitarian Air Service (UNHAS) based on flight schedules and aircraft size. These adjustments only take into account domestic use and not international bunker fuel. Domestic use is estimated at 33 per cent of total jet kerosene imports.

Sources: [1] Ministry of Petroleum. Yearly Crude Oil Production. Total Summary Report. Information for 2012 and 2016 was taken from U.S. Energy Information Administration, statistics for South Sudan, available at: https://www.eia.gov/

[2] Ministry of Finance and Economic Planning. Yearly Reports from South Sudan Customs Service Statistics (spreadsheets for 2012, 2014, 2015 and 2016).

Hoth Mai, N. J, Mayai, A. T., and Tiitmamer, N., (2016). Sporadic Fuel Crisis in South Sudan: Causes, Impacts and Solutions. The Sudd Institute.

[3] Japan International Cooperation Agency (JICA), Ministry of Agriculture, Forestry, Cooperatives and Rural Development and Ministry of Livestock and Fisheries Industries (2015). Comprehensive Agricultural Development Master Plan.

Rabah, A. A., Nimer, H. B., Doud, K. R., and Ahmed, Q. A., (2016). Modelling of Sudan's Energy Supply, Transformation, and Demand. This reference was used only to estimate agricultural values.

In order to estimate consumption by sector, a high-level analysis was conducted to determine where fuels are consumed by IPCC source categories (energy industries, manufacturing industries and construction, transport, commercial and institutional, residential and agriculture, forestry and fishing). This is not a true sectoral analysis as comprehensive sector data needed to determine a bottom-up calculation of consumption were not available. The sectoral consumption is based on South Sudanese consumption patterns, supplemented with South Sudan's typical energy supply data.

**Table 2.3: Energy consumption by sector (% of total)**

| Fuel | Agriculture | Transport | | Commercial | Residential | Industrial | | |
|---|---|---|---|---|---|---|---|---|
| | | Road | Air | | | Electricity | Oil and gas | Other |
| Crude oil | - | - | - | - | - | - | 100 | - |
| Natural gas | - | - | - | - | - | - | 100 | - |
| Diesel oil | 1 | 75 | - | 3 | 6 | 10 | - | 5 |
| Gasoline | - | 100 | - | - | - | - | - | - |
| Jet kerosene | - | - | 100 | - | - | - | - | - |
| Liquid petroleum gas | - | - | - | 40 | 60 | - | - | - |
| Fuelwood | - | - | - | 10 | 90 | - | - | - |
| Charcoal | - | - | - | 10 | 90 | - | - | - |
| Agriculture residues | - | - | - | - | 100 | - | - | - |

Notes: Crude oil and natural gas are assumed to be only used by the oil and gas industry. Gasoline and jet kerosene are assumed to be used only as transport fuel. Diesel oil estimates are based on the energy supply and demand study for Sudan: Rabah, A. A., Nimer, H. B., Doud, K. R., and Ahmed, Q. A., (2016). Modelling of Sudan's Energy Supply, Transformation, and Demand.

Tables 2.4, 2.5 and 2.6 present combustion and fugitive emissions for $CO_2$, $CH_4$ and $N_2O$ based on the sectoral approach for the years 2012, 2013, 2014 and 2015.

**Table 2.4: Total carbon dioxide ($CO_2$) emissions per energy subsector**

| Source | Energy subsector | $CO_2$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 239 | 961 | 1,311 | 1,301 | 445% |
| | 2. Manufacturing industries and construction | 30.7 | 24.8 | 17.7 | 20.1 | -35% |
| | 3.a. Civil aviation | 28.7 | 25.9 | 21.7 | 24.6 | -14% |
| | 3.b. Road transportation | 644 | 520 | 371 | 421 | -35% |
| | 4.a. Commercial/Institutional | 24.4 | 20.8 | 16.2 | 18.4 | -25% |
| | 4.b. Residential | 55.0 | 46.1 | 34.9 | 39.6 | -28% |
| | 4.c. Agriculture/Forestry/Fishing | 6.14 | 4.96 | 3.54 | 4.02 | -35% |
| Fugitive emissions | 2.a. Oil | 0 | 0 | 0 | 0 | - |
| | 2.b. Natural gas | 0 | 0 | 0 | 0 | - |
| | 2.c. Venting and flaring | 0 | 0 | 0 | 0 | - |
| **TOTAL ENERGY EMISSIONS** | | **1,027** | **1,603** | **1,776** | **1,828** | **+78%** |

**Table 2.5: Total methane ($CH_4$) emissions per energy subsector**

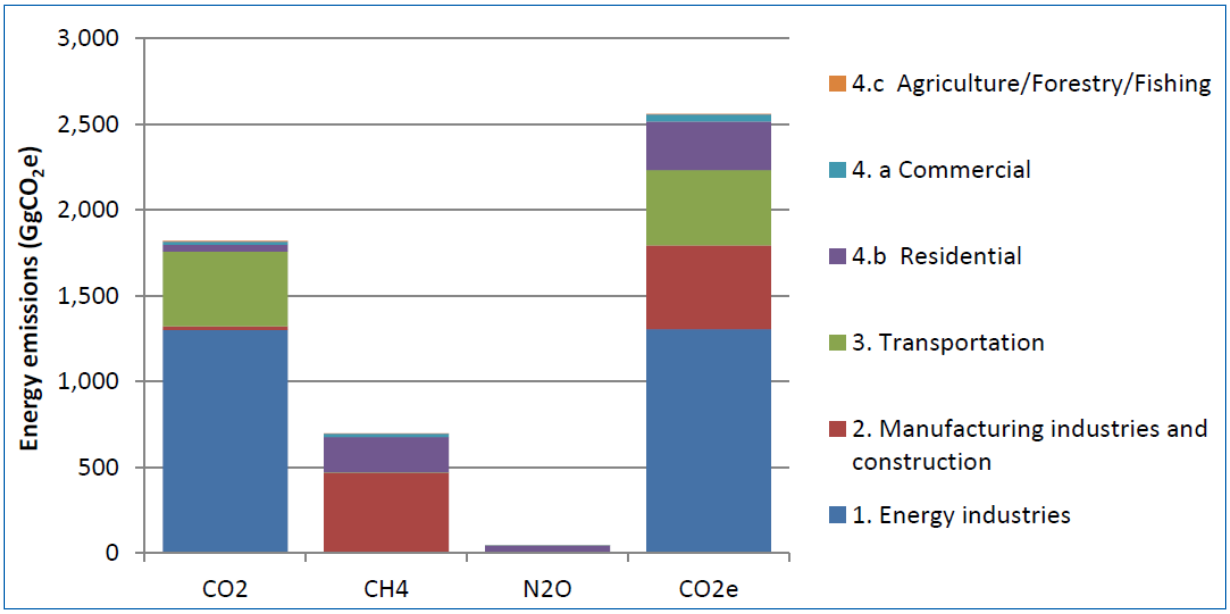
| Source | Energy subsector | $CH_4$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 3.31 | 3.49 | 3.65 | 3.80 | +15% |
| | 2. Manufacturing industries and construction | 0.001 | 0.001 | 0.001 | 0.001 | 0% |
| | 3.a. Civil aviation | 0.002 | 0.002 | 0.002 | 0.002 | 0% |
| | 3.b. Road transportation | 0.085 | 0.068 | 0.049 | 0.055 | -35% |
| | 4.a. Commercial/Institutional | 0.825 | 0.853 | 0.881 | 0.910 | 10% |
| | 4.b. Residential | 8.91 | 9.22 | 9.54 | 9.83 | 10% |
| | 4.c. Agriculture/Forestry/ Fishing | 0.42 | 0.34 | 0.24 | 0.27 | -36% |
| Fugitive emissions | 2.a. Oil | 1.93 | 9.94 | 13.9 | 13.8 | +615% |
| | 2.b. Natural gas | 0 | 0 | 0 | 0 | 0% |
| | 2.c. Venting and flaring | 1.20 | 6.18 | 8.66 | 8.56 | +613% |
| **TOTAL ENERGY EMISSIONS** | | **16.683** | **30.094** | **36.923** | **37.228** | **+123%** |

**Table 2.6: Total nitrous oxide ($N_2O$) emissions per energy subsector**

| Source | Energy subsector | $N_2O$ emissions (t) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 2.0 | 7.9 | 10.8 | 10.7 | +447% |
| | 2. Manufacturing industries and construction | 0.25 | 0.20 | 0.14 | 0.16 | -35% |
| | 3.a. Civil aviation | 0.24 | 0.22 | 0.18 | 0.21 | -14% |
| | 3.b. Road transportation | 5.37 | 4.34 | 3.10 | 3.51 | -35% |
| | 4.a. Commercial/Institutional | 10.0 | 10.3 | 10.6 | 10.9 | +9% |
| | 4.b. Residential | 109 | 112 | 116 | 119 | +10% |
| | 4.c. Agriculture/Forestry/Fishing | 0.05 | 0.04 | 0.03 | 0.03 | -35% |
| Fugitive emissions | 2.a. Oil | 0 | 0 | 0 | 0 | - |
| | 2.b. Natural gas | 0 | 0 | 0 | 0 | - |
| | 2.c. Venting and flaring | 0 | 0 | 0 | 0 | - |
| **TOTAL ENERGY EMISSIONS** | | **126** | **135** | **140** | **145** | **+15%** |

The energy industries subsector generated the largest proportion of $CO_2$ emissions (71 per cent) in 2015. $CH_4$ emissions related to fugitive emissions from the oil and gas subsector and accounted for 67 per cent of total $CH_4$ emissions. $N_2O$ emissions are largest for the residential subsector, accounting for 82 per cent of these emissions, and are primarily driven by biomass burning. Figure 2.6 illustrates the contribution of emissions from different energy subsectors for each of the GHGs. Emissions are expressed in $CO_2e$ so that the relative importance of $CO_2$, $CH_4$ and $N_2O$ emissions can be easily compared.

**Figure 2.6: GHG emissions per energy subsector in 2015 ($GgCO_2e$)**




Emissions from international bunker fuels are summarized in Table 2.7.

**Table 2.7: Total GHG emissions from bunker fuels (in tons)**

| Sector/fuel | GHG | Bunker fuel emissions (t) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Aviation jet kerosene | $CO_2$ | 57,548 | 51,814 | 43,532 | 49,266 | -14% |
| | $CH_4$ | 4.06 | 3.66 | 3.08 | 3.48 | -14% |
| | $N_2O$ | 0.487 | 0.439 | 0.369 | 0.418 | -14% |

Notes: Bunker fuel for international travel compared with domestic use is not known. The values in this table are based on the assumption that approximately 25 per cent of total aviation jet kerosene fuel demand is for domestic use, with the rest used for international air travel and therefore considered bunker fuel.

Indirect GHG emissions are presented in Tables 2.8, 2.9, 2.10 and 2.11.

**Table 2.8: Total nitrogen oxide ($NO_x$) emissions per energy subsector**

| Source | Energy subsector | $NO_x$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 1.08 | 23.62 | 34.86 | 34.83 | +3,125% |
| | 2. Manufacturing industries and construction | 0.084 | 0.068 | 0.048 | 0.055 | -35% |
| | 3.a. Civil aviation | 0.121 | 0.109 | 0.092 | 0.104 | -14% |
| | 3.b. Road transportation | 6.62 | 5.35 | 3.82 | 4.33 | -35% |
| | 4.a. Commercial/ Institutional | 0.39 | 0.37 | 0.33 | 0.36 | -8% |
| | 4.b. Residential | 3.48 | 3.46 | 3.42 | 3.57 | +3% |
| | 4.c. Agriculture/Forestry/ Fishing | 0.10 | 0.082 | 0.058 | 0.066 | -34% |
| **TOTAL ENERGY EMISSIONS** | | **11.875** | **33.059** | **42.628** | **43.315** | **+265%** |

Table 2.9: Total carbon monoxide (CO) emissions per energy subsector

| Source | Energy subsector | CO emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 2.84 | 9.55 | 12.8 | 12.8 | +350.7% |
| | 2. Manufacturing industries and construction | 0.004 | 0.003 | 0.003 | 0.003 | -25% |
| | 3.a. Civil aviation | 0.041 | 0.037 | 0.031 | 0.035 | -14.6% |
| | 3.b. Road transportation | 27.6 | 22.3 | 15.9 | 18.1 | -34.4% |
| | 4.a. Commercial/ Institutional | 19.8 | 18.5 | 16.8 | 18.1 | -8.6% |
| | 4.b. Residential | 185 | 185 | 182 | 190 | +2.7% |
| | 4.c. Agriculture/Forestry/ Fishing | 0.08 | 0.07 | 0.05 | 0.055 | -31.3% |
| **TOTAL ENERGY EMISSIONS** | | **235.365** | **235.46** | **227.584** | **239.093** | **-+1.6%** |

Table 2.10: Total non-methane volatile organic compounds (NMVOC) emissions per energy subsector

| Source | Energy subsector | NMVOC emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 40.159 | 10.535 | 20.718 | 22.6 | -44% |
| | 2. Manufacturing industries and construction | 0.002 | 0.002 | 0.002 | 0.001 | -50% |
| | 3.a. Civil aviation | 0.021 | 0.018 | 0.015 | 0.017 | -19% |
| | 3.b. Road transportation | 5.26 | 4.25 | 3.03 | 3.44 | -35% |
| | 4.a. Commercial/ Institutional | 1.53 | 1.53 | 1.51 | 1.57 | +3% |
| | 4.b. Residential | 26.7 | 21.6 | 15.4 | 117.5 | +340% |
| | 4.c. Agriculture/Forestry/ Fishing | 20 | 20 | 10 | 10 | -50% |
| **TOTAL ENERGY EMISSIONS** | | **93.672** | **57.935** | **50.675** | **155.128** | **+66%** |

**Table 2.11: Total sulphur dioxide ($SO_2$) emissions per energy subsector**

| Source | Energy subsector | $SO_2$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Combustion emissions | 1. Energy industries | 0.014 | 0.056 | 0.076 | 0.076 | +443% |
| | 2. Manufacturing industries and construction | 0.058 | 0.047 | 0.033 | 0.038 | -34% |
| | 3.Transport | 0.31 | 0.25 | 0.18 | 0.20 | -35% |
| | 4. Commercial/Institutional/ Residential | 7.58 | 7.10 | 6.43 | 6.92 | -9% |
| **TOTAL ENERGY EMISSIONS** | | **7.96** | **7.45** | **6.72** | **7.23** | **-9%** |

## Industrial processes sector

The industrial processes sector includes anthropogenic emissions from production processes in industry that are not from fuel combustion, since these have been are reported in the energy sector.

South Sudan's economy is underdeveloped and does not have many industries outside oil production and basic natural resources, including forest and agricultural products. As a result, there are no industrial process subsectors of importance in South Sudan that emit significant emissions. The only emissions attributable to industrial processes are those related to the consumption of HFCs. While South Sudan does not manufacture HFCs, it does import products that are known to contain HFC gases, such as refrigeration and air-conditioning equipment and vehicles, which is where these emissions originate.

Emissions are estimated on the assumption that they are equal to the amount of HFCs that are imported in the country and that no HFCs are destroyed. Total refrigerator and air conditioner imports are provided in Table 2.12.

**Table 2.12: Imports of refrigerators and air-conditioning units (2012–2017)**

| Type | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Air conditioners | 71,136 | 81,286 | 81,329 | 81,245 | 779 | 2,680 |
| Vehicle air conditioners | 1,136 | 3,122 | 3,938 | 1,843 | 3,287 | 3,869 |
| Refrigerators | 4,750 | 4,849 | 4,877 | 4,821 | 4,514 | 1,783 |

Notes: Imports of air conditioner and refrigerator units were only available for 2016 and 2017. Estimates were made for the other years based on the relative GDP of previous years. In addition, the number of vehicle air conditions charged with HFCs was estimated based on an average imported vehicle price of US$15,000, except in 2017, which is the true number of vehicles imported.

Source: Ministry of Finance and Economic Planning. Yearly Reports from South Sudan Customs Service Statistics (spreadsheets for 2012, 2014, 2015, 2016 and 2017).

Refrigerators and air conditioners are assumed to be charged with HFCs before they are imported into South Sudan. The general assumption is that all units are charged with HFC 134-a (or Freon 134-a), which is the most common coolant used in the market. The average charge for the different types of refrigeration and air-conditioning units is provided in Table 2.13.

**Table 2.13: Average charge of imported unit**

| Refrigeration and air-conditioning unit | Average charge (kg) |
|---|---|
| Air-cooled air conditioners | 1.536 |
| Vehicle air conditioners | 0.700 |
| Refrigerator (small) | 0.150 |

Source: IPCC Technology and Economic Assessment Panel (TEAP), (2005). Safeguarding the Ozone Layer and the Global Climate System. Chapters 4 (Refrigeration), 5 (Residential and Commercial Air Conditioning and Heating) and 6 (Mobile Air Conditioning).

Total HFC emissions from industrial processes, specifically product emissions, are presented in Table 2.14, on the assumption that all emissions are HFC 134-a, which has a global warming potential of 1,300.

**Table 2.14: Total hydrofluorocarbons (HFC) emissions from industrial processes**

| Source | Industrial processes subsector | HFC emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|---|
| | | 2012 | 2013 | 2014 | 2015 | |
| Consumption of HFCs | 2. Product emissions | 0.0035 | 0.0055 | 0.0064 | 0.0043 | +25% |

## Solvent and other product use

No information on solvent and other product use has been provided in this report due to the insufficient data available and the very low contribution of this sector to overall GHG emissions.

## Agriculture

South Sudan's agricultural sector has not grown significantly since independence as a result of conflict and drought the country and contributes very little to overall GDP, despite most of the population practising agricultural activities. Estimates of livestock numbers are not particularly reliable, but are likely to have been relatively stable since 2012, while production of major crops, including sorghum and maize, is expected to have increased.

Agricultural activities contribute to GHG emissions through various processes, with $CH_4$ and $N_2O$ being the only significant gases emitted by the sector. $CH_4$ emissions are produced from enteric fermentation and manure management associated with livestock, as well as prescribed burning of savannahs and crop residues. $N_2O$ emissions originate primarily from natural fertilizers (manure and crop residues) applied to cultivated soils and are based on IPCC assumptions regarding atmospheric deposition and leaching from soils. Other $N_2O$ emission sources include prescribed

burning of savannahs and crop residues and are based on land areas or production quantities combined with default IPCC emission factors.

A Tier 1 approach was used to calculate enteric fermentation and manure management emissions based on regional default IPCC emission factors and the population of each category of livestock.

$CH_4$ emissions were also estimated for rice cultivation based on the area of rice under cultivation and information on the type of irrigation patterns. In order to calculate $N_2O$ emissions from soils and animal production, the amount of nitrogen input from animal waste, nitrogen-fixing crops and crop residues was estimated. While it is likely that the country imports some synthetic nitrogen fertilizers, it is not thought to be a significant amount. Estimates by the Food and Agriculture Organization of the United States (FAO) also suggest that the country has a limited use of synthetic fertilizers. Direct and indirect $N_2O$ emissions into the atmosphere were then estimated from these inputs using the default IPCC emission factors.

Livestock population estimates were gathered from several different sources including the South Sudan Comprehensive Agricultural Development Master Plan and the FAO, which are presented in Table 2.15.

**Table 2.15: Historic livestock population (head of livestock) (2012–2016)**

| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Dairy cattle | N/A | N/A | N/A | N/A | N/A |
| Non-dairy cattle[1] | 11,757,000 | 11,765,000 | 11,817,000 | 11,817,000 | 11,817,000 |
| Sheep[1,2] | 13,900,000 | 14,050,000 | 14,425,000 | 14,425,000 | 14,425,000 |
| Goats[1,2] | 12,950,000 | 12,975,000 | 12,975,000 | 12,975,000 | 12,975,000 |
| Donkeys[1] | 300,000 | 320,000 | 330,000 | 330,000 | 330,000 |
| Poultry[1] | 15,000,000 | 15,000,000 | 15,000,000 | 15,000,000 | 15,000,000 |

Notes: Without additional data, it was estimated that livestock populations were static for 2015 and 2016. Sources also indicated two different estimates of sheep and goat livestock populations, so an average of the two estimates was used.

Sources: [1] FAO. FAOSTAT Database. Accessed 12 August 2014 for 1995–1998.

[2] JICA, Ministry of Agriculture, Forestry, Cooperatives and Rural Development and Ministry of Livestock and Fisheries Industries (2015). Comprehensive Agricultural Development Master Plan.

The estimated area of rice cultivation was based on South Sudan's reported 50,000 medans (with one medan approximating 60 x 70 m) under production by government and private growers and is provided in Table 2.16. It was unknown how production has changed overtime, so the area under cultivation remains constant.

**Table 2.16: Area of rice under cultivation (2012–2016)**

| Metric | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Area (ha) | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |

Crop production estimates were gathered from various sources and are presented in Table 2.17.

**Table 2.17: Production quantity of crops in metric tons (2012–2016)**

| | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|
| Sorghum[2] | 551,750 | 627,175 | 887,369 | 887,369 | 887,369 |
| Maize[2] | 238,254 | 270,825 | 383,182 | 383,182 | 383,182 |
| Total cereals[1] | 790,000 | 898,000 | 1,270,551 | 1,270,551 | 1,270,551 |
| Groundnuts[2] | 185,302 | 185,302 | 185,302 | 185,302 | 185,302 |
| Cassava[2] | 42,762 | 42,762 | 42,762 | 42,762 | 42,762 |

Notes: Without additional data, it was estimated that cereal and maize production were static for 2015 and 2016 and that groundnuts and cassava production were the same for all years.

Sources: [1] FAO, FAOSTAT Database. Accessed 12 August 2014.

[2] Proportion of crops based on JICA, Ministry of Agriculture, Forestry, Cooperatives and Rural Development and Ministry of Livestock and Fisheries Industries (2015). Comprehensive Agricultural Development Master Plan.

Savannahs are intentionally burned during the dry season primarily for agricultural purposes, which includes ridding the land of weeds and pests, promoting nutrient cycling and encouraging the growth of new grasses for animal grazing. Most large-scale burning takes place in humid savannahs because arid savannahs lack sufficient grass cover to sustain fire. Humid savannahs are burned every one to four years on average with the highest frequency in Africa. For South Sudan, the practice is assumed to occur only in the high-rainfall savannah zone, which covers approximately 93,000 km$^2$. About 35 per cent of the total area is estimated to be burned every year based on the default values for South Sudan's savannah zone as per the "Revised 1996 IPCC Guidelines".

Table 2.18 and Table 2.19 present agricultural emissions for $CH_4$ and $N_2O$.

**Table 2.18: Total $CH_4$ emissions per agriculture subsector**

| Source | $CH_4$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | |
| A. Enteric fermentation | 502 | 503 | 507 | 507 | +1% |
| B. Manure management | 18.0 | 18.1 | 18.3 | 18.3 | +1% |
| C. Rice cultivation | 3.0 | 3.0 | 3.0 | 3.0 | 0% |
| E. Prescribed burning of savannahs | 27.2 | 27.2 | 27.2 | 27.2 | 0% |
| F. Field burning of agriculture residues | 0.53 | 0.61 | 0.86 | 0.86 | +61% |
| **TOTAL AGRICULTURE EMISSIONS** | **550** | **552** | **556** | **556** | **+1%** |

**Table 2.19: Total $N_2O$ emissions per agriculture subsector**

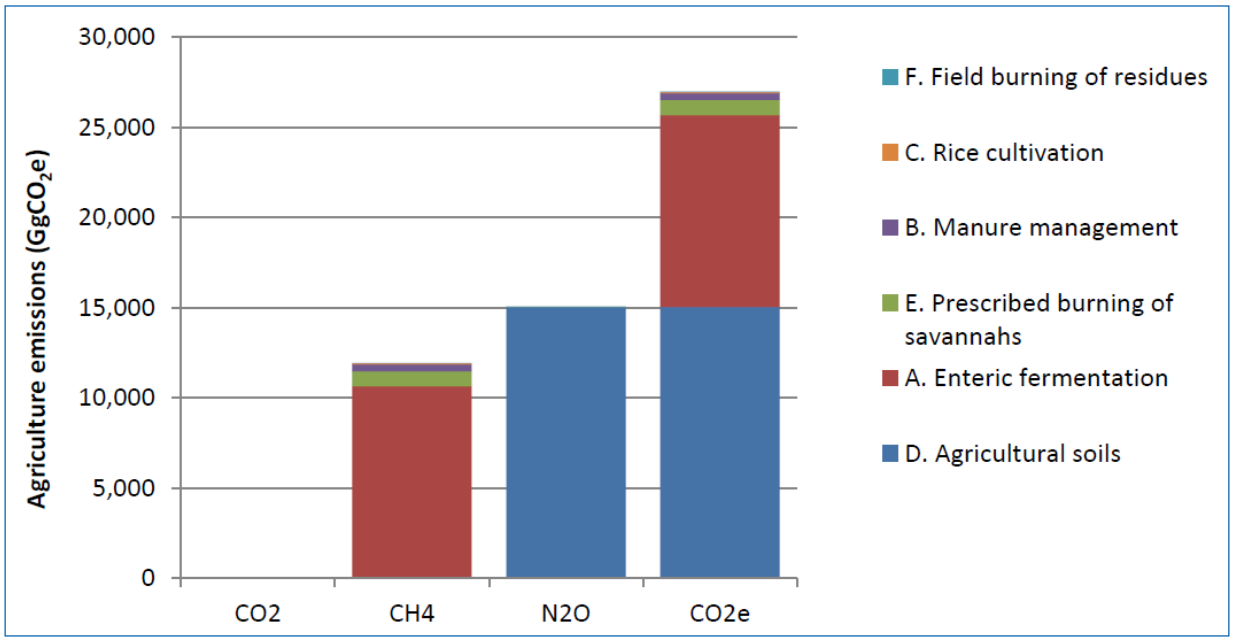
| Source | $N_2O$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | |
| D. Agricultural soils | 47.9 | 48.1 | 48.5 | 48.5 | +1% |
| E. Prescribed burning of savannahs | 0.34 | 0.34 | 0.34 | 0.34 | 0% |
| F. Field burning of agriculture residues | 0.018 | 0.020 | 0.028 | 0.028 | +61% |
| **TOTAL AGRICULTURE EMISSIONS** | **48.3** | **48.5** | **48.9** | **48.9** | **+1%** |

Enteric fermentation is a digestive process in ruminant animals, by which carbohydrates are broken down by microorganisms into simple molecules for absorption into the blood stream, producing $CH_4$ as a by-product. As such, this subsector is responsible for the largest proportion of $CH_4$ emissions in the country, which is estimated at 90 per cent.

$N_2O$ emissions are largest for the agricultural soils subsector, accounting for 99 per cent of these emissions.

Figure 2.7 illustrates the contribution of emissions from different agricultural subsectors for each of the GHGs. Emissions are expressed in carbon dioxide equivalent ($CO_2e$) so that the relative importance of emissions of $CH_4$ and $N_2O$ can be easily compared.

**Figure 2.7: GHG emissions in 2015 per agriculture subsector expressed in $CO_2e$ (Gg)**




Indirect GHG emissions of $NO_x$ and CO are the result of prescribed burning of savannahs and field burning of agricultural residues. Tables 2.20 and 2.21 identify these emissions for the 2012–2015 period.

**Table 2.20: Total $NO_x$ emissions per agriculture subsector**

| Source | $NO_x$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | |
| E. Prescribed burning of savannahs | 17.7 | 17.7 | 17.7 | 17.7 | 0% |
| F. Field burning of agriculture residues | 0.63 | 0.72 | 1.02 | 1.02 | +61% |
| **TOTAL AGRICULTURE EMISSIONS** | **18.3** | **18.4** | **18.7** | **18.7** | **+2.1%** |

**Table 2.21: Total CO emissions per agriculture subsector**

| Source | CO Emissions (Gg) | | | | Change 2012-2015 |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | |
| E. Prescribed burning of savannahs | 1,040 | 1,040 | 1,040 | 1,040 | 0% |
| F. Field burning of agriculture residues | 11.2 | 12.7 | 18.0 | 18.0 | +61% |
| **TOTAL AGRICULTURE EMISSIONS** | **1,051** | **1,052** | **1,058** | **1,058** | **+0.6%** |

## Land use, land-use change and forestry

The LULUCF sector includes estimates of emissions and removals of GHGs associated with increases or decreases of carbon in living biomass as land-use changes over time, for example, the conversion of a forest area to cropland or the establishment of new forest lands through reforestation or afforestation.

As recommended by the 2003 IPCC "Good Practice Guidance for Land Use, Land-Use Change and Forestry", estimates are provided for emissions and removals from land that did not undergo any land-use change, reflecting an increase or loss of carbon under the same type of use (e.g. carbon increases in secondary or even primary vegetation in managed areas), as well as land conversions for the six IPCC land-use categories (forest land, cropland, grassland, wetlands, settlements and other land).

South Sudan's forest cover has declined the last 10 years and it currently estimated at around 30 per cent.

The only gas covered in this sector is $CO_2$, as other GHGs such as $CH_4$ and $N_2O$ from imperfect burning of wood were not estimated.

### Methodology

A global land-use data approach is the basis for consistent representation of land areas. The method employed is described as Approach 1 in the 2003 IPCC "Good Practice Guidance for Land Use, Land-Use Change and Forestry". The data set employed is from the FAO "Global Forest Resource Assessment 2015. Country Report, South Sudan". However, as it is first forest assessment report for South Sudan, the data set is very limited and was supplemented with information available from other sources, including the South Sudan Comprehensive Agricultural Development Master Plan and a presentation made at a workshop on forest management and

climate change in Eastern Africa, which took place in Dar Es Salaam, Tanzania in 2016. More detailed land-use data from South Sudan was unavailable when preparing this report. However, South Sudan is working to implement a national forest policy and inventory.

While it is known that forest reserves accounted for approximately 763,000 ha in 2014 it is not known how these reserves are distributed among different land-use types (e.g. tropical rainforests, plantation forests, other forests). As a result, they are included in these land representations.

Carbons stocks or gains and losses are calculated only for biomass pools above and below ground over a 10-year period between 2005 and 2015. Other pools, such as soil organic carbon, dead organic matter (litter and dead wood pools), are not considered as there are little data available to track the carbon flows of these pools. A simplifying Tier 1 assumption has therefore been made putting the net flow of these carbon pools at zero.

**Land representation**

The FAO "Global Forest Resource Assessment 2015. Country Report, South Sudan" presents land-use data only for a single time period that relates to 2013. Representation of land use over a longer time period is not available. In order to estimate land-use areas over a 10-year period, assumptions were made regarding the rate of deforestation. Adjustments were then made to forest land areas, as well as cropland and grassland land types, where it was assumed that land conversions had occurred. Land-use types and historic areas that are mapped to the six IPCC land-use categories are presented in Table 2.22.

**Table 2.22: Areas of different land-use categories and state classifications between 2005 and 2015**

| FAO land-use categories | IPCC category | Area (ha) | | | Change in area (ha), 2005–2015 |
|---|---|---|---|---|---|
| | | 2005 | 2010 | 2015 | |
| Tropical rainforests | Forest land | 2,650 | 2,562 | 2,452 | -197 |
| Plantation forests | Forest land | 190 | 190 | 190 | - |
| Other forests | Forest land | 4,766 | 4,591 | 4,372 | -395 |
| Other wooded land | Forest land | 35,427 | 33,763 | 31,675 | -3,752 |
| Bush land | Grassland | 21,151 | 22,500 | 24,192 | +3,041 |
| Arable land and permanent crops | Cropland | 1,772 | 2,350 | 3,075 | +1,303 |
| Inland water bodies | Other land | 444 | 444 | 444 | - |
| **Total area for South Sudan** | | **66,400** | **66,400** | **66,400** | **-** |

Notes: The rate of deforestation is assumed to have been accelerating since 2005 as reported by Thulstrup, A., and Henry, W. J., (2015). Women's Access to Wood Energy during Conflict and Displacement: Lessons from Yei County, South Sudan. Unasylva 243/244, Vol. 66, 2015/1–2. Total deforestation in 2013 was estimated at 278 kha/year (kha = kilo hectare).

Deforested areas are assumed to have been converted into cropland (30 per cent) and bush land (70 per cent). As other wooded land is less than 50 per cent forest cover and half the biomass of other forest types, the land converted (change in area) is multiplied by two to be equal to deforestation in other forest areas.

Sources: General land-use areas from: FAO, (2014). Global Forest Resources Assessment 2015. Country Report, South Sudan; Republic of South Sudan presentation for the Forest Management and Climate Change in Eastern Africa Workshop. 14–16 December 2016. Dar Es Salaam, Tanzania.

Deforestation Rate from: United Nations Development Programme (UNDP), (2012). Environmental impacts risks and opportunities assessment: Natural resources management and climate change in South Sudan.

## Land-use change and forestry activity data

In order to estimate annual land-use changes between 2005 and 2015, initial areas were estimated for both periods based on available data provided in Table 2.23. The net land-use change is from forest land to either cropland or grassland, with estimates placing the net conversion of forest land at 2,330,000 ha over the 10-year period. A non-spatially explicit land-use change matrix as described in the 2003 IPCC "Good Practice Guidance for Land Use, Land-Use Change and Forestry" was developed and is presented in Table 2.24.

**Table 2.23: Land-use changes per area between 2005 and 2015 (kha)**

| Final / Initial | Tropical rainforests | Plantation forests | Other forests | Other wooded land | Bush land | Arable land and permanent crops | Inland water bodies | Final area |
|---|---|---|---|---|---|---|---|---|
| Tropical rainforests | 2,452 | | | | | | | 2,452 |
| Plantation forests | | 190 | | | | | | 190 |
| Other forests | | | 4,372 | | | | | 4,372 |
| Other wooded land | | | | 31,675 | | | | 31,675 |
| Bush land | 138 | | 276 | 2,626 | 21,151 | | | 24,192 |
| Arable land and permanent crops | 59 | | 118 | 1,126 | | 1,772 | | 3,075 |
| Inland water bodies | | | | | | | 444 | 444 |
| Initial area | 2,650 | 190 | 4,766 | 35,427 | 21,151 | 1,772 | 444 | **66,400** |
| Net change | -197 | 0 | -395 | -3,752 | 3,041 | 1,303 | 0 | 0 |
| Annual change | **-10** | **0** | **-20** | **-188** | **152** | **65** | **0** | **-1** |
| Annual change (%) | **-0.39** | **0.00** | **-0.43** | **-0.56** | **0.67** | **0.00** | **0.00** | |

Note: Land-use changes over a 10-year period are indicated in light green cells.

Wood removals between 2005 and 2015 for fuelwood, charcoal production and commercial uses were estimated based on a number of sources identified in Table 2.24.

**Table 2.24: Estimated wood removal in tons of dry matter (tDm)**

| Year | Wood removal (tDm) | | | |
|---|---|---|---|---|
| | Fuelwood | Charcoal production | Sawn wood and logs | Industrial wood |
| 2005 | 1,130,888 | 534,887 | 47,845 | 193,555 |
| 2006 | 1,180,993 | 562,916 | 49,965 | 202,131 |
| 2007 | 1,235,195 | 593,281 | 52,258 | 211,409 |
| 2008 | 1,291,864 | 625,309 | 54,656 | 221,108 |
| 2009 | 1,348,699 | 658,174 | 57,060 | 230,836 |
| 2010 | 1,404,000 | 691,200 | 59,400 | 240,300 |
| 2011 | 1,457,228 | 717,405 | 61,652 | 249,410 |
| 2012 | 1,508,746 | 742,767 | 63,832 | 258,227 |
| 2013 | 1,558,845 | 767,432 | 65,951 | 266,802 |
| 2014 | 1,608,143 | 791,701 | 68,037 | 275,240 |
| 2015 | 1,657,117 | 815,812 | 70,109 | 283,622 |

Sources: JICA, Ministry of Agriculture, Forestry, Cooperatives and Rural Development and Ministry of Livestock and Fisheries Industries, (2015). The Republic of South Sudan Comprehensive Agriculture Development Master Plan. Final Report.

### Greenhouse gas emissions

Table 2.25 provides a summary of $CO_2$ emissions or removals that relate to different land-use categories, carbon pools and IPCC LULUCF guideline categories.

**Table 2.25: Total LULUCF $CO_2$ emissions (Gg)**

| Land-use category[1] | | Carbon pool | Sector in IPCC guidelines[2] | Annual change in carbon stocks $CO_2$ (Gg)[3] |
|---|---|---|---|---|
| Initial land use | Land use during reporting year | | | 2005–2015 |
| FL | FL | Living biomass | 5A | -25,341 |
| Subtotal for forest land | | | | **-25,341** |
| FL | CL | Living biomass | 5B | +9,197 |
| Subtotal for cropland | | | | **+9,197** |
| FL | GL | Living biomass | 5B | +18,905 |
| Subtotal for grassland | | | | **+18,905** |
| Subtotal for other land | | | | **0** |
| **TOTAL** | | | | **+2,761** |

Notes: [1] FL – Forest land, CL – Cropland, GL – Grassland, WL – Wetlands, SL – Settlement land, OL – Other land.

[2] Headings from the IPCC Guidelines Reporting Instructions, p. 1.14–1.16: 5A – Changes in forest and other woody biomass stocks; 5B – Forest and grassland conversion; 5C – Abandonment of managed lands; 5D – $CO_2$ emissions and removals from soil, and 5E – Other.

[3] For the purpose of reporting, it is necessary to reverse the sign so that the resulting values are expressed as (-) for removal or uptake and (+) for emissions.

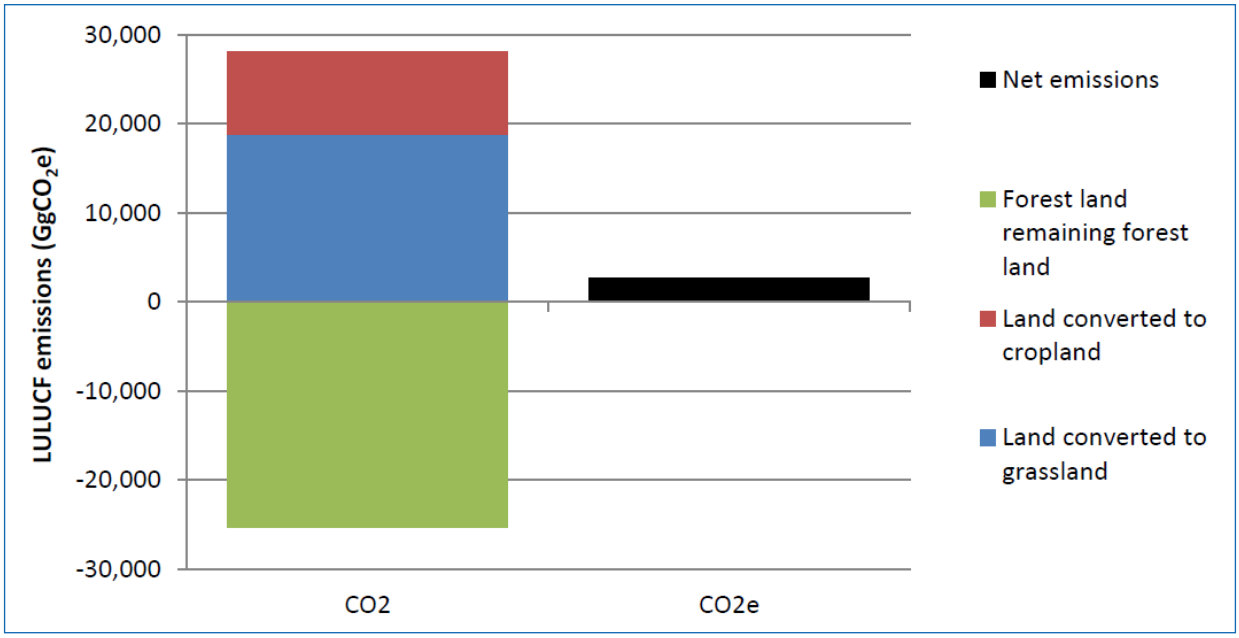
Both Table 2.25 and Figure 2.8 show that South Sudan's LULUCF sector was a marginal net emitter (net loss from carbon pools) between 2005 and 2015. The average $CO_2$ emissions over this time period were 2.7 megatons (Mt)[ii] per year. This finding is consistent with the observed loss of forest cover in South Sudan over the same time period, where most of the country's living biomass is stored. The annual average decrease in carbon related to wood removal was estimated at 13,768 tons of carbon (tC), while conversions of forest land to cropland or grassland was 7,664 gigagrams of carbon (GgC).[iii] These decreases in carbon stock were offset by the increase of biomass in forests, which was estimated at 20,679 GgC.

Emissions related to vegetation fires in forests (not to prescribed burning of savannahs) were not estimated for the agricultural sector.

[ii] One megaton is one million tons.

[iii] One gigagram is 1,000 tons.

**Figure 2.8:** GHG emissions and sinks per LULUCF subsector in 2015, expressed in $CO_2e$ (Gg)




## Waste

GHG emissions can be produced through processes to dispose, treat and recycle waste. The most significant gas produced from this source is $CH_4$. Two major sources contribute to $CH_4$ production: solid waste disposal and wastewater treatment. In both cases, methanogenic bacteria break down organic matter in the waste to produce $CH_4$. The emission potential increases where there are better control conditions at disposal sites and in locations where they are greater amounts of disposed solid waste. The emission potential increases for wastewater when it is treated in anaerobic conditions and has a high degree of organic content, as is the case for wastewater from residential and commercial sectors.

### Methodology

The calculation of $CH_4$ emissions from solid waste disposal sites (SWDS) was completed using the Tier 1 mass balance approach from the "Revised 1996 IPCC Guidelines" and does not take into account how waste degrades over time. Rather, the calculation assumes that all potential $CH_4$ is released in the year that the waste is disposed. This simplified approach has been taken because there is very little data and information available about historic waste disposal over time.

To estimate $CH_4$ emissions from domestic and industrial wastewater first required determining the total amount of organic material (biodegradable components) in the wastewater of different handling systems. Once determined, this value was then multiplied by the IPCC default emission factors that represented the amount of $CH_4$ produced for each kilogram of biodegradable material.

It is also possible to calculate estimates of indirect $N_2O$ emissions from human sewage by determining its nitrogen (N) content, which should be estimated according to the consumption of an average person in South Sudan, before applying a default IPCC emission factor (kg $N_2O$/kg human sewage N).

### Waste activity data

Most solid waste in South Sudan is either burned or placed in small waste pits.[103] Some solid municipal waste is collected in Juba and taken to unmanaged SWDS. Very little information has been collected related to these operations other than the approximate collection rate. The following assumptions based on data from 2015 have been used to estimate emissions from SWDS.

**Table 2.26: Generation rate of solid waste disposal sites in South Sudan and waste amounts received**

| Parameter | Units | Value | Data source |
|---|---|---|---|
| Total domestic and commercial/industrial waste generation rate | Kg/day/person | 0.67 | Bella, V. D. and Vaccari, M., (2012). *Integrated Solid Waste Management. Technical Elements for Juba*. Research Centre on Appropriate Technologies for Environmental Management in Developing Countries. University of Brescia. |
| Total population of Juba considered | Persons | 500,000 in 2012<br>567,400 in 2015[1] | |
| Fraction of solid waste sent to unmanaged deep SWDS (Representing collected waste) | % | 15%<br>(20,813 tons/year in 2015) | |
| Fraction of solid waste sent to unmanaged shallow SWDS | % | 15%<br>(20,813 tons/year in 2015) | Estimated |
| Solid waste not sent to SWDS (this includes amounts that are burned) | % | 70%<br>(97,130 tons/year in 2015) | Calculated |

Note: [1] Population in 2015 for municipal waste generation estimate based on urban population growth rate from World Bank data.

The solid wastes outlined in Table 2.27 were assumed to have the following composition based on information from a study conducted by the Japanese International Cooperation Agency (JICA) and presented in the City of Nairobi Environment Outlook.

**Table 2.27: Composition of municipal wastes in Juba**

| Type | Municipal waste composition (%) |
|---|---|
| Food waste | 28.8 |
| Paper | 12.1 |
| Wood | 3.7 |
| Textile | 11.8 |
| Nappies | 1.2 |
| Plastics and other inert materials | 42.4 |
| **TOTAL** | **100** |

Source: Bella, V. D. and Vaccari, M., (2012). Integrated Solid Waste Management. Technical Elements for Juba. Research Centre on Appropriate Technologies for Environmental Management in Developing Countries. University of Brescia.

In South Sudan, there are no wastewater treatment plants or sewer systems. Open pit latrines (traditional and ventilated improved pit latrines) and septic tanks (found only in urban areas) dominate the domestic and commercial wastewater systems in South Sudan.

The percentage of domestic sewage treated by different wastewater treatment systems is shown in Table 2.28. The methane conversion factor represents the percentage of total potential methane emissions that can be expected for each system and is based on IPCC defaults from the "2006 IPCC Guidelines for National Greenhouse Gas Inventories".

**Table 2.28: Domestic wastewater treatment systems**

| Wastewater treatment systems | Total sewage (%)[1] | Methane conversion factor[2] |
|---|---|---|
| Pit latrine | 24 | 0.1 |
| Septic system | 0.5 | 0.5 |
| Other – none | 75.4 | 0 |
| **Average based on total** | **100** | **0.0265** |

Source: [1] South Sudan, National Bureau of Statistics, Statistical Yearbook 2014.

[2] Methane conversion factor from Table 6.5 in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 5: Waste.

### Greenhouse gas emissions

Tables 2.29 and 2.30 present $CH_4$ and $N_2O$ emissions for the waste sector.

**Table 2.29: Total $CH_4$ emissions per waste subsector**

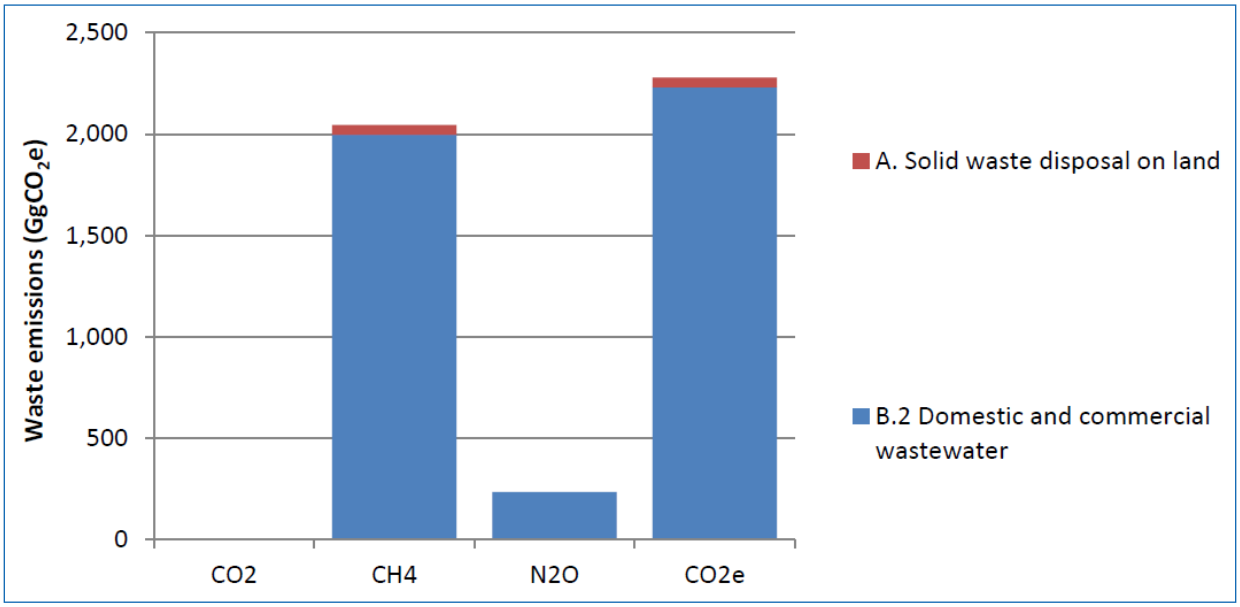
| Source | $CH_4$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | |
| A.2. Solid waste disposal on land | 1.02 | 1.06 | 1.11 | 1.16 | **+13%** |
| B.2. Domestic and commercial wastewater | 159 | 167 | 176 | 185 | **+16%** |
| **TOTAL WASTE EMISSIONS** | **160** | **169** | **177** | **186** | **+16%** |

**Table 2.30: Total $N_2O$ emissions per waste subsector**

| Source | $N_2O$ emissions (Gg) | | | | Change 2012–2015 |
|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2015 | |
| A.2. Solid waste disposal on land | - | - | - | - | **-** |
| B.2. Domestic and commercial wastewater | 0.69 | 0.71 | 0.73 | 0.76 | **+10%** |
| **TOTAL WASTE EMISSIONS** | **0.69** | **0.71** | **0.73** | **0.76** | **+10%** |

Domestic and industrial wastewater accounts for more than 99 per cent of overall $CH_4$ emissions. Figure 2.9 identifies the relative importance of $CH_4$ and $N_2O$ emissions for the different waste subsectors in 2015.

**Figure 2.9: GHG emissions per waste subsector in 2015, expressed in $GgCO_2e$**



### Indirect greenhouse gas emissions

Indirect GHG emissions have not been estimated for the waste sector as they are too small and there are no sufficient data available.

## Key category analysis for emission sources

A Key Category Analysis (KCA) was carried out for the 2015 inventory results. With the exclusion of LULUCF emissions and removals, two emission sources accounted for more than 80 per cent of GHG emissions in terms of $CO_2e$. The most important emission sources were both related to agriculture and in particular livestock. $N_2O$ emissions from agriculture soils accounted for 47.5 per cent of emissions, while enteric fermentation accounted for 33.6 per cent of overall emissions. The major contributor to $N_2O$ emissions from agricultural soils is manure, either applied or left on agricultural lands. In total, 12 IPCC source categories comprise 99.1 per cent of GHG emissions in South Sudan, which are listed in Table 2.31 from highest to lowest in terms of their contribution.

**Table 2.31: Key Category Analysis for IPCC sources (excluding LULUCF)**

| IPCC source category | Sector | Source categories to be assessed in Key Category Analysis | Applicable GHG | Emission estimate (2015, non-LULUCF) ($GgCO_2e$) | Level assessment, excluding LULUCF (%) | Cumulative level, excluding LULUCF (%) |
|---|---|---|---|---|---|---|
| 4.D | Agriculture | $N_2O$ (direct and indirect) emissions from agricultural soils | $N_2O$ | 15,034 | 44.7 | 44.7 |
| 4.A | Agriculture | $CH_4$ emissions from enteric fermentation in domestic livestock | $CH_4$ | 10,639 | 31.6 | 76.3 |
| 6.B | Waste | $CH_4$ emissions from wastewater handling | $CH_4$ | 3,886 | 11.6 | 87.9 |
| 1.A.1 | Energy | $CO_2$ emissions from stationary combustion (liquid-A) | $CO_2$ | 1,301 | 3.9 | 91.8 |
| 4.E | Agriculture | $CH_4$ emissions from savannah burning | $CH_4$ | 571 | 1.7 | 93.5 |
| 1.B.2 | Energy | $CH_4$ fugitive emissions from oil and gas operations | $CH_4$ | 469 | 1.4 | 94.9 |
| 1.A.3 | Energy | $CO_2$ mobile combustion: road vehicles | $CO_2$ | 421 | 1.3 | 96.2 |
| 4.B | Agriculture | $CH_4$ emissions from manure management | $CH_4$ | 383 | 1.1 | 97.3 |
| 6.B | Waste | $N_2O$ emissions from wastewater handling | $N_2O$ | 235 | 0.7 | 98.0 |
| 1.A.4 | Energy | Other sectors: residential $CH_4$ | $CH_4$ | 207 | 0.6 | 98.6 |

| IPCC source category | Sector | Source categories to be assessed in Key Category Analysis | Applicable GHG | Emission estimate (2015, non-LULUCF) ($GgCO_2e$) | Level assessment, excluding LULUCF (%) | Cumulative level, excluding LULUCF (%) |
|---|---|---|---|---|---|---|
| 4.E | Agriculture | $N_2O$ emissions from savannah burning | $N_2O$ | 104 | 0.3 | 98.9 |
| 1.A.1 | Energy | $CH_4$ (non-$CO_2$) emissions from stationary combustion | $CH_4$ | 80 | 0.2 | 99.1 |
| **TOTAL** | | | | **33,330** | | |

When including LULUCF emissions and removals, the most important emission source or sink is in fact from the LULUCF sector, in particular $CO_2$ sequestered by forest land remaining forest land, which was estimated to account for 30 per cent of overall emissions and removals. The largest emission sources were land converted to grassland, which accounted for 22 per cent of total emissions and removals, followed by $N_2O$ emissions from agricultural soils and $CH_4$ emissions from enteric fermentation. In total, 15 IPCC source categories comprise 99.7 per cent of GHG emissions and removals, which are listed in Table 2.32 from highest to lowest in terms of their contribution.

**Table 2.32: Key Category Analysis for IPCC sources (including LULUCF)**

| IPCC source category | Sector | Source categories to be assessed in Key Category Analysis | Applicable GHG | Total absolute estimate, including LULUCF (2015) ($GgCO_2e$) | Level assessment, ncluding LULUCF (%) | Cumulative level, including LULUCF (%) |
|---|---|---|---|---|---|---|
| 5.A | LULUCF | Forest land remaining forest land | $CO_2$ | -25,340.8 | 29.1 | 29.1 |
| 5.C | LULUCF | Land converted to grassland | $CO_2$ | 18,905.2 | 21.7 | 50.8 |
| 4.D | Agriculture | $N_2O$ (direct and indirect) emissions from agricultural soils | $N_2O$ | 15,039.9 | 17.3 | 68.1 |
| 4.A | Agriculture | $CH_4$ emissions from enteric fermentation in domestic livestock | $CH_4$ | 10,639.2 | 12.2 | 80.3 |
| 5.B | LULUCF | Land converted to cropland | $CO_2$ | 9,197.3 | 10.6 | 90.9 |
| 6.B | Waste | $CH_4$ emissions from wastewater handling | $CH_4$ | 3,886.4 | 4.5 | 95.4 |
| 1.A.1 | Energy | $CO_2$ emissions from stationary combustion (liquid-A) | $CO_2$ | 1,301.1 | 1.5 | 96.9 |
| 4.E | Agriculture | $CH_4$ emissions from savannah burning | $CH_4$ | 570.5 | 0.7 | 97.6 |

| IPCC source category | Sector | Source categories to be assessed in Key Category Analysis | Applicable GHG | Total absolute estimate, including LULUCF (2015) ($GgCO_2e$) | Level assessment, ncluding LULUCF (%) | Cumulative level, including LULUCF (%) |
|---|---|---|---|---|---|---|
| 1.B.2 | Energy | $CH_4$ fugitive emissions from oil and gas operations | $CH_4$ | 468.6 | 0.5 | 98.1 |
| 1.A.3 | Energy | $CO_2$ mobile combustion: road vehicles | $CO_2$ | 420.9 | 0.5 | 98.6 |
| 4.B | Agriculture | $CH_4$ emissions from manure management | $CH_4$ | 383.3 | 0.4 | 99 |
| 6.B | Waste | $N_2O$ emissions from wastewater handling | $N_2O$ | 234.6 | 0.3 | 99.3 |
| 1.A.4 | Energy | Other sectors: residential $CH_4$ | $CH_4$ | 206.5 | 0.2 | 99.5 |
| 4.E | Agriculture | $N_2O$ emissions from savannah burning | $N_2O$ | 104.2 | 0.1 | 99.6 |
| 1.A.1 | Energy | $CH_4$ (non-$CO_2$) emissions from stationary combustion | $CH_4$ | 79.8 | 0.1 | 99.7 |
| **TOTAL** | | | | **36,096.70** | | |

Based on the KCA and the uncertainty analysis, it is possible to prioritize efforts to improve the inventory and identify recommendations. These recommendations are provided in the chapter on uncertainty analysis.

## Quality assurance and quality control plan and implementation

Quality checks carried out for this GHG inventory related to calculations, data processing, completeness and documentation are summarized in Table 2.33.

The QA process was carried out by an external reviewer who was not involved in compiling the inventory, in order to guarantee an unbiased review from a different technical perspective. The external reviewer ensured that the inventory's results, assumptions and methods were reasonable. A public review process was also carried out to supplement the external review, which comprised two reviews, one during the data verification stage and another during the report validation process. At the data verification stage, activity data, emission factors and the methodology used were all reviewed. Any comments made were incorporated into the process and used to refine the GHG inventory report, which was then reviewed during the validation stage.

**Table 2.33: Key inventory activity data gaps and recommendations**

| Quality control activity | Procedure |
|---|---|
| The national inventory was checked for transcription errors related to data input and references | Confirmation that all references cited are included in the text and reference list.<br>Input data from each category were cross-checked for transcription errors and accuracy. |
| The national inventory was checked to ensure that emissions and removals by sinks were calculated accurately | The Excel spreadsheet calculations were checked by three different consultants. When calculating the emissions, the consultant in charge (GHG inventory consultant) was responsible for QA and checks. |
| The national inventory was checked to ensure that parameters and units were recorded and that conversion factors were applied appropriately | The units were properly labelled and the conversion factors were consistent for all calculations. |
| The national inventory was checked for time series consistency | Temporal consistency was checked in time series input data.<br>Consistency in the method applied for calculations was verified. |
| The national inventory was checked for completeness | Transparency for all categories and subcategories included and excluded from the inventory was checked.<br>Transparency in the data from incomplete estimates was confirmed. Default IPCC emission factors were used throughout. |
| Trend check | Comparisons were made for time series and transparency trends related to the causes of significant changes or variations.<br>Unusual and unexplained trends for activity data or other parameters across the time series were checked. |

## Uncertainty analysis

Estimates of emissions and removals of GHGs presented in this inventory have uncertainty for several reasons, such as the lack of precise activity data and incomplete knowledge of processes that cause emissions or removals of GHGs. The "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" recognizes that while there will always be a degree of uncertainty in estimates, the objective should be to produce accurate estimates (i.e. estimates that are neither underestimated nor overestimated) and to seek to improve their precision whenever possible.

In accordance with the recommendations, attempts were made to ensure that estimates of GHGs and removals included in the inventory were not biased. Estimate precision varied depending on each sector's available data and resources that could be used to determine emission factors that suited South Sudan's circumstances. Where the KCA identified emissions and removals as the

most important overall, emphasis was given, where possible, to ensuring that the best activity data and emission factors available were used.

The overall level of uncertainty of this inventory lies in the uncertainty associated with the activity and emission factor data used in the estimates, as well as any other parameters. For most sectors, it was not possible to carry out a detailed uncertainty analysis, since it would have demanded consideration effort to analyse the accuracy and precision of the basic information used. Nevertheless, a general evaluation of the inventory's precious was conducted based on the judgment and knowledge of inventory specialists, with the aim being to identify sources of emissions and removals that could be allocated additional resources in the future to reduce the level of overall uncertainty. The precision of activity data, emission factors and emission or removal estimates is expressed as ± a given percentage based on a 95 per cent confidence interval limit.

Table 2.34 details the results of the uncertainty analysis for emission and removal estimates. More detailed descriptions of uncertainties are provided in the sectoral inventory reports.

When considering activity data and emission factors, the highest level of uncertainty relates to LULUCF estimates, specifically those of sources and sinks associated with forest lands and remaining forest lands. The combined uncertainty for such estimates as a percentage of total national emissions for 2015 is 76 per cent. The next highest level of uncertainty also relates to LULUCF emissions, in particular those associated with the conversion of forest land to grassland. The combined uncertainty of these estimates as a percentage of total national emissions for 2015 is 38 per cent.

**Table 2.34: Tier 1 uncertainty calculations and reporting**

| IPCC source category | Gas | 2015 emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as a % of total national emissions for 2015 |
|---|---|---|---|---|---|---|
| | | $GgCO_2e$ | % | % | % | % |
| 1.A.1. Energy. Stationary combustion | $CO_2$ | 1,301.1 | 30.0 | 5.0 | 30.4 | 1.1 |
| | $CH_4$ | 79.8 | 30.0 | 50.0 | 58.3 | 0.1 |
| | $N_2O$ | 3.3 | 30.0 | 100.0 | 104.4 | 0.0 |
| 1.A.2. Energy. Manufacturing industries and construction | $CO_2$ | 20.1 | 50.0 | 5.0 | 50.2 | 0.0 |
| | $CH_4$ | 0.0 | 50.0 | 50.0 | 70.7 | 0.0 |
| | $N_2O$ | 0.1 | 50.0 | 100.0 | 111.8 | 0.0 |
| 1.A.3. Energy. Mobile combustion: road vehicles | $CO_2$ | 420.9 | 50.0 | 5.0 | 50.2 | 0.6 |
| | $CH_4$ | 1.2 | 50.0 | 50.0 | 70.7 | 0.0 |
| | $N_2O$ | 1.1 | 50.0 | 100.0 | 111.8 | 0.0 |
| 1.A.3. Energy. Mobile combustion: aircraft | $CO_2$ | 24.6 | 50.0 | 5.0 | 50.2 | 0.0 |
| | $CH_4$ | 0.0 | 50.0 | 50.0 | 70.7 | 0.0 |
| | $N_2O$ | 0.2 | 50.0 | 100.0 | 111.8 | 0.0 |

| IPCC source category | Gas | 2015 emissions | Activity data uncertainty | Emission factor uncertainty | Combined uncertainty | Combined uncertainty as a % of total national emissions for 2015 |
|---|---|---|---|---|---|---|
| 1.A.4. Energy. Other sectors: commercial | $CO_2$ | 22.4 | 50.0 | 5.0 | 50.2 | 0.0 |
| | $CH_4$ | 19.1 | 50.0 | 50.0 | 70.7 | 0.0 |
| | $N_2O$ | 3.4 | 50.0 | 100.0 | 111.8 | 0.0 |
| 1.A.4. Energy. Other sectors: residential | $CO_2$ | 39.6 | 30.0 | 5.0 | 30.4 | 0.0 |
| | $CH_4$ | 206.5 | 30.0 | 50.0 | 58.3 | 0.3 |
| | $N_2O$ | 37.0 | 30.0 | 100.0 | 104.4 | 0.1 |
| 1.A.4. Energy. Other sectors: agriculture/ forestry/fishing | $CO_2$ | 4.0 | 50.0 | 5.0 | 50.2 | 0.0 |
| | $CH_4$ | 0.0 | 50.0 | 50.0 | 70.7 | 0.0 |
| | $N_2O$ | 0.0 | 50.0 | 100.0 | 111.8 | 0.0 |
| 1.B.2. Energy. Fugitive oil and gas operations | $CH_4$ | 468.6 | 50.0 | 40.0 | 64.0 | 0.8 |
| 2.F. Industrial processes. Substitutes for ozone depleting substances | HFCs | 4.3 | 50.0 | 25.0 | 55.9 | 0.0 |
| 4.A. Agriculture. Enteric fermentation in domestic livestock | $CH_4$ | 10,639.2 | 10.0 | 30.0 | 31.6 | 9.2 |
| 4.B. Agriculture. Manure management | $CH_4$ | 383.3 | 10.0 | 50.0 | 51.0 | 0.5 |
| 4.E. Agriculture. Savannah burning | $CH_4$ | 570.5 | 40.0 | 50.0 | 64.0 | 1.0 |
| | $N_2O$ | 104.2 | 40.0 | 70.0 | 80.6 | 0.2 |
| 4.F Agriculture. Agricultural residue burning | $CH_4$ | 18.0 | 40.0 | 50.0 | 64.0 | 0.0 |
| | $N_2O$ | 8.8 | 40.0 | 70.0 | 80.6 | 0.0 |
| 4.D. Agriculture. (Direct and indirect) agricultural soils | $N_2O$ | 15,039.9 | 10.0 | 50.0 | 51.0 | 21.1 |
| 4.C. Agriculture. Rice production | $CH_4$ | 63.0 | 30.0 | 50.0 | 58.3 | 0.1 |
| 5.A. LULUCF 1. Forest land remaining forest land | $CO_2$ | -25,340.8 | 104.0 | 30.0 | 108.2 | 75.4 |
| 5.B. LULUCF 2. Land converted to cropland | $CO_2$ | 9,197.3 | 67.0 | 30.0 | 73.4 | 18.6 |
| 5.C. LULUCF 2. Land converted to grassland | $CO_2$ | 18,905.2 | 67.0 | 30.0 | 73.4 | 38.1 |
| 6.A. Waste. Solid waste disposal sites | $CH_4$ | 24.3 | 50.0 | 50.0 | 70.7 | 0.0 |
| 6.B. Waste. Wastewater handling | $CH_4$ | 3,886.4 | 30.0 | 40.0 | 50.0 | 5.3 |
| | $N_2O$ | 234.6 | 30.0 | 40.0 | 50.0 | 0.3 |
| **TOTAL** | **36,391.2** | | | | | |

The results in Table 2.34 suggest that efforts to reduce the overall uncertainty of South Sudan's GHG inventory could be focused on only a few emission sources. In total, six source categories contribute to a combined uncertainty that is above 2 per cent as a percentage of total national emissions for 2015. The following recommendations are made to reduce uncertainties associated with these six sources which would greatly reduce the inventory's overall uncertainty:

1. **Carbon stocks for forest land remaining forest land.** The primary activity should be to improve the overall understanding of carbon stocks in forests and the representation of forest lands in the inventory.
2. **Carbon emissions from land converted to cropland.** New land-use data should be gathered to establish the amount of forest lands that have been converted to croplands in recent years. In addition, it is important to improve estimates of the amount of carbon released from these conversions.
3. **$N_2O$ emissions from agricultural soils**. $N_2O$ emissions primarily derive from the application of manure to soil or from manure simply left on grazing lands. Improving livestock population estimates and determining country-specific rates of nitrogen excretion from livestock will greatly improve overall estimates. Country-specific Tier 2 nitrogen excretion rates for different livestock categories describe the annual average nitrogen excretion for each livestock species in the country in kilogram of nitrogen per animal per year. Nitrogen excretion rates can be derived from data on the gas' intake and retention, which typically requires the animal's gross energy intake (megajoules per animal per day), the percentage of crude protein in the animal's diet, milk production of dairy cattle and daily weight gain. Improving the estimates of total quantities of nitrogen fertilizers and agricultural residues applied as fertilizers to fields would also reduce uncertainty.
4. **Carbon emissions from land converted to grasslands.** New land-use data should be gathered to establish the amount of forest lands that have been converted to grasslands in recent years. In addition, it is important to improve estimates of the amount of carbon released from these conversions.
5. **Enteric fermentation**. While Tier 1 emission factors are used in analysis, the adoption of a Tier 2 methodology would significantly improve the quality of the estimates. Using a Tier 2 methodology would require the development of country-specific emission factors based on enhanced livestock characteristics. Data needed for developing such factors includes average daily feed intake or average weight gain per day, feeding conditions, milk production, fat content of milk, percentage of females that give birth, number of offspring and feed digestibility. It is recommended that this is pursued for cattle livestock (dairy and non-dairy), as this population is responsible for 72 per cent of total enteric fermentation emissions. Improvements in the estimates of overall livestock populations would also reduce uncertainty.
6. **Domestic wastewater handling.** Tier 1 emission factors are combined with available data on the prevalence of different domestic wastewater handling systems in South Sudan. The estimate of methane emissions from domestic wastewater handling is based on an estimate of the population using pit latrines (24 per cent) and the methane conversion factor of 0.1 for these latrines. Both activity and emission factor data should be reviewed to determine whether this level of emissions is expected to increase.

## Inventory gaps, needs and recommendations

Since gaining independence, South Sudan has suffered deep political, socioeconomic and humanitarian strife and struggles even to deliver the most basic services to its citizens. A significant number of gaps, needs and constraints were identified when preparing this NC GHG inventory for South Sudan. Gaps not only include information on activity data, but also resources and capacity. There is a strong need for institutional capacity-building and training of government staff to carry out the data collection and analysis required to reduce inventory uncertainties and improve the quality of activity data and emission factors used to generate the report.

The subsections summarize specific gaps, needs and recommendations associated with activity data collection. Several recommendations are also proposed to enhance the country's capacity and move towards the development of an integrated and sustainable GHG inventory system.

### Activity data collection

Key data gaps were identified for activity data and are outlined in Table 2.35 according to IPCC sector. Specific recommendations are also provided that aim to address these data gaps. Additional recommendations related to the key category and uncertainty analyses are included in the previous section.

**Table 2.35: Key inventory activity data gaps and recommendations**

| IPCC sector | Key activity data gap identified | Recommendation for addressing data gap |
|---|---|---|
| **Energy** | National energy balances, including imports, exports, consumption and international bunker data for major economic sectors, are unavailable (e.g. residential, commercial, transportation, industry, etc.). | National energy balances should be routinely prepared by the Government through a collaboration of relevant ministries (e.g. Ministry of Finance and Economic Planning, Ministry of Petroleum and Mining, Ministry of Electricity and Dams). Accurate data on fuel imports and crude exports are also important for forecasting the national energy demand and planning the supply. |
| | Customs data acquired through the project was of low reliability and quality. Data on fuel imports and the imports of some equipment were difficult to reconcile and may contain different types of errors (e.g. omissions, transcription errors, transposition errors, mixed units, etc.). | Further efforts for QA/QC are needed to increase the reliability and usefulness of customs data. Consideration should be given to the establishment of an enhanced QA/QC system to improve data reviews and corrective action. |

| IPCC sector | Key activity data gap identified | Recommendation for addressing data gap |
|---|---|---|
| | Estimates of woodfuel and charcoal consumption have very high uncertainty and are not based on recent surveys. The values used in this report have been adjusted from per capita consumption statistics for East Africa based on expert opinion. | A nationwide bottom-up survey of producers or a top-down survey of consumers should be conducted (e.g. by the Ministry of Environment and Forestry, Ministry of Energy and Dams, Ministry of Agriculture and Food Security) to reduce the level of uncertainty associated with woodfuel and charcoal production and demand. These data will also advise the formulation of South Sudan's energy policy with regard to domestic biomass use. |
| | Only the most basic information on South Sudan's total oil and gas output Sudan was collected. It is unclear how much fuel is consumed nationally for extraction and distribution, especially in terms of self-consumption (e.g. captive generation plants). It is also unclear how much of this fuel may only be refined for self-consumption. Currently, nearly half of all national energy emissions in the oil and gas sector are estimated to be from self-consumption. | Information should be collected from South Sudan's national oil and gas company, the Nile Petroleum Corporation (Nilepet), so that proper estimates can be made of GHG emissions related to the combustion of crude oil and other refined products for extraction and distribution. Knowledge of the difference between gross production and total exports would also be very useful, since all oil production is exported. |
| | Estimates of installed capacity of grid electricity can be reported by the Ministry of Finance and Economic Planning, the Ministry of Electricity and Dams and the SSEC. However, not much is known about the capacity factor and conversion efficiency of these units. | A report should be developed that clearly articulates the annual operational characteristics and fuel consumption of generators providing electricity to the grid, including decommissioned and temporarily non-operational units. This kind of monitoring would also facilitate better management of electricity generation and fuel consumption. |
| **Industrial processes** | There is no information available on the amount of HFCs imported annually in bulk and in products. Bulk imports of HFCs could possibly be tracked by customs, though better accounting of products that typically contain HFC materials would also be helpful. For example, refrigerators are listed in the customs tracking form, but no data were collected before 2016. | Training and support should be provided to customs agents so that products containing HFCs (air conditioners, refrigerators and aerosol products) can be reliably tracked. If implemented, this would make it possible for a survey to be conducted to accurately estimate the number of imported products that contain HFCs, as well as the charge and type of HFCs in the products. |

| IPCC sector | Key activity data gap identified | Recommendation for addressing data gap |
|---|---|---|
| **Solvent and product use** | This inventory does not provide estimates of emissions from solvent and product use. Information on imported solvents, paints and bulk nitrous oxides is currently not obtainable from customs data. | Data could be collected that summarizes annual quantities in consistent units for different solvents, paints and nitrous oxide using HS codes for tracking. |
| **Agriculture** | Agriculture emissions (which total 78 per cent of those recorded in the inventory) are largely from livestock, either directly through enteric fermentation or agricultural soils and management of manure on pasture. Emission estimates were made using Tier 1 methods and have a high level of uncertainty. Livestock population estimates are also highly uncertain. | Given that agricultural emissions largely comprise the inventory's overall emissions, attention should be focused on:<br>1. verifying livestock animal populations<br>2. collecting data so that Tier 2 methods can be used for enteric fermentation (average body weight, gross energy intake)<br>3. collecting data so that Tier 2 methods can be used for manure management emissions (country-specific daily volatile solid excretion, $CH_4$ conversion factors by management system and climate region, maximum $CH_4$ producing capacity for livestock manure)<br>4. improving estimates of the default emission factor for the amount of $N_2O$ emitted from urine and dung deposited by grazing animals on pasture, ranges and paddocks (i.e. 2 per cent of N deposited by cattle, donkeys and swine and 1 per cent by sheep and goats). |
| | The area of prescribed savannah burning was estimated from IPCC defaults. The area of 3,486 kha should be reviewed. | An assessment should be carried out on savannah burning to determine whether the estimated areas burned represent existing management conditions in South Sudan. |
| | Prescribed crop residue burning was estimated for two major crops (sorghum and maize). IPCC defaults were used to estimate the tons of dry matter burned from the tons of sorghum and maize produced. | The Ministry of Agriculture and Food Security should review the assumptions regarding prescribed crop residue burning and, if necessary, conduct surveys to estimate the extent of the practice for different crops. |

| IPCC sector | Key activity data gap identified | Recommendation for addressing data gap |
|---|---|---|
| **LULUCF** | Changes in land use were estimated using a very limited forest-oriented data set of land-use classification from the FAO. The data were used as they were the best available when work for the inventory was being carried out. | New data sets from geographic information systems (GIS) should be made available to estimate changes in land-use classifications and potential changes in biomass density for forests and land uses in South Sudan. Continued research and effort is required to improve the understanding of South Sudan's existing carbon pools. |
| | The biomass density of existing forests was estimated based on a very limited data set. | |
| | Estimates of wood removed from forests for woodfuel and charcoal were based on per capita consumption estimates and are unreliable and not based on recent surveys. | Improved estimates of woodfuel removal and charcoal production would enhance the robustness of the LULUCF sector's removal and emission estimates. |
| **Waste** | Estimates of domestic and industrial solid waste sent to SWDS have a high degree of uncertainty. Work carried out for this inventory only drew on collection and generation rates, rather than knowledge of SWDS, their characteristics and operation. | Data should be gathered on the amount of contracted waste collected and deposited to disposal sites. Such data should be estimated either through weight records or the number of recorded vehicle loads. Information should be collected for sites receiving waste, particularly on their depth of waste, coverage material, extent of mechanical compacting and levelling of waste, degree of scavenging, control of fires and whether leachate drainage systems or gas ventilation systems are in place. |
| | Estimates of overall improved sanitation are from UNDP's 2014 statistics for South Sudan. Estimates of the percentage of the population using pit latrines and septic systems should be reviewed to determine whether they are reasonable. | An expert review of domestic wastewater treatment systems should be conducted to validate the assumptions that there are no significant wastewater treatment plants and that primary treatment systems are either limited to pit latrines and septic systems or carry out no treatment. |

### Capacity-building

Capacity-building is required at both the institutional and personnel levels and multi-sectoral representation (i.e., energy, industrial processes, solvent and product use, agriculture, LULUCF and waste) is important. Although some basic training on GHG inventory work has been provided, it is recommended that training workshops be conducted as part of future GHG inventory work to provide sectoral level training to both government staff and local consultants. These workshops should focus on familiarizing a wide audience of stakeholders with inventory methodologies and tools, engaging them in the data-collection process and providing them with hands-on experience with inventory data, methods and tools. The ultimate objective should be that appointed government staff can complete considerable aspects of inventory work with limited outside consultancies.

Different national and county government departments and organizations integral to information gathering for the different sectors (e.g. Ministry of Agriculture and Food Security, Ministry of Environment and Forestry, Ministry of Livestock and Fisheries Industries, Ministry of Finance and Economic Planning, Ministry of Petroleum and Mining, Ministry of Electricity and Dams) need to develop their capacity to support GHG inventories. One suggested approach is to provide training for sector leads from each of the six major sink/source categories (energy, industrial processes, solvent and product use, agriculture, LULUCF and waste). It is recommended that when developing future inventories, the responsibilities, roles, resources and training for sectoral teams should be clearly identified from the outset. Government officials that are ultimately responsible for preparing the inventory should receive sector training to enable them to provide assistance to national experts.

Capacity-building should be designed to establish ongoing data collection and analysis in all the relevant government ministries and departments, and should include the necessary private sector participation at both the association and industry sector levels.

**Sustainable greenhouse gas inventory systems**

Developing a sustainable GHG inventory system should be an ultimate objective for South Sudan, so that it can address the challenge of more frequent and demanding reporting of inventories to the UNFCCC. Frequent, accurate, consistent, complete and transparent reporting for South Sudan is crucial for not only meeting international obligations but also for assessing Nationally Appropriate Mitigation Actions (NAMAs) and Intended Nationally Determined Contributions (INDCs), and for projecting global progress towards targets to prevent dangerous climate change warming.

In the context of more frequent reporting of national GHG inventories by non-Annex I Parties, it is imperative that the preparation process shift from a project-based approach to a more internalized and institutionalized approach.[104] This shift would support the timely delivery of the required information and more efficient use of available resources by Parties. South Sudan's First National Communication (FNC) is expected to be completed with local consultation and validation. However, there is no clear internal structure or sufficient capacity to permit the takeover of inventory development. To this end, as much as possible the consultants have attempted to keep clear records of activity data used in this inventory and methodologies followed so that they will be useful in preparing future inventories.

The key components of a sustainable GHG inventory system that have been identified by IPCC and UNFCCC guidelines are indicated below:

- institutional arrangements
- methods and data documentation
- QA/QC procedures
- archiving
- Key Category Analysis
- inventory improvement planning.

A brief description of each of these components follows. However, any system must be tailored to account for national circumstances and constraints. Further details of these components are available from the United States Environmental Protection Agency's (US EPA) approach to building sustainable national GHG inventory management systems using pre-defined National System Templates.

### Institutional arrangements

Institutional arrangements identify how different organizations can work together for collective action. These arrangements can be either formal or informal, and should include provisions that define the roles and responsibilities of all the organizations that are involved in the inventory preparation process, including key stakeholders. In South Sudan, the Ministry of Environment and Forestry had overall responsibility for the FNC, including the preparation of the GHG inventory, however there was no established special agency responsible for coordinating QA/QC activities. This function was performed by the consultants, who identified data sources and providers in consultation with the thematic working groups for each of the six IPCC emission sectors. For future inventories, it is highly recommended that the Government of South Sudan mandates an agency that will be responsible for QA/QC procedures during the GHG inventory preparation process.

By assessing and documenting the strengths and weaknesses of existing institutional arrangements for inventory development, inventory teams can ensure the inventory's continuity and integrity, promote the institutionalization of the inventory process, and facilitate the prioritization of future improvements. Memorandums of Understanding (MOUs) can be executed between the lead institution and lead sector institutions, clearly outlining the expected deliverables and responsibilities and ensuring that they have a mandate for making ongoing contributions to inventory preparations. By clearly defining institutional arrangements, it will be easy to assess the existing capacity gaps and how they should be addressed.

A sustainable GHG inventory system is best served by a strong lead institution that has a sound and capable expert team to develop inventories without extensive support from external consultants.

### Methods and data documentation

Documenting the choice of methodologies and the activity data and emission factors used to prepare estimates of GHG emissions and removals is critical to the transparency of the inventory. Identifying documentation procedures can help inventory teams report the origin of methodologies, activity data sets and emission factors used to estimate emissions or removals. Future inventory teams can then refer to the documentation to determine what information was collected, how the data were obtained, and what methods were used, as well as to reproduce estimates.

### Information on quality assurance/quality control

Quality assurance (QA) is a planned system of reviewing procedures. It is performed by personnel not directly involved in the inventory compilation and development process. Quality control (QC) is a system of routine technical activities to assess and maintain the quality of the inventory

as it is being compiled, performed by the personnel compiling the inventory. Identifying QA/QC procedures can help establish a cost-effective QA/QC programme that improves transparency, consistency, comparability, completeness and confidence in national GHG inventories.

### Archiving

Archives refer to a collection of records in a given location that have been created as the inventory has been developed (references, methodological choice, expert comments, revisions, etc.). An archive system helps make a national inventory transparent, allows estimates to be easily reproduced and facilitates the development of subsequent inventories by future inventory team members.

The lead institution should consider employing an Archiving Officer to undertake this task.

### Key Category Analysis

Key Category Analysis (KCA) has been conducted for this inventory and identifies the sources and/or sinks that make the greatest contribution to national emissions, and which thus should be the focus of improvement efforts. Resources should be allocated to prioritize the necessary data collection and development of country-specific emission factors.

### Inventory improvement plan

The concept of continual improvement is useful in developing inventories with the objective of increasing the transparency, consistency, comparability, completeness and accuracy of inventories over time. Inventory improvement planning is the process of developing specific priorities for future capacity-building projects based on the needs identified for each of the key components of sustainable GHG inventories (i.e., institutional arrangements, methods and data documentation, QA/QC procedures, archiving and KCA). One of the key inputs into the inventory improvement process should be feedback obtained through reviews of previous GHG inventory reports.

## Summary tables

Table 2.36: Summary tables by sector

| | Inventory year: 2015 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Source | Energy subsector | Emissions/removals (Gg $CO_2$ emissions) | | | | Total (Gg $CO_2$ emissions) |
| | | | Net $CO_2$ | $CH_4$ | $N_2O$ | HFC | |
| | **Total including LULUCF** | | **4,589.72** | **779.75** | **194.14** | **0.00** | **5,563.61** |
| | **Total excluding LULUCF** | | **1,828.72** | **779.75** | **194.14** | **0.00** | **2,802.61** |
| Energy sector | Combustion emissions | 1. Energy industries | 1,301.00 | 3.80 | 10.70 | -00 | **1,315.50** |
| | | 2. Manufacturing industries and construction | 20.10 | 0.00 | 0.16 | -00 | **20.26** |
| | | 3.a. Civil aviation | 24.60 | 0.00 | 0.21 | -00 | **24.81** |
| | | 3.b. Road transportation | 421.00 | 0.06 | 3.51 | -00 | **424.57** |
| | | 4.a. Commercial/Institutional | 18.40 | 0.91 | 10.90 | -00 | **30.21** |
| | | 4.b. Residential | 39.60 | 9.83 | 119.00 | -00 | **168.43** |
| | | 4.c. Agriculture/Forestry/ Fishing | 4.02 | 0.27 | 0.03 | -00 | **4.32** |
| | Fugitive emissions | 2.a. Oil | -00 | 13.80 | -00 | -00 | **13.80** |
| | | 2.b. Natural gas | -00 | -00 | -00 | -00 | **-00** |
| | | 2.c. Venting and flaring | -00 | 8.56 | -00 | -00 | **8.56** |
| | **TOTAL ENERGY EMISSIONS** | | **1,828.72** | **37.23** | **144.51** | **-00** | **2,010.46** |
| | | | | | | | |
| Industrial process sector | Consumption of HFCs | 2. Product emissions | -00 | -00 | -00 | 0.0043 | **0.0043** |
| | **TOTAL ENERGY EMISSIONS** | | **-00** | **-00** | **-00** | **0.0043** | **0.0043** |
| | | | | | | | |
| Agriculture sector | A. Enteric fermentation | | -00 | 507.00 | -00 | -00 | **507.00** |
| | B. Manure management | | -00 | 18.30 | -00 | -00 | **18.30** |
| | C. Rice cultivation | | -00 | 3.00 | -00 | -00 | **3.00** |
| | D. Agricultural soils | | -00 | -00 | 48.50 | -00 | **48.50** |
| | E. Prescribed burning of Savannahs | | -00 | 27.20 | 0.34 | -00 | **27.54** |
| | F. Field burning of agriculture residues | | -00 | 0.86 | 0.03 | -00 | **0.89** |
| | **TOTAL AGRICULTURE EMISSIONS** | | **-00** | **556.36** | **48.87** | **-00** | **605.23** |
| | | | | | | | |
| Waste sector | A.2. Solid waste disposal on land | | -00 | 1.16 | -00 | -00 | 1.16 |
| | B.2. Domestic and commercial wastewater | | -00 | 185.00 | 0.76 | -00 | 185.76 |
| | **TOTAL WASTE EMISSIONS** | | **-00** | **186.16** | **0.76** | **-00** | **186.92** |

| | Land-use category | | Carbon pool | Sector in IPCC Guidelines | Annual change in carbon stocks $CO_2$ (Gg) for 2005 to 2015 |
|---|---|---|---|---|---|
| | Initial land use | Land use during reporting year | | | |
| Land use, land-use change and forestry (LULUCF) | FL | FL | Living biomass | 5A | (25,341.0) |
| | Subtotal for forest land | | | | (25,341.0) |
| | FL | CL | Living biomass | 5B | 9,197.0 |
| | Subtotal for cropland | | | | 9,197.00 |
| | FL | GL | Living biomass | 5B | 18,905.0 |
| | Subtotal for grassland | | | | 18,905.00 |
| | Subtotal for other land | | | | -00 |
| | **TOTAL** | | | | **2,761.00** |

CHAPTER 3

# PROGRAMMES CONTAINING MEASURES TO FACILITATE ADEQUATE ADAPTATION TO CLIMATE CHANGE

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## Introduction

Although South Sudan has little historical or current responsibility for global climate change, and national emissions are small relative to global emissions, the country is highly vulnerable to the impacts of climate change. Adaptation to climate change is therefore the country's main priority. At present, South Sudan has low adaptive capacity to withstand the adverse impacts of climate change due to the high dependence of a majority of the population on climate-sensitive sectors, coupled with poor infrastructure facilities, conflict and insecurity, weak institutional set-ups and a lack of financial resources.

Assessing the impacts of present and projected climate change on natural and socioeconomic systems is therefore central to the issue of climate change for South Sudan. When preparing this chapter on measures to facilitate adequate adaptation to climate change, an assessment was conducted to identify climate change impacts (now and in the future) and the most vulnerable areas in each of the seven agroecological zones of South Sudan. The assessment involved using documented historical climate information as an indicator of future climate, and how this change would impact the following key livelihood sectors in South Sudan:

- agriculture
- hydrology and water
- forestry.

The three factors of vulnerability (exposure, sensitivity and adaptive capacity) were also assessed. Following a workshop aimed at identifying climate change impacts now and in the future, the most vulnerable areas and ongoing and planned adaptation measures, a critical analysis of the links between climate, sector impacts and the current socioeconomic baseline conditions in South Sudan was carried out. This led to the key areas that are vulnerable to climate change being identified. Based on the analysis of ongoing and planned adaptation measures to address climate change in these areas, recommendations of measures needed to fill the gaps and integrate adaptation into national strategies were proposed.

## Baseline climatic, environmental and socioeconomic scenario

South Sudan's baseline climatic, environmental and socioeconomic scenarios have been described in detail in chapter 1 of this INC report. The country is situated between latitudes 3°N and 13°N and longitudes 24°E and 36°E with varied landforms of plains, mountains and plateaus. These landforms are drained by the Nile and its numerous tributaries, with the clay plains of the Sudd Wetland – consisting of lakes, marshes and extensive floodplains – covering close to 100,000 $km^2$ of the central part of the country.

The country has distinct climatic areas, which are influenced by the annual movements of the Intertropical Convergence Zone. The rainfall pattern is seasonal, with the rainy season lasting from April to October, with a short dry spell in June, followed by the dry season between November and March.

South Sudan faces several development challenges due to decades of political instability, poverty and persistent food insecurity, all of which are exacerbated by climate change. With more than

50 per cent of the population living below the national poverty line, a weak economy and ongoing political conflict, South Sudan also ranks among the most fragile states in the world. Despite its fertile soils and abundant water making it one of the richest agricultural areas in Africa, frequent flooding, droughts, ongoing conflict and the displacement of millions of people have drastically reduced food production, to the point where an estimated 7.5 million people are currently considered food insecure.[105] Other challenges exacerbating environmental destruction include: forest fires, overgrazing, traditional quarrying methods, charcoal burning and oil exploration.

## Climate change in South Sudan

According to the Government of South Sudan, climate change in South Sudan is manifested in:

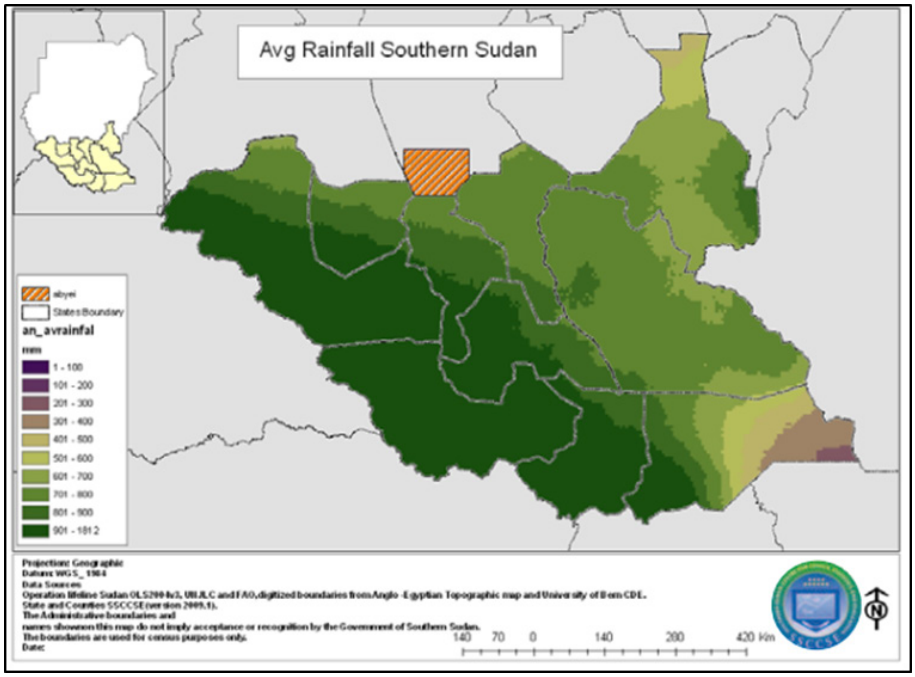
- erratic duration and timing of rain
- delayed and shorter rainy season
- some areas receiving generally less rain, leading to a drop in water tables
- the southward expansion of desert.[106]

### Present climate change (trends and baseline)

The country has distinct climatic areas, which are influenced by the annual movements of the Intertropical Convergence Zone. Climate ranges from hot and dry in the south-east near the border with Kenya and north-east near the border with Sudan, to temperate in the southern highlands. South Sudan receives about 1 billion $m^3$ of rain annually, which can be classified into two major rainfall regimes – unimodal and bimodal. The unimodal rainfall regime occurs in the north, with a six-month wet season from May to October. The southern part of the country comprised of Greater Equatoria (Western, Central and Eastern Equatoria) has a bimodal rainfall regime with high rainfall for 7–8 months a year, while the rest of the country has a unimodal regime. The country receives most of its rain during the long-rain season between June and September, which provides enough water across parts of the country for farming and livestock.

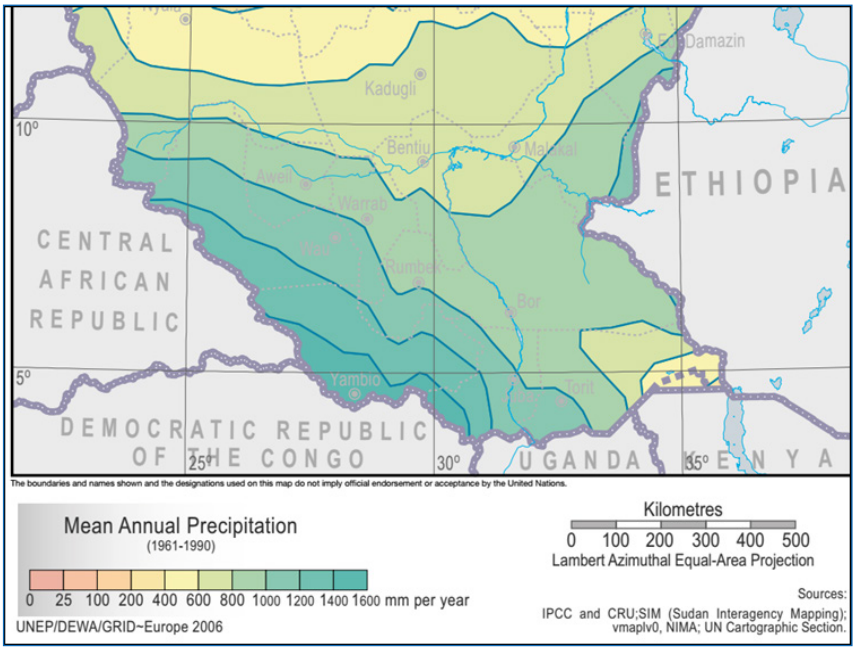
Data show a prevalent rainfall pattern of low precipitation in the north-east and south-east, and high rainfall in the south-west (Figure 3.1 and Figure 3.2): the area along the border with the Central African Republic, the Democratic Republic of Congo and Uganda receives the most rainfall throughout the year. There is considerable variation in rainfall from year to year and from location to location.

**Figure 3.1:** Average rainfall in South Sudan




Source: South Sudan, National Bureau of Statistics.

**Figure 3.2:** Precipitation zones of South Sudan




Source: UNEP, 2017.

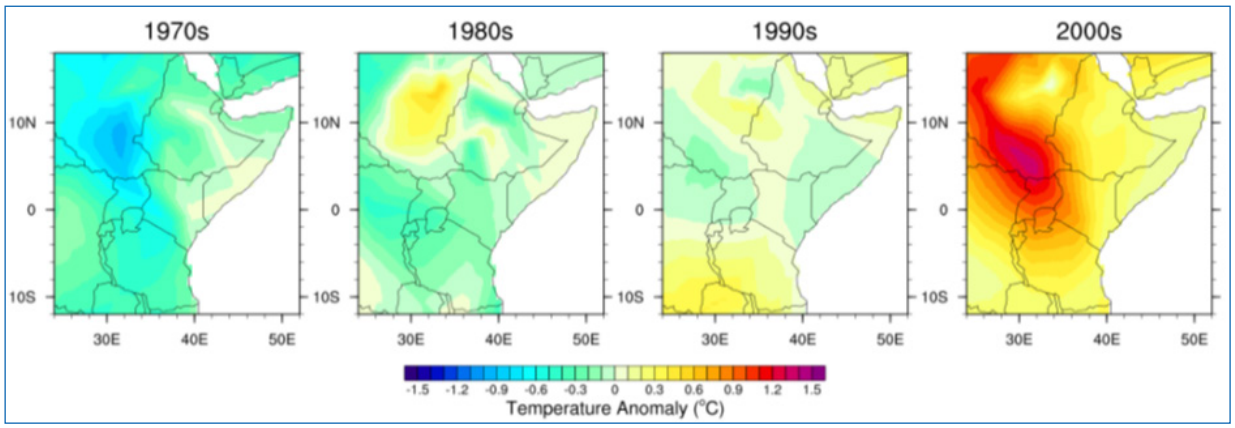
As already noted in chapter 1 of this report, the country's climate is semi-humid, with significant variations in rainfall and the length of the dry season: annual rainfall ranges from 200 mm in the south-east (Eastern Equatoria) to 1,200–2,200 mm in the forest zone in Western Equatoria and the Equatoria highlands. In the northern states, rainfall varies between 700 mm and 1,300 mm. Mean annual temperatures vary between 26°C and 32°C. Temperature in South Sudan varies with location: average temperatures range between 18°C and 30°C, with the coldest temperatures experienced in elevated areas. The hottest month is generally March, whereas the coldest is August.

## Historical climate

### Temperature

Over the past decades, the temperature in South Sudan has increased considerably compared with other regions in the Eastern Africa region. Significant warming over the past 30 years has been observed, with the central and southern regions of South Sudan reportedly among the most rapidly warming locations on the globe, with station temperatures increasing as much as 0.4°C per decade.[107] A mean increase in annual temperature between 1951 and 2000 of 1.3°C per century has been reported.[108] Figure 3.3 shows the difference between the mean decadal (ten-year) temperature and the mean temperature over the 1963 to 2012 period from data taken from the Climatic Research Unit (CRU) TS3.22 data set. The figure shows that much of South Sudan was over 2°C warmer on average in the 2000s than in the 1970s.

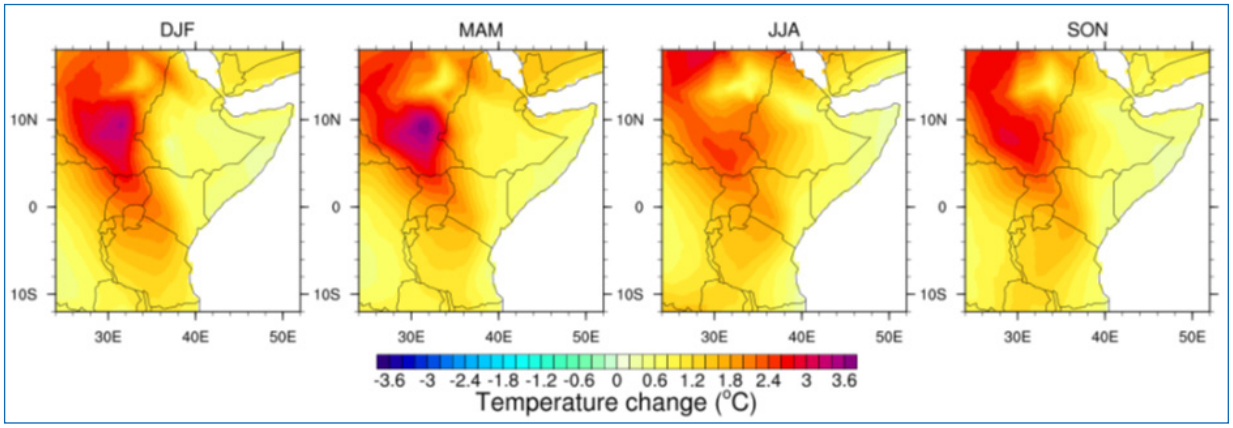
**Figure 3.3: Difference between mean decadal temperatures and 1963 to 2012 mean temperatures at each grid cell. Data taken from the CRU TS3.22 data set**




Source: Daron, 2014.

Figure 3.4 shows the seasonally averaged spatial and temporal changes in temperature in East Africa during the period 1963 to 2012. Despite annual and decadal variability across all seasons and locations, temperature increases were generally higher (approximately 1.8°C to 3.8°C) in the central and north-western part of the region, and especially in South Sudan. While there was an increase in temperatures in all seasons, the highest increases were found in the March–May period.

**Figure 3.4: Temperature change between 1963 and 2012 at each grid cell, according to a linear trend, for the four seasons: December, January and February (DJF), March, April and May (MAM), June, July and August (JJA) and September, October and November (SON). Data taken from the CRU TS3.22 data set**

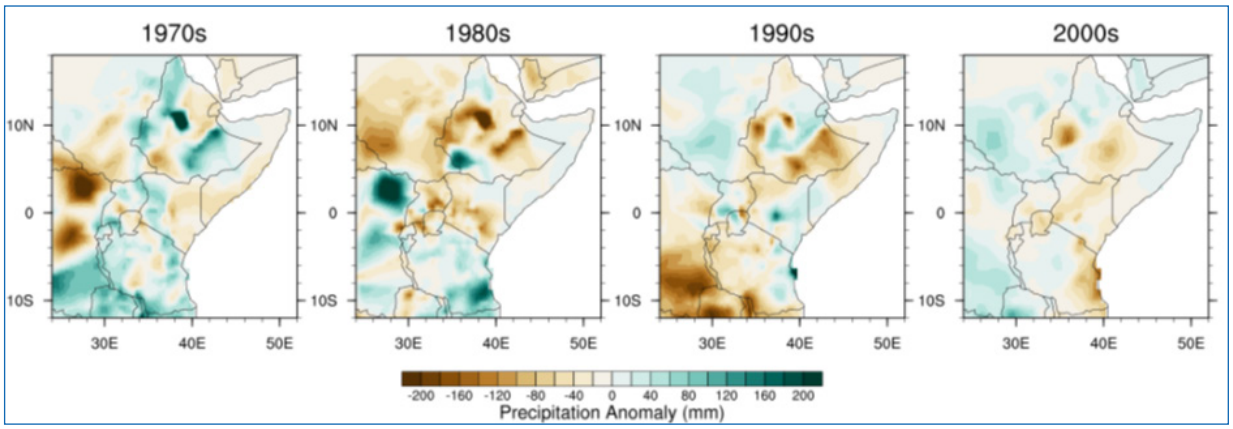



Source: Daron, 2014.

### Rainfall

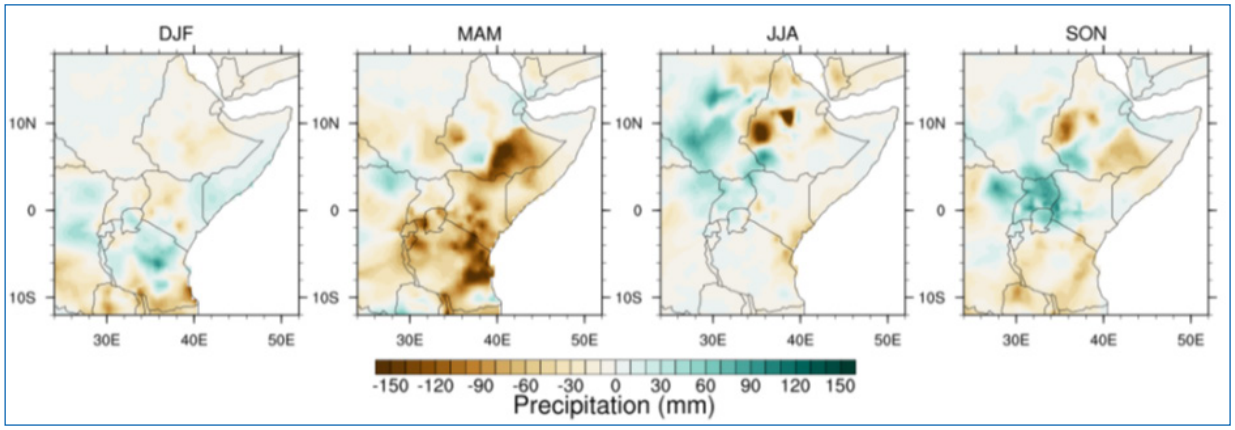
Data taken from the CRU TS3.22 data set for the period between the 1970s and 2000s do not show major decadal changes in rainfall (Figure 3.5). However, a 10 to 20 per cent decline in rains and increased variability in the amount and timing of rainfall from year to year and from region to region since the mid-1970s have been reported.[109] Figure 3.6 shows how the total rainfall has changed for each season from 1963 to 2012. For South Sudan, the most notable change is in the June–August season, with increased rainfall. As noted by Daron (2014),[110] observations of rainfall are nevertheless subject to substantial uncertainty and must be treated cautiously and the conclusions must be interrogated in the context of additional regional and local-scale information and observed data sets.

**Figure 3.5: Difference between decadal mean annual rainfall totals and 1963 to 2012 mean annual rainfall totals for each grid cell. Data taken from the CRU TS3.22 data set**




Source: Daron, 2014.

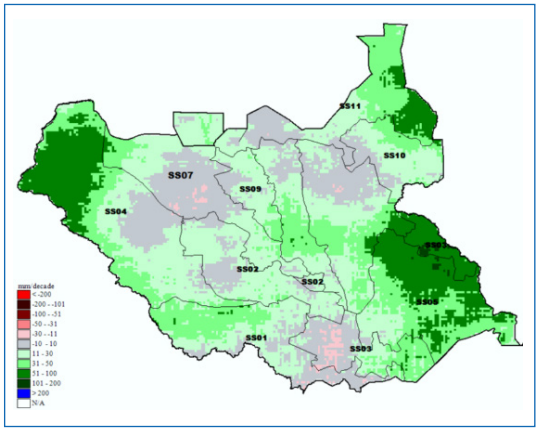
**Figure 3.6: Change in rainfall between 1963 and 2012 at each grid cell, according to linear trend, for the seasons: December, January and February (DJF), March, April and May (MAM), June, July and August (JJA) and September, October and November (SON). Data taken from the CRU TS3.22 data set**




Source: Daron, 2014.

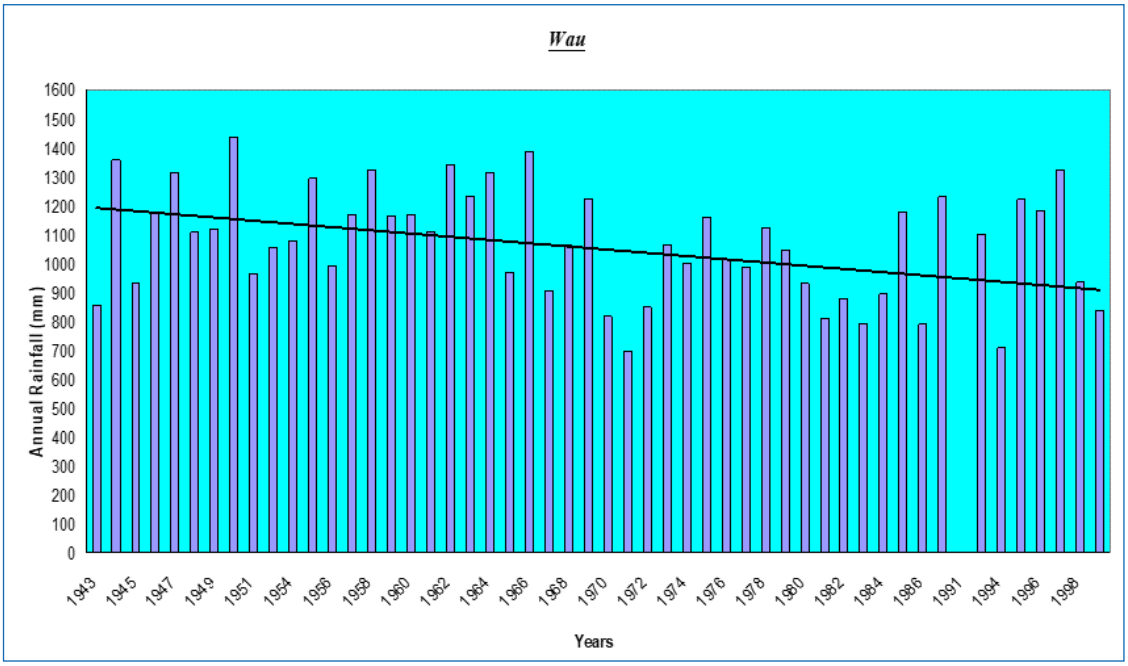
An analysis of weather station data for the period 1981–2013 indicates high rainfall variability across the regions (Figure 3.7). Whereas the southern and central regions have experienced a decrease in rainfall, some parts of the western and eastern regions have experienced increased rainfall.[111]

**Figure 3.7: Rainfall trend overlaid with livelihood zones as defined by WFP (grey areas indicate a decreasing trend while green areas indicate an increasing trend)**




Annual rainfall measurements at Renk, Juba, Malakal, Raga and Aweil meteorological stations in South Sudan from 1975 to 2010 show no clear trend of annual rainfall decrease but significant fluctuations from year to year. Data on monthly rainfall in Malakal between 1990 and 2010 show a trend of delayed and shortening rainy seasons over time. A longer period of data (1975 to 2010) from Aweil shows a similar trend and, moreover, a tendency towards an earlier finish to the rains, resulting in a more drastic shortening of the rainy season.[112] A mean precipitation decline of 41 mm per month per century between 1951 and 2000 has been reported.[113] A 58-year trend test of annual rainfall (1943–2000) conducted by the World Bank preliminary water information assessment study in 2011 for Wau station, Western Bahr el Ghazal shows a declining trend with a 95 per cent confidence interval (Figure 3.8).

**Figure 3.8:** Decreasing trend in Wau annual rainfall




Source: Government of South Sudan, 2011.

South Sudan receives most of its rain between June and September, and rainfall totals of more than 500 mm during this season typically provide enough water for farming and livestock. Between 1960 and 1989, the region receiving (on average) this much rain or more was vast – over 858,000 km$^2$. This area has decreased in the last 20 years, exposing populations in Upper Nile, Jonglei and Eastern Equatoria to increased rainfall deficits. In the Upper Nile, the 500 mm rainfall band moved south by 1 degree, from approximately 11°N to 10°N. If present rainfall trends continue, by 2025 the drying impacts are likely to reach Western and Northern Bahr el Ghazal, Warrap, Unity, Lakes and Central Equatoria, which have a combined population of 4.1 million. The area receiving more than 500 mm of rainfall could shrink by 249,000 km$^2$ (30 per cent of the 1960–1989 area), leaving a large number of people exposed to increased food insecurity and impacting crop production in the south-eastern part of the country.[114]

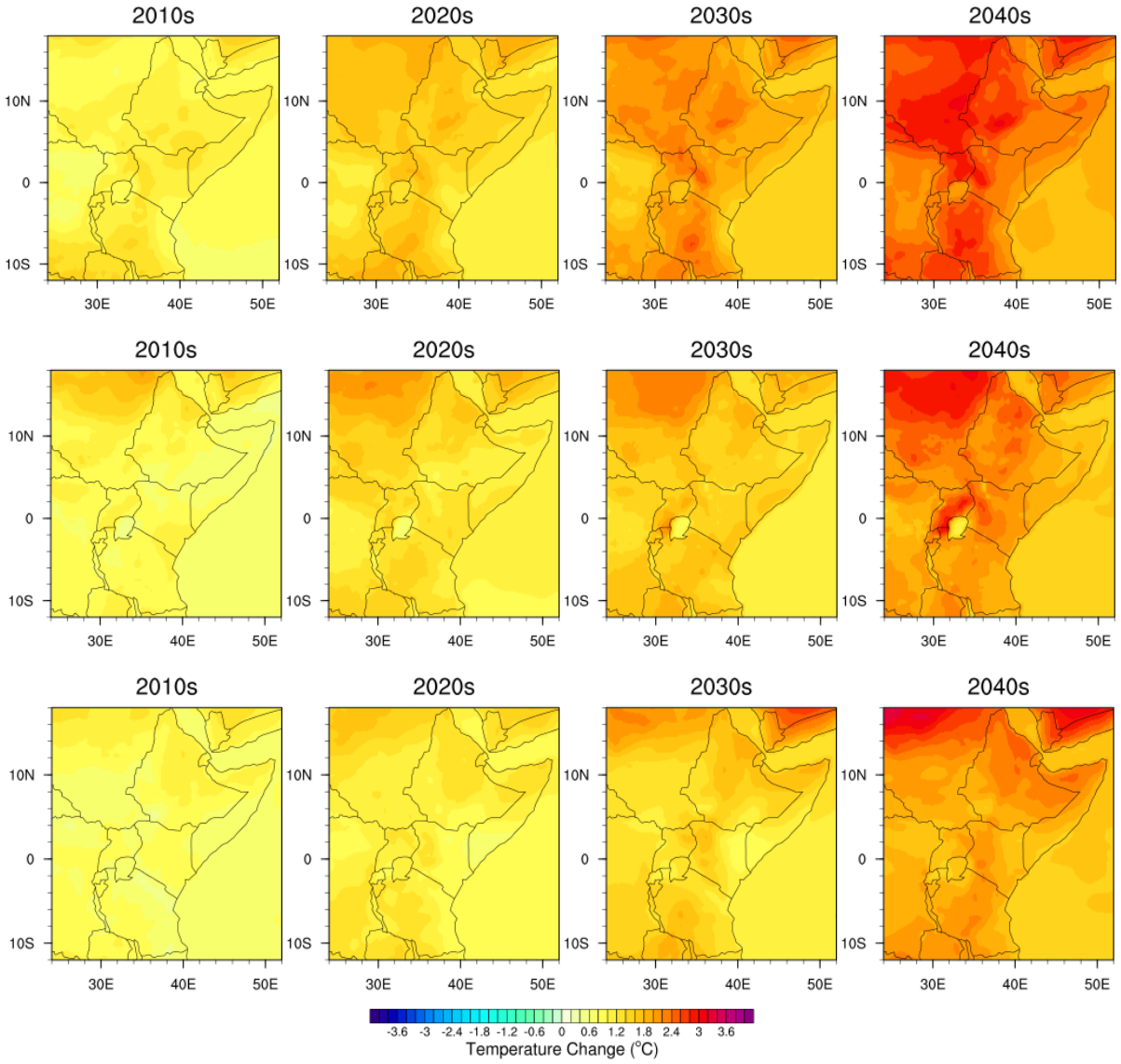
## Future climate

### Temperature

All projections agree that South Sudan will get warmer by 2060, with lower increases in the south. By 2060, warming is projected to range from 1.5°C to 3.1°C during August to between 1.1°C and 2.1°C during January.[115] General Circulation Models (GCMs) indicate that the annual mean temperatures in South Sudan have risen since the 1960s. The GCMs indicate that the mean annual temperature is projected to increase by 1°C from 2020 values by 2060.[116] Temperatures are projected to increase by 0.6–1.7°C by the 2030s and by 1.1–3.1°C by the 2060s compared with the 1961–1990 GCM baseline. Projections suggest that the number of days and nights that are considered 'cold' in the current climate will become very rare.

Figure 3.9 shows decadal changes in mean temperature for three CORDEX models[iv] under the RCP8.5 scenario: A = HadGem2-CCLM4; B = ICHEC-CCLM4; and C = ICHEC-KNMI. All models indicate that substantial increases will occur in South Sudan.

**Figure 3.9: Difference between decadal mean temperatures and the 1950–2000 mean temperatures, at each grid cell, for three CORDEX models under the RCP8.5 scenario: A = HadGem2-CCLM4; B = ICHEC-CCLM4; and C = ICHEC-KNMI**




Source: Daron, 2014.

## Rainfall

While there is no consensus on the direction of change in rainfall in most projections, the current increased variability of rains, in terms of onset, duration and totals, is likely to continue. The variability in rainfall is high in the semi-arid northern and eastern parts of the country. Changes in climatic patterns, both long-term and seasonal, have a detrimental effect on people's livelihoods

[iv] Coordinated Regional Climate Downscaling Equipment.

including those that depend on climate-sensitive income, such as seasonal or daily agricultural labour, sale of rain-fed crops and fishing.

Projections of rainfall under climate change conditions shows sharp deviations from baseline expectations. Results from some of the models show average rainfall decrease of about 6 mm/month during the rainy season.[117]

## Future climate change implications

Since 1980, substantial warming has been observed in South Sudan. This warming, which is two and a half times greater than the global average air temperature change, is making 'normal' years effectively drier.[118] Any observed warming of more than 1°C is equivalent to another 10–20 per cent reduction in rainfall.[119] This warming will lead to reduced and variable rainfall. The combination of the effects of warmer and drier weather conditions leads not only to increasing evapotranspiration and more droughts, but also to more flooding as rain becomes more unpredictable and inconsistent in volume. Consequently, these changes will affect agriculture and natural resources, which are the main livelihood sources of over 80 per cent of the population. Unless communities adapt to these climatic changes, they will reduce agricultural production, increase food insecurity, waterborne diseases and conflict and generally hinder the socioeconomic development of South Sudan.

| Box 1: Key facts about climate trends in South Sudan | |
|---|---|
| **Historical change** | **Future change** |
| 1. Much of South Sudan was over 2°C warmer on average in the 2000s than in the 1970s, with the central and southern regions registering an increase of as much as 0.4°C per decade – one of the highest worldwide.<br>2. Rains in South Sudan have declined by 10–20 per cent since the mid-1970s.<br>3. A general trend of a delayed and shortened rainy season over the years has been reported in many places. | 1. The 858,000 km$^2$ area receiving more than 500 mm rainfall between 1960 and 1989 has declined in the last 20 years and is expected to reduce by 249,000 km$^2$ (30 per cent of the area) if present rainfall trends continue by 2025.<br>2. South Sudan will get warmer by about 1°C by 2060 compared with 2020 values.<br>3. Average rainfall is expected to decline by 10–20 per cent for any observed warming of more than 1°C. |
| **Climate change implications** | |
| **A warm climate and drier weather have strong food security implications, reducing crop harvests and pasture availability, and amplifying the impacts of droughts and floods in South Sudan. Rain-fed agriculture may be rendered unsustainable if the current climate changes trend continues.** | |

## Extreme weather events

Extreme weather events in South Sudan are indicators that the climate is changing. The rainy season used to be from March/April to October/November. However, this pattern is changing. Seasonal patterns are becoming erratic and rain-fed agricultural areas have been decreasing

noticeably in the north and east of South Sudan.[120] Drought and floods are among the main sources of vulnerability in South Sudan, with about 56 per cent of the population surveyed reporting to be vulnerable to drought and flood shocks.[121]

The erratic seasonal patterns of precipitation, mostly manifested in both widespread and localized droughts and floods, have a huge environmental impact. These widespread weather events are a result of either above or below normal rainfall across the country, while localized events are caused by concentrated above or below normal rainfall in a certain region. Intensification of flood and drought episodes – as shown by the following observed extreme weather events – are a clear reflection of a changing climate.

- There is an increased incidence of droughts, which have become more frequent in South Sudan. Notable ones occurred in 1989, 1990, 1997, 1998, 2000, 2008–2009, 2010–2011, 2014 and 2017.
- Flooding frequency has increased in recent decades in South Sudan. For example, floods occurred in 1962–1965, 1978–1979, 1988, 1994, 1996, 1998, 1999, 2006, 2007, 2013, 2014 and 2015. These were major floods in 1988 and 2013, while 1996 and 2007 witnessed flood incidences of relatively high intensities.
- Floods and droughts occurring within the same season have become widespread, with droughts happening earlier in the season (around May/June) and floods occurring later (around August/September).
- Flash floods often occur when the Nile River and its tributaries overflow during August and September. Flooding is common in low-lying areas, particularly in areas close to the Sudd Wetland and White Nile River – leading to crop and livestock losses. Flooding in South Sudan has become more frequent in the last two decades.
- Floods are becoming severe and take longer to recede.
- The 1988 floods affected nearly the entire country. Between August and November 2013, floods affected about 150,000 people, destroying crops, property and infrastructure. The Government of South Sudan declared the country a disaster zone in October 2013 after seven of the country's 10 regions were heavily flooded.[122]
- Flooding in July–August 2014 resulted in deaths, over 40,000 people being displaced, property being destroyed and a widespread malaria epidemic.
- In September 2015, flooding displaced 2,000–3,000 households.[123]

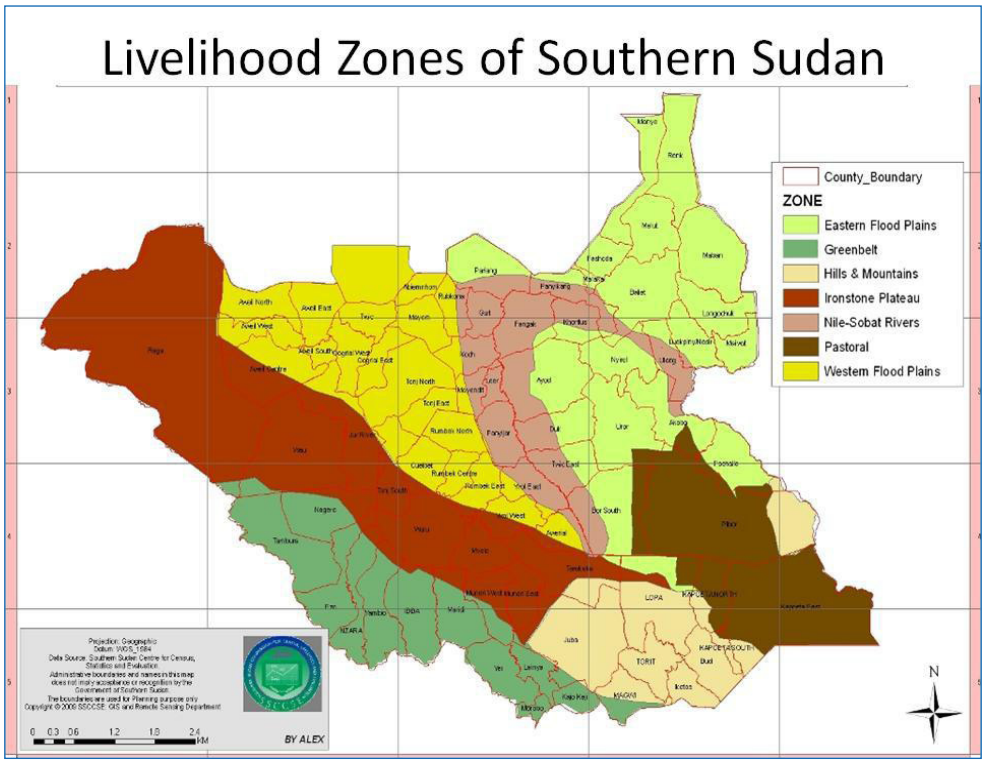
## Climate change impacts and vulnerability

As the preceding section has shown, South Sudan is experiencing substantially warmer and drier weather, which is leading to more droughts. In addition, rainfall has become more erratic, which is increasing the frequency and severity of floods. According to the Sudan Post-Conflict Environmental Assessment,[124] expected changes in weather patterns are projected to exacerbate existing household vulnerabilities and to exceed current coping mechanisms, further limiting poor people's capacity to maintain sustainable livelihoods. In order to understand climate change vulnerabilities and identify the most vulnerable areas of South Sudan, an analysis has been conducted on livelihood activities in the seven agroecological zones of South Sudan as well as on climatic risks and impacts of climate change on key sectors of the economy that support these livelihoods.

## Livelihood characteristics in South Sudan

South Sudan can be classified into various agroecological zones. The most used classification divides the country into seven such zones (Figure 3.10), based on their livelihood patterns (crop production, livestock rearing, off-farm income generation), physical geography, agro-ecology and market access. Within the seven zones, the population's livelihoods and key economic drivers are highly dependent on agriculture and natural resources, as shown in Table 3.1. Cropping is mostly located in the northern and western parts of the country, livestock keeping is mostly located in the eastern and south-eastern parts of the country, and agropastoral is located at the margin between the two.

**Figure 3.10: Livelihood zones of South Sudan**




## Sector impacts and vulnerability

Agriculture, water resources and environment are identified as key thematic areas for adaptation in the National Adaptation Programme of Actions (NAPA) for South Sudan.[125] This section analyses the climate change risks and potential impacts for agriculture, hydrology and water resources, and forestry sectors.

### Agricultural sector

Agriculture is the backbone of South Sudan's economy. Nearly 80 per cent of its population is engaged in crop production, livestock (keeping of cattle, goats and sheep) and fisheries.

The main crops grown in South Sudan are sorghum, maize, finger millet, rice, groundnuts, cassava, sesame, beans, fruits and vegetables as well as coffee, tea, cotton and sugar. South Sudan's GDP

in 2014 was approximately US$13 billion, of which agriculture contributed about 15 per cent.[126] The country's cultivable area totals about 2.76 million ha (4 per cent of the total land area), with nearly 50 per cent found in the Upper Nile, Jonglei and Warrap states. There is wide variation between states, with 58 per cent of households in Western Bahr el Ghazal engaging in agriculture, compared with 88 per cent in Eastern Equatoria (Figure 3.11).

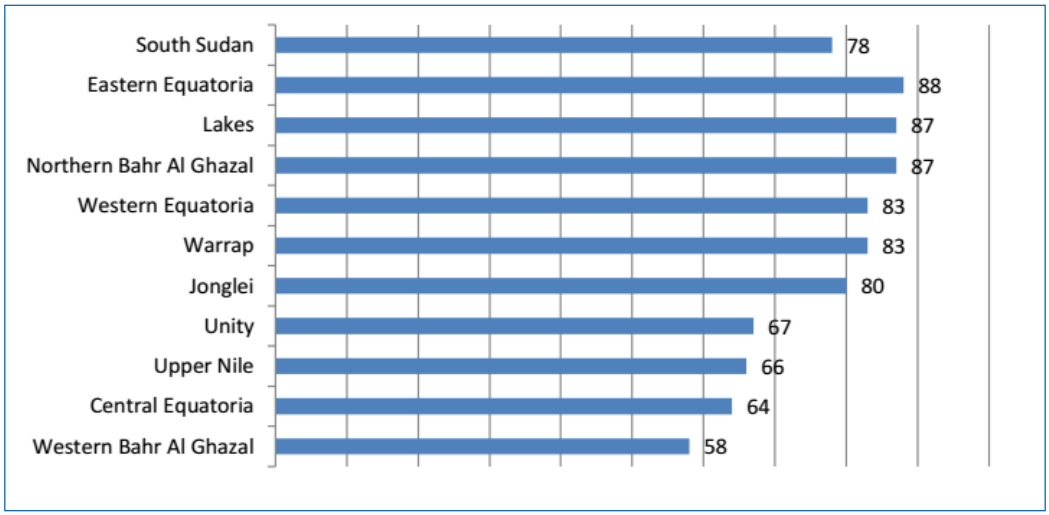
**Table 3.1: Key livelihood activities in South Sudan**

| Livelihood zone | States covered | Livelihood characteristics |
|---|---|---|
| **Green Belt Zone** | Most of Western Equatoria and parts of Central and Eastern Equatoria | Relies almost exclusively on agriculture, with potential for surplus production. The zone benefits from a bimodal rainfall pattern. Cassava is a major safety net in the Western and Central states and is intercropped with a wide range of crops such as cereals, sesame, groundnuts, pigeon peas and beans during the first year. W. Equatoria and C. Equatoria are the leading states in cassava and groundnut production. New areas are being opened up for groundnut production in C. Equatoria. Other crops grown include sweet potatoes, maize and millet. Poor infrastructure and the related lack of access to markets are a major disincentive for farming.<br>Smallholder rural and urban/peri-urban livestock keeping is focused on poultry and goats and few cattle. Traditional and modern beekeeping and wild honey gathering are additional sources of income. |
| **Ironstone Plateau Zone** | Western Bahr el Ghazal and parts of Lakes, Warrap, Northern Bahr el Ghazal, Central Equatoria and Western Equatoria | Heavily dependent on crop production, mainly sorghum, groundnuts, sesame and tobacco. Cassava is a major safety net and W. Bahr el Ghazal is among the three main producers. Two-year cassava is planted as a sole crop or intercropped with groundnuts, sorghum and sesame.<br>Parts are largely agropastoral, with livestock production being the predominant source of income. N. Bahr el Ghazal and Warrap are the leading states in livestock production. During periods of distress, livestock sales provide a source of income. |
| **Hills and Mountains Zone** | A large part of Eastern Equatoria and parts of Central Equatoria and Jonglei | Both agriculture and pastoralism are practised. Reliance on cattle increases during dry years. Cassava is intercropped with other crops in selected areas. The communities most vulnerable to droughts are found in low lands. Communities living in mountains who cultivate cereals, pulses and vegetables are less affected because of favourable rain conditions. |

| Livelihood zone | States covered | Livelihood characteristics |
|---|---|---|
| Pastoral Area/Arid Zone | Parts of Eastern Equatoria, Jonglei and Upper Nile | Driest zone, with one cropping season. Swamps are used for grazing during the dry season. The zone is characterized by nomadic pastoralism with a strong reliance on livestock, especially in Jonglei, which is one of the key livestock production states. Small-scale crop production supplements livestock production. This area has a food deficit most of the time and there is exclusive reliance on livestock trade for food. |
| Nile and Sobat Rivers | Jonglei and parts of Upper Nile | Abundance of water resources and good vegetation for grazing, but flooding hampers access. The zone is an important dry season grazing area. Livestock production is a main livelihood activity in Jonglei. Crop farming is important in this zone, although crop production is currently affected by war leading to cereal deficit. The Upper Nile is the most mechanized farming state in South Sudan.<br>Apart from crops and livestock, wild foods and fish contribute significantly to household consumption in this zone. |
| Western Flood Plains | Parts of Warrap, Unity, Lakes and Northern Bahr el Ghazal | Main source of income is agro-pastoralism, which is supplemented by fish and wild foods. Livestock are important for both food and income. These states are the biggest livestock producers in South Sudan.<br>Cassava is planted as a boundary crop in the three Rumbek counties in Lakes State. Lakes is the leading state in groundnut production. New areas have recently been opened up for groundnut production in Warrap and Lakes. Crop production is currently affected by war, leading to cereal deficit in Unity State.<br>Livelihoods in Western Flood Plains and Eastern Flood Plains (below) are highly dependent on changing water levels. Seasonal flooding increases yield of pasture for livestock, fish and wild foods, but can affect agriculture production and settlement. |
| Eastern Flood Plains | Parts of Upper Nile, Jonglei and Eastern Equatoria | Inhabited by both pastoralists and agro-pastoralists. Low-lying terrain and black cotton soils pre-dispose the area to flooding. Crop production is currently affected by war, leading to cereal deficit in the two states. |

Source: Derived from a review of the South Sudan NAPA, the FAO 2016 Special Report, the IGAD 2016 Policy Brief and the AfDB 2013 Infrastructure Action Plan.

**Figure 3.11: Agricultural households by state (%)**




Source: NBHS, 2009.

Most rural sector activities currently focus on smallholder, low-input, low-output subsistence agriculture instead of production for markets. This is largely due to:

- little access to improved agricultural inputs and techniques such as seeds and fertilizers, storage facilities, advisory services and irrigation development
- the difficulties farmers face in accessing markets due to the poor road network, lack of other transport modes, and miscellaneous taxes and charges, including bribes
- the lack of a critical mass of associations to help farmers and rural producers enter the marketplace and that aim to minimize the cost of inputs, help farmers access loan finance at affordable rates and influence farm-gate prices
- uncertainties pertaining to property rights and access to land.[127]

Agricultural production depends on timing and quality of cultivation, quality of seeds used, weeding frequency and pest and disease profiles. The use of traditional farming tools has led to low yields averaging about 0.65 tons/hectare. In addition, pre- and post-harvest losses are high (up to 40 per cent) due to pests and diseases, the lack of post-harvest machinery and equipment for harvesting, handling, packaging and processing, and the lack of storage, cooling and transportation facilities.

Soil fertility is sustained by shifting and fallowing within a recognized farm area, and through the use of animal dung in Northern Bahr el Ghazal, Western Bahr el Ghazal (Jur River County) and Warrap states. In locations where shifting opportunities are limited and the dung does not come from the farmers' own livestock, contract-dunging by pastoralists' herds and flocks on private farmland is a traditional way of sustaining soil fertility.

Agriculture is, for the most part, based on small, hand-cultivated units often farmed by women-headed households. Despite the availability of land for farming, manual land preparation limits the area that households can cultivate. Since making use of animal traction would allow households to cultivate larger plots and plant in line to ease weeding, the Government of South Sudan, FAO and NGO-based extension agents are promoting it on a small-scale in various states. In addition to social and cultural barriers, the main constraints are the lack of spare parts and skills to maintain mouldboard ploughs largely imported from Uganda, and plough models that are poorly adapted

to local soil conditions. Mechanized farming is practised mainly in the Upper Nile counties of Renk, Melut and Wadakona and to a limited extent in Malakal and Bentiu in Unity State.[128] The Ministry of Agriculture and Food Security has identified the fertile soils of the Green Belt Zone stretching from Central Equatoria to Eastern Equatoria as the most suitable area for medium and large-scale commercial agriculture.

While the country produces and consumes a wide range of agricultural commodities, some commodities have become more prominent in national consumption patterns. Cereals (primarily sorghum and maize), millet and rice are the dominant staple crops in South Sudan. For the country as a whole, cereal consumption accounts for about 48 per cent of total basic food consumption in terms of value. Livestock accounts for approximately 30 per cent, fish 4 per cent, roots 2 per cent, seeds about 3.8 per cent and other non-cereal crops combined 12.7 per cent. Sorghum is the main crop cultivated, with a wide range of local landraces. It is the main staple food in all states, except for the three Equatorias where the local diet is based on maize flour (largely imported from Uganda) and cassava (mainly in the Green Belt). In Northern and Western Bahr el Ghazal, Warrap and Lakes, sorghum is often intercropped with sesame and millet. Maize is normally cultivated in limited areas, close to homesteads and often used for green consumption. In some locations such as Upper Nile, maize – instead of sorghum – is cultivated in larger plots, provided the soil is suitable.

Minor cereal crops such as bulrush millet, finger millet and upland rice are also cultivated in certain locations. Groundnut, which is cultivated on sandy soils in most locations, makes an important contribution to household diets and is the main cash crop contributing to farming household income at certain periods of the year. In parts of Central and Western Equatoria, sweet potato, yam, coffee, mango and papaya are commonly grown. Okra, cowpea, green gram, pumpkin and tobacco are also widely grown around homesteads. Vegetables such as onions or tomatoes are not commonly grown in rural areas, but are increasingly cultivated near cities to supply urban markets.[129]

Twenty-five years ago, the country was a net exporter of agricultural products to regional markets. Due to conflict-related destruction, poor infrastructure and lack of investment in the agricultural sector, South Sudan is now a net importer of food, currently importing as much as 50 per cent of its needs, including 40 per cent of its cereals from neighbouring countries, particularly Kenya and Uganda. Total food imports are estimated to be in the range of US$200–300 million a year.[130] Total cereal consumption in 2016 was estimated at 1.3 million tons, while the net cereal production from the traditional sector at 921,000 tons created a cereal deficit of about 381,000 tons.[131] The largest shortfall is usually observed in the three most conflict-affected states of Jonglei, Unity and Upper Nile states.

## Food security in South Sudan

The main drivers of food security in South Sudan are:

- conflicts
- crop production, mainly influenced by rainfall
- market prices, mostly influenced by conflicts and infrastructure.

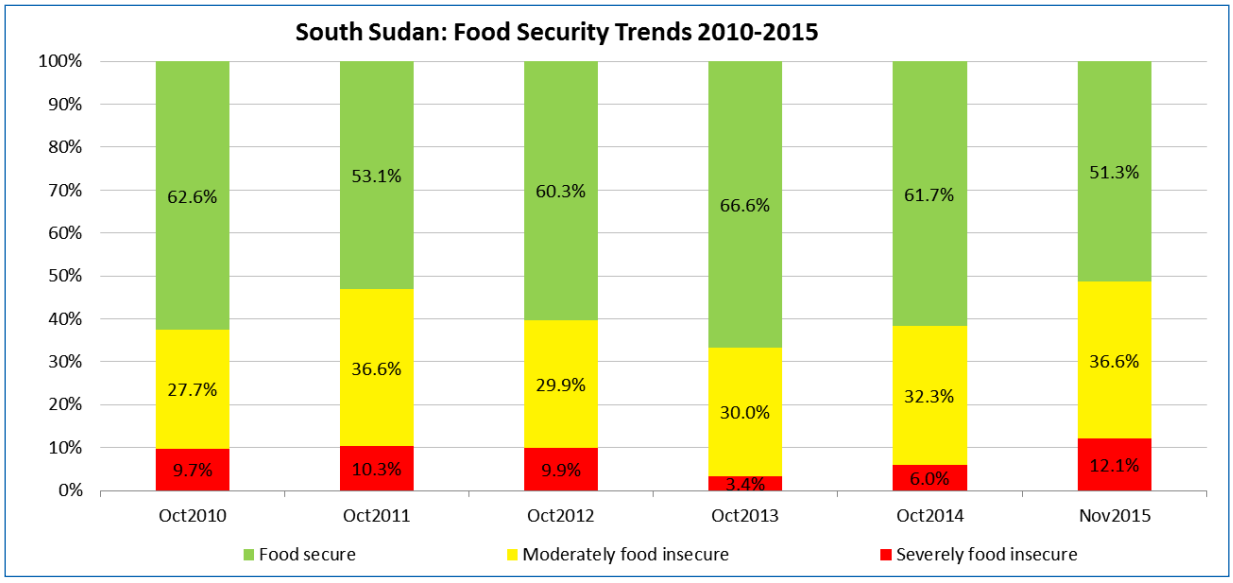
The economic downturn in South Sudan has exacerbated this situation, resulting in sharply increased prices, particularly in conflict-affected areas of the Greater Upper Nile Region and other heavily market-dependent states of Greater Bahr el Ghazal region.

Based on their food consumption, food access and coping strategies, households are classified into three categories:

- severely food insecure
- moderately food insecure
- food secure.

The first two levels grouped together are referred to as "food insecure".[132] In November 2015, about 49 per cent of the population of South Sudan were moderately to severely food insecure (see Figure 3.12). This represents a marked worsening of the situation when compared with 2014 (when it stood at around 38 per cent).

**Figure 3.12: South Sudan – food security status around harvest time (October), 2010–2015**




Source: FAO, 2016.

At the state level, the highest levels of severe food insecurity are seen in Upper Nile, Jonglei, Lakes and Northern Bahr el Ghazal states. Parts of Lakes State have been affected by conflict spillover impacts, while Northern Bahr el Ghazal is one of the states further away from import trade routes, exposing households to the impacts of high food prices. These high values were recorded in November, just after harvest time when household stocks had just been replenished.[133]

### Livestock

Cattle, goats and sheep provide livelihoods for about 80 per cent of the population, with herds (mostly cattle) concentrated primarily in Bahr el Ghazal states, Warrap, Lakes, Unity and Jonglei.[134] The huge livestock population in these areas emit GHGs associated with enteric emissions and decomposing manure. Table 3.2 shows the distribution of livestock in South Sudan's original 10 states. Livestock is an integral part of South Sudanese livelihood systems and sales of small ruminants represent an important source of income that largely determines pastoralists' capacity to purchase food items. Livestock are raised in the following three production systems, which are dependent on access to grazing land and watering points:

- nomadic, based largely on herding of cattle, camels, sheep and goats in the semi-arid north
- semi-nomadic agro-pastoralism, combining the herding of cattle and some sheep with cultivation (Dinka, Nuer)
- a sedentary system, whereby cattle and small livestock are reared in close proximity to villages.[135]

Livestock in South Sudan is characterized by low calving percentages at 30 per cent, high death rates of young stock (neonatal-to-weaning) quoted at 15–40 per cent and adult death rates ranging from 5 to 10 per cent per annum.[136]

**Table 3.2: Livestock distribution in South Sudan states**

| State | Cattle | Sheep | Goats | Total |
|---|---|---|---|---|
| Central Equatoria | 878,434 | 1,153,283 | 1,265,977 | 3,297,694 |
| Eastern Equatoria | 888,278 | 1,132,541 | 1,025,297 | 3,046,116 |
| Western Equatoria | 675,091 | 1,153,283 | 1,169,705 | 2,998,079 |
| Jonglei | 1,464,671 | 1,207,214 | 1,400,758 | 4,072,643 |
| Unity | 1,180,422 | 1,754,816 | 1,487,402 | 4,422,640 |
| Upper Nile | 983,027 | 439,741 | 640,209 | 2,062,977 |
| Lakes | 1,310,703 | 1,464,421 | 1,232,282 | 4,007,406 |
| Warrap | 1,527,837 | 1,369,005 | 1,290,045 | 4,186,887 |
| Western Bahr el Ghazal | 1,247,536 | 1,120,095 | 1,265,977 | 3,633,608 |
| Northern Bahr el Ghazal | 1,579,160 | 1,630,361 | 1,285,231 | 4,494,752 |
| **Total** | **11,735,159** | **12,424,760** | **12,062,883** | **36,222,802** |

Source: IGAD, 2016.

### Fisheries

Due to South Sudan's Nile River basin, other rivers and its wetland (the biggest in the world), fisheries have their own socioeconomic and cultural importance. According to a 2010 baseline survey report on agriculture and animal resources in South Sudan, about 14 per cent of households in South Sudan rely on fisheries for their livelihood.[137] However, as a resource, fish is underutilized. Given its potential, the South Sudan Vision 2040 places fisheries among the Priority Programmes for Economic Development under the National Goal 3, Increased Prosperity.

Many challenges constrain fisheries' development in South Sudan, the main ones being the absence of policy incentives, lack of storage facilities due to weak or total absence of power supply and the absence of effective processing technologies. Fish production is under threat from war, theft and displacement in the conflict zones stretching along the banks of the Nile from Terekeka to Renk counties and along the Sobat River.[138] In addition, inadequate transport infrastructure limits producers' access to markets, thus hampering fisheries' development in South Sudan. As a result of these challenges, almost nothing is known about the status of the country's fisheries and aquaculture in terms of resource management, statistics, research and the productive capacities of the lakes and rivers.

Simple fishing techniques are used, such as gillnets, throw nets and hooks. On the Nile and in the Sudd Wetland, fishermen from Sudan operate with fast boats.[139] Fishing has a significant effect on diet throughout the riverine and swamp counties. Nationally, the annual catch is estimated to be between 40,000 and 45,000 tons.

## Climate risks and potential impacts

### Crop production

Agriculture in South Sudan is vulnerable to climate variability, since over 95 per cent of agricultural production is rain-fed and therefore dependent on seasonal rains. In 2003, Sudan's First National Communication (FNC) under UNFCCC predicted decreasing yields of sorghum (the staple grain of the majority of the population) and millet in the future. This is supported by recent evidence that shows a yield loss of 5–25 per cent of the baseline (2000 climate) over most of the country's sorghum harvest area.[140] Hydro-meteorological hazards, particularly late onset/early and erratic rains and long dry spells are associated with crop failures across South Sudan. Early rains in February/March 2015 and reduced rains in July 2015 affected many people's livelihoods in the country.[141] Floods and waterlogging affected crop production in all low-lying areas in the same year while crop yield – especially in sandy areas – declined.[142] Rainy seasons are also tending to be shorter and sometimes interrupted, which results in an early harvest before crops are fully grown.[143]

Droughts, floods and increasing climate variability are negatively impacting the economy of South Sudan and nutrition status of South Sudanese, who depend on crop production for their livelihoods. Reduced food production as a result of climate variability will increase food prices and household food expenditure and exacerbate livelihood vulnerabilities in the most at-risk areas. Consequently, food security will be jeopardized, further reducing community resilience to the impacts of climate change.

### Livestock

Climate change threatens the existence of livestock as well as the livelihoods of pastoralist communities in South Sudan due to the loss of pasture lands and reduced access to water resources, which in turn can lead to deadly conflicts among pastoralist communities. The impacts of climate change thus also cause national security issues.[144] A look at the yearly conflict trends in drying areas from 2001 to 2011 suggests a moderate negative correlation i.e. years with higher water levels consistently have fewer conflicts than those with low water levels. From 2005 to

2007 as water levels increased, the number of armed conflict events decreased steadily while the inverse trend occurred from 2007 to 2009, before conflicts decreased again when water levels rose in 2010.[145]

Climate change can also exacerbate existing tensions over land use among and between farmers and pastoralists as they compete for increasingly scarce resources. For example, pastoralists might change their migration patterns in search of water and pasture, thus coming into contact with existing agricultural lands and other pastoralists. Meanwhile, as a result of a reduction in the area receiving adequate rainfall to support agriculture (500 mm), farmers are expanding agricultural land to areas previously used as seasonal pasture to cope with declining yields and soil quality.

A prolonged dry season will lead to more conflicts and adverse impacts on the livelihoods of many livestock-dependent households, whose resilience is already weak as they have limited livelihood diversity, and are often prone to livestock diseases and cattle raiding.

### Fisheries

In its 2012 report on environmental impacts, risks and opportunities, the Government of South Sudan noted that reduced rainfall would make many migratory fish species disappear, and only fish able to survive in stagnating dry season ponds or in mud would survive. Fishermen in Nyamlel fishing the Lol River reported that five of the 15 known fish species had disappeared from their river, and the average size of the fish catch had also decreased.[146]

Future plans to drain part of the Sudd Wetland in order to increase the quantity of water available for hydropower and irrigation downstream (a project that has been proposed and started but never completed) are expected to decrease the wet season spawning areas for many fish species and therefore reduce fish production. Coupled with climate change, this reduction is bound to have major impacts on fishery in the Sudd Wetland and about 1.7 million people in South Sudan that depend on fisheries for their livelihoods.

Box 2 presents a summary of the climate risks and potential impacts for the agricultural sector in South Sudan.

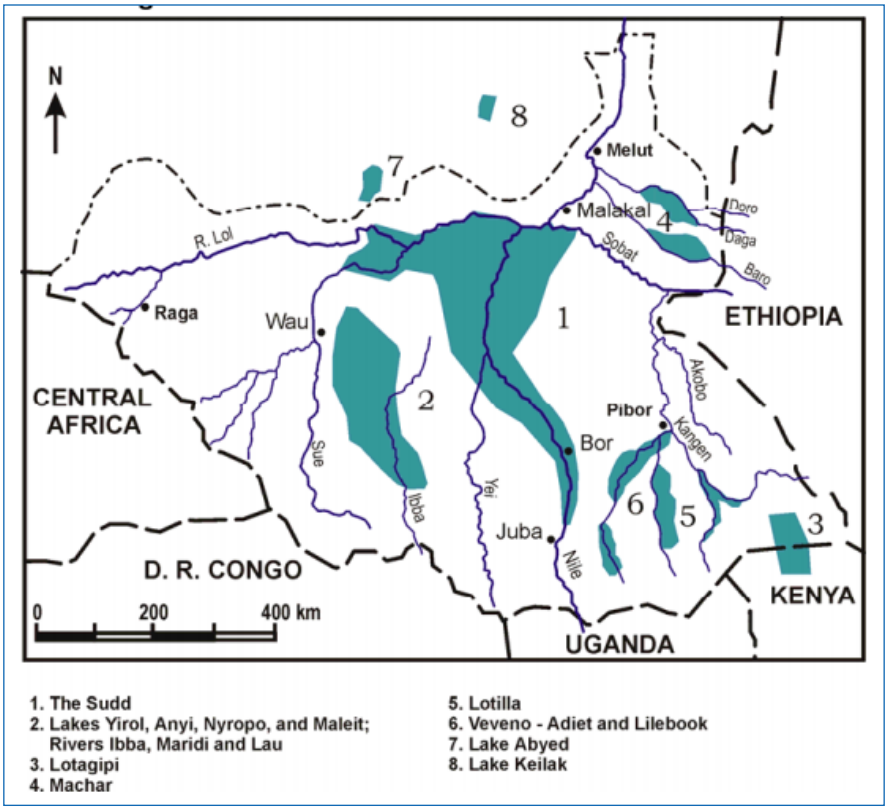
**Box 2: Climate risks and potential impacts: agriculture (crop production, livestock and fishery)**

1. Increased temperatures and reduced rainfall could lead to loss of productive agricultural lands and a decline in fish size and diversity.
2. Seasonal patterns in South Sudan have become erratic and rain-fed agricultural areas have decreased significantly in the northern and eastern parts of the country as a result of climate change.
3. Reduced rainfall in combination with increasing temperatures could make reliance on rain-fed agriculture no longer feasible, with significant impacts on food security.
4. Increased rainfall variability – onset and length of rainy season – has led to delayed planting and earlier harvest (i.e. a shortened growing season), leading to reduced yields and/or crop failure.
5. Increased incidence of drought and flooding have led to loss of pasture lands and reduced access to water resources for livestock.
6. Climate change in general is likely to increase local conflicts over land use and resources between and among pastoralists and farmers.
7. Multiple stressors faced by livestock will interact with climate change and variability to amplify the vulnerability of livestock-keeping communities. In other words, pest and disease pressure on livestock is expected to increase as a result of climate change.
8. Rapid population growth and the expansion of farming and pastoralism under a more variable climate regime could dramatically increase the number of at-risk people in South Sudan over the coming years and exacerbate tensions and conflicts.

### Hydrology and water resources sector

The national water supply in South Sudan is a combination of surface and groundwater. The surface water resources are abundant, diversified and distributed uniformly in space during the wet season, but are spatially unevenly available during the dry season. The total renewable water resources for South Sudan are estimated at 49.5 $km^3$/year. This translates to per capita availability of about 4,567 $m^3$/year. South Sudan's major surface water resources are shown in Figure 3.13. Its major water resources are the Nile (White and Blue Nile), its tributaries and aquifers.

**Figure 3.13:** South Sudan's surface water resources




Source: USAID, 2007.

### The Nile Basin

South Sudan accounts for approximately 20 per cent of the total area of the Nile Basin, with the balance being accounted for by Kenya, Uganda, Tanzania, Rwanda and Burundi. Any changes in water resources in these countries will have an impact on the volume of Nile waters in South Sudan. The drainage system for surface water in South Sudan follows the Nile River system and most of the water is carried by the White Nile, which is fed by three major South Sudanese tributaries:

- the Bahr el Ghazal (comprising three sub-basins of Kiir, Loll and Jur)
- the Baḥr el-Jebel (comprising numerous tributaries such as Yei, Aswa and Kiit)
- the Sobat River (comprising sub-basins such as Pibor, AkoboBaro).

### Wetlands

Much of South Sudan is covered by wetlands, the largest of which is the Sudd, Arabic for "barrier." As a barrier to the southward encroachment of the Sahara Desert, its preservation is expected to offer South Sudan's most significant contribution to buffering against climate change impacts at the regional level. The Sudd starts with the Baḥr el-Jebel and extends to its confluence with the White Nile. An inland delta of the White Nile, the Sudd is made up of lakes, swamps, marshes and extensive flood plains. It is one of the largest wetlands in the world, averaging about 30,000 km$^2$ and covering about 5 per cent of the area of South Sudan. The Sudd has been declared a Ramsar site, which confers global recognition and importance to this wetland. There are many other wetland systems throughout South Sudan, some of which are quite extensive. However, as they

are only protected if they are part of national parks, game reserves or forest reserves, many of them are at risk from exploitation. Estimates show that wetlands comprise 7 per cent of the total area of South Sudan.[147]

### Groundwater aquifers

There is very limited information on South Sudan groundwater basins, their detailed hydrogeologic characteristics and resource potentials. Although there is no exact figure about how much groundwater is abstracted from the various basins, there is large groundwater potential and current abstraction, which is spread all over the country, is only a small fraction of the resources available. The bulk of South Sudan's groundwater resources are found in the Umm Ruwaba formation and basement complex, which is characterized by unconsolidated clays and gravels with low to high permeability. The basement complex prevails in parts of Western Equatoria, Eastern Equatoria and Central Equatoria as well as in Western Bahr el Ghazal states and is characterized by poor water-bearing formation. However, fractures and weathered zones provide good-quality water in good quantities. The Umm Ruwaba formation is recharged by seasonal rainfall and river flooding. In South Sudan, groundwater is the principal source of drinking water, with more than 60 per cent of the population relying on wells and boreholes for access to water.[148] However, very little work has been undertaken to determine the distribution and extraction levels of these resources. Hence, the full extent of the aquifers and related characteristics is unknown.[149]

### Water use, access and challenges

Water serves various needs including domestic, livestock, wildlife, forestry, agriculture, mining and ecological. Most of the water used in South Sudan is externally generated from upstream countries, whereas the share of water generated from rainfall is erratic and prone to drought. In dry years, internal water resources fall dramatically, in severe cases down to 15 per cent of the annual average. This hydrologic variability, coupled with no investment in storage facilities, has made South Sudan prone to periodic floods and droughts.

Sediment transported during the flood season causes the upper catchment to degrade. Water scarcity is also due to prolonged drought and inefficient water use. There are additional issues related to sand dune encroachment in the Nile course and the volume of water that is lost to evaporation in the Sudd region. Water resources are underdeveloped, with very limited, mostly nonfunctional infrastructure. After decades of war, access to water supply and sanitation services is severely constrained.

### Climate risks and potential impacts

Climate change could reduce water availability in the country, which would have several impacts on water resources. The highlands of neighbouring countries are the main catchments of the Nile River. These catchments are highly sensitive to seasonal temperature variation. For example, a 2°C increase in temperature could cause the average natural flow in the Equatorial Lakes and Bahr el Ghazal sub-basins to fall by 50 per cent.[150] There have been reports that rivers coming from the plateau along the border with the Central African Republic are drying up: a number of rivers that were reported to have been permanent in the past have become seasonal in the last two decades. This applies to rivers such as the Kiir, Lol, Jur, Gal and Peyia.[151] The ecological

impact of rivers changing from perennial to seasonal is significant, as are the consequences for livelihoods. The decrease of water flow in the rivers is most likely related both to land use (forest clearing, overgrazing and forest fire accelerating erosion and siltation) and climate change (less rainfall and more evaporation).

Swamp areas are decreasing and there are reports of trees dying in some areas due to the lack of water.[152] The annual maximum flooded areas of the Sudd Wetland has been on the decline since the 1960s due to decreasing rains and increased water utilization upstream. The decline will be more significant if the Government goes ahead to complete the Jonglei Canal, which involves draining part of the Sudd Wetland to increase the quantity of water available for hydropower and irrigation downstream. Decreasing water levels due to climate change would heavily impact the one-third of the population that still relies on surface water for domestic use. In addition, a dramatic impact is to be expected on wildlife, livestock and fish, as the dry season food supply for wildlife and livestock will decrease due to reduced flooding and habitat degradation. Wildlife species within and near the Sudd Wetland are vulnerable to floods, while those in the eastern and northern parts of the country are vulnerable to drought as rain has been decreasing in these areas.[153] Climate change has the potential to alter the migratory routes (and timings) of species that use both seasonal wetlands (e.g. migratory birds) and track seasonal changes in vegetation (e.g. herbivores).

The hydrologic variability as a result of climate change, coupled with no investment in domestic storage structures, has made South Sudan hostage to periodic floods and droughts. Since the majority of households rely on surface water for their needs, climate change will have a severe impact on them and will reduce their resilience to natural hazards, such as droughts and floods.

Three decades of low rainfall and periodic severe drought have led to disputes over water resources, with water rights proving a continued source of tension between South Sudan and Sudan. Across the region, access to water from the Nile has sparked conflict between nations. There is concern that climate change may exacerbate South Sudan's existing instability – nationally, regionally and locally.[154,155,156]

Box 3 presents a summary of the climate risks and potential impacts for the hydrology and water resources sector in South Sudan.

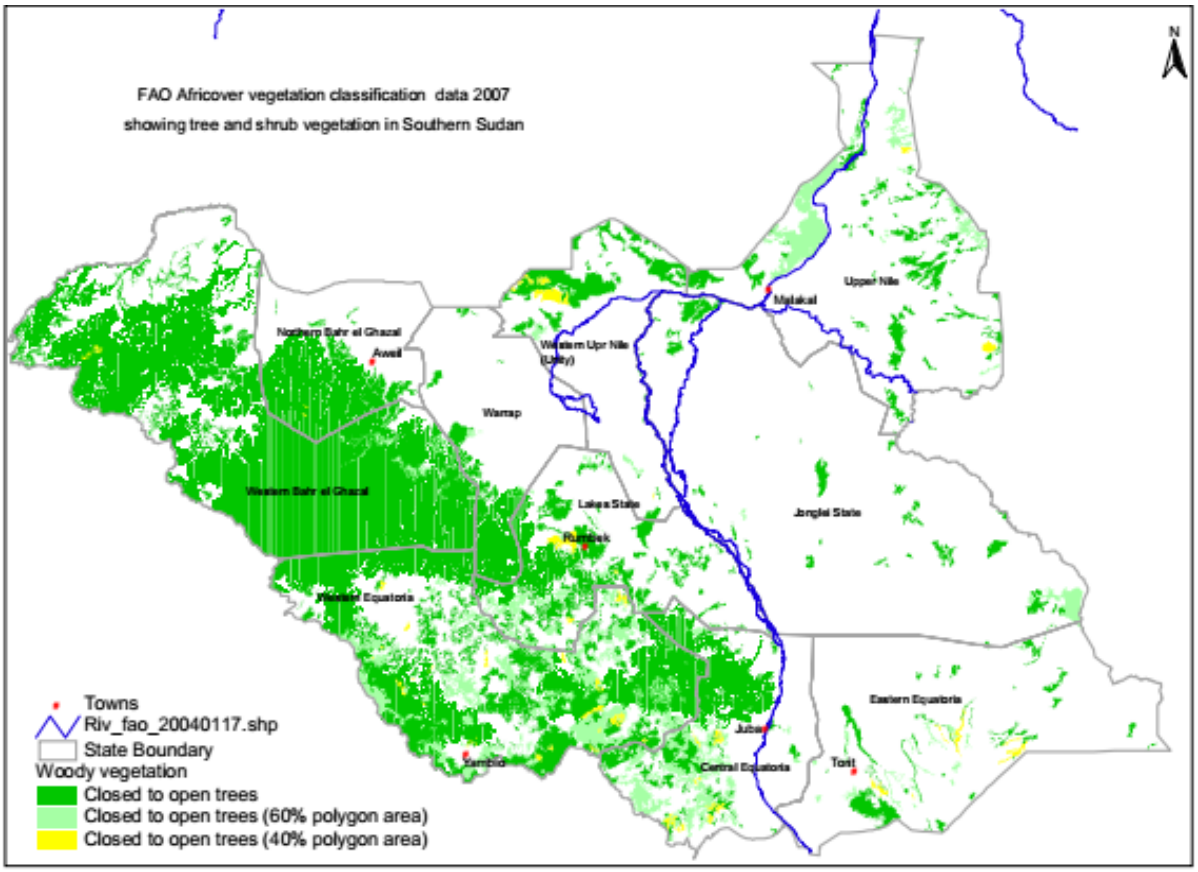
**Box 3: Climate risks and potential impacts: hydrology and water resources**

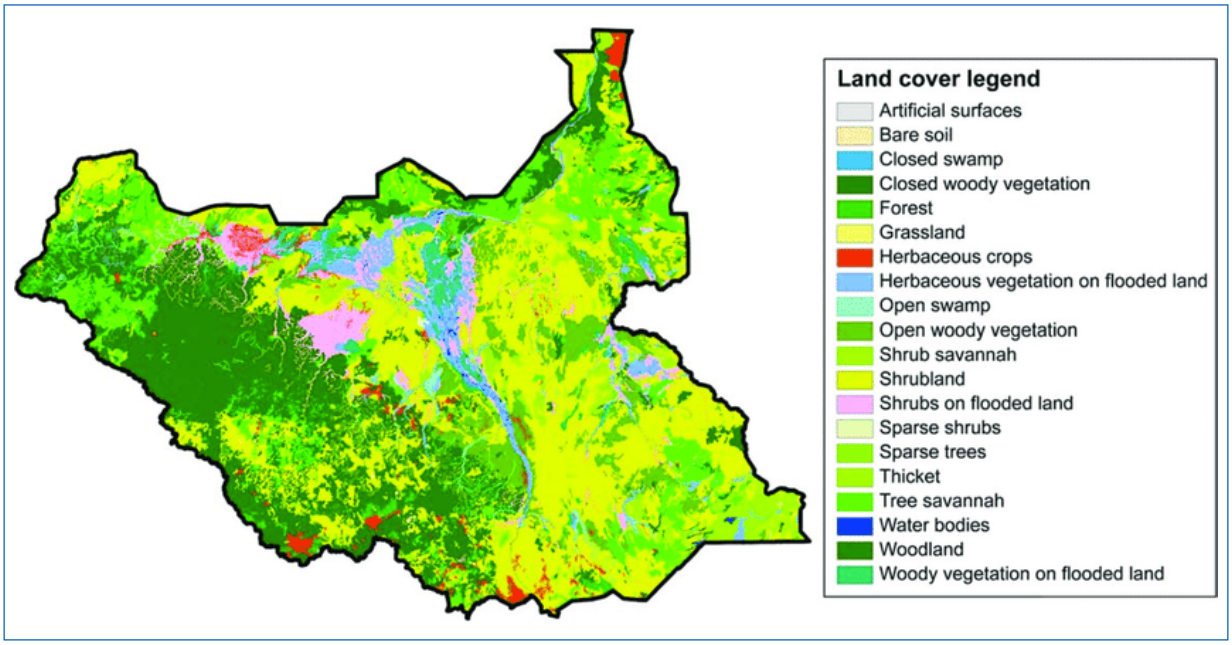
1. Rising temperatures and increased rainfall variability will reduce water quantity. This may lead to reduced crop production and food availability for humans, livestock, wildlife and fish.
2. Reduced rainfall in combination with rising temperatures will reduce river water flows and may lead to rivers drying up, and a change from perennial to seasonal flows due to increased evaporation. It will also result in the water table dropping and wetland reducing in size.
3. Prolonged dry seasons can lead to reduced water quality in stagnating water ponds.
4. A decline in water resources as a result of increased dry spells and low rainfall has the potential to increase conflicts over rights and access to water at the national and regional levels.

### Forestry sector

South Sudan has diverse natural forests (lowland and mountain forests) and woodlands, making it one of the richest areas in terms of concentrated biodiversity in Africa. It is estimated that these natural forests and woodlands cover a total area of about 207,422 km$^2$ or about 33 per cent of the country's total land area. Forest reserves account for only 3 per cent of the total forested area of the country and commercial plantations are negligible, accounting for 1,900 km$^2$ (about 0.1 per cent of the total forested area). There are 46 Central Forest Reserves (CFRs) and 22 State Forest Plantations. Therefore, a large percentage of forests are not demarcated or offered any type of government protection. Figure 3.14 below shows that most of the woody vegetation is concentrated in Green Belt Zone and the Ironstone Plateau.

**Figure 3.14: Distribution of woody vegetation in South Sudan**






### Lowland forests

South Sudan's tropical lowland moist forest is confined to a few scattered small localities in the south-west near its borders with the Central African Republic (CAR), the Democratic Republic of Congo (DRC) and Uganda as well as the foothills of the Imatong Mountains. This habitat type is found in the very northernmost of the Congo Basin forests including small areas on the Aloma Plateau in Yei County, Azza Forest in Maridi County, and the Yambio area. With its Congo Basin biogeographic affinity, this habitat type has some fauna and flora similar to that of Central Africa. It is home to threatened species, including the eastern chimpanzee (*Pan troglodytes schweinfurthii*), elephants (*Loxodonta africana* and *Loxodonta africana cyclotis*) as well as diverse forest communities. The lowland bongo (*Tragelaphus eurycerus*), forest buffalo (*Syncerus caffer nanus*), giant forest hog (*Hylochoerus meinertzhageni*), red river hog (*Potamochoerus porcus*) and a number of forest monkeys occur in these areas. Other lowland forests also occur in the Loti, Talanga and Lobone areas in the State of Eastern Equatoria.

### Montane forests

South Sudan's montane forests occur in the Imatong, Didinga and Dongotono Mountains of Eastern Equatoria.[157] This ecological region is about 960 km$^2$. Rainfall increases with altitude, reaching about 2,500 mm per annum at 2,600 m above sea level. The montane vegetation is dominated by species of Vernonia, Hagenia, Albizia, Podocarpus and Erica forming zones from the grasslands (Afro-Montane), to the Afro-Alpine dominated by Erica shrub thicket.[158] Common large mammals include forest ungulates such as bushpig (*Potamochoerus larvatus*), bushbuck, Harvey's duiker (*Cephalophus harveyi*), blue duiker (*Cephalophus monticola*), buffalo, primates such as black and white colobus (Colobus guereza) and others. The Imatong Mountains have very rich birdlife, including a number of species not found elsewhere in South Sudan,[159,160] some of which are endemic to this habitat type. Similarly, plant life is very diverse, with several plants that are endemic to the region. More than 50 per cent of plant species recorded in South Sudan occur in this region.[161] Because of their biogeographical isolation from similar African montane

forests, the Imatong Mountains present an opportunity for plant and animal endemism. The only protected area in this habitat type is the Imatong Forest Reserve.

### Savannah woodland

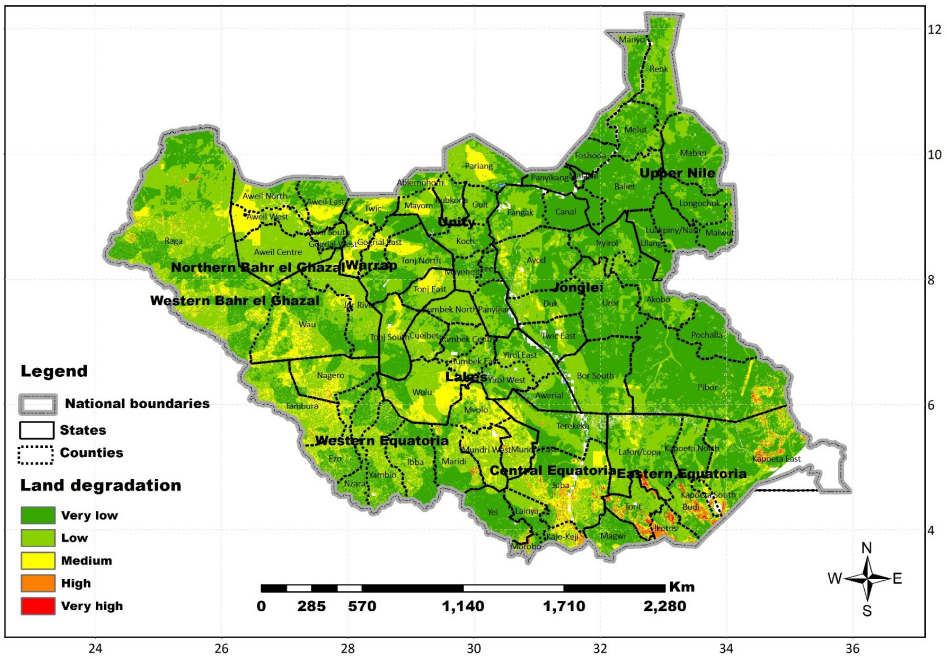
South Sudan's savannah woodland forms the largest ecological region in South Sudan, stretching diagonally from the north-western border of South Sudan with Northern Sudan along the CAR, DRC and Ugandan borders in Western and Central Equatoria to Magwi County in Eastern Equatoria. This region forms ecotones between the patches of lowland forest to the west and grassland savannah and floodplains to the east, and sits primarily on the Ironstone Plateau of South Sudan. Common large mammals of the wooded savannah include elephant, hippopotamus (*Hippopotamus amphibius*), waterbuck (*Kobus ellipsiprymnus*), giraffe, bushbuck (*Tragelaphus scriptus*), Oribi (*Ourebia ourebi*), duikers (*Cephalophus sp.*), Uganda Kob (*Kobus kob thomasi*), warthog (*Phacochoerus africanus*), hartebeest (*Alcelaphus buselaphus lelwel*), giant eland (*Taurotragus derbianus*), buffalo and various species of primates and carnivores. Representative protected areas found in this habitat are Southern, Nimule, Lantoto and Badingilo National Parks, and Ashana, Chelkou, Boro and Numatina Game Reserves.

### Forest uses and challenges

Forests are a source of significant income for people, communities, state governments and the central Government. They harbour globally significant biodiversity, support diverse wildlife habitats and contain valuable commercial products, including cabinet-grade timber trees such as mahogany, ebony and teak. In addition to their direct benefits in the form of income, food and fodder for wildlife and domesticated animals, forests provide many vital indirect benefits in the form of environmental protection (shade, wind belts), improved agricultural production (from increased soil fertility to mulching and nitrogen fixation), food (shea butter and wild fruits and fodder for wildlife) and act as a significant GHG sink. Almost the entire population of South Sudan is dependent on forests as a source of energy (fuelwood and charcoal) and other environmental goods and services. The forestry sector contributed US$395.4 million to the economy in 2011, which was approximately 0.7 per cent of GDP.[162] These statistics may not include non-timber products, the most significant of which is firewood (see chapter 1 of this report).

The wide range of environmental services provided by forests – such as provision and maintenance of water resources, flood mitigation and food sources – could be affected by climate change. The impacts of climate change on these services are likely to be made worse by the current challenges facing the forestry sector, the main ones being forest base degradation from wild fires, overgrazing, illegal logging, unplanned and inefficient agricultural practices, unregulated charcoal industry and forest governance challenges associated with weak and inadequate coordination mechanisms between national and state governments. Figure 3.15 below illustrates the average 2010 to 2012 land degradation over South Sudan.[163]

Figure 3.15: Extent of land degradation




Source: MESA-ICPAC 2013 as presented in WFP, 2014.

## Climate risks and potential impacts

Forests are vulnerable to climate change due to the fact that trees have long lifetimes and low adaptive capacity to changing ecological conditions. In South Sudan, climate change will affect already stressed, threatened and highly exploited forest ecosystems. Human-induced degradation of forestry in South Sudan (and the associated effects on goods and environmental services provided by the sector) and drier conditions associated with climate change will compromise South Sudan's ability to respond to the impacts of climate change. This is likely to cause friction between competing forms of land use and competition for resources within land-use sectors, which often leads to social conflicts and instability.[164,165]

Climate change is projected to affect individual organisms, populations, species distribution and ecosystem composition and function both directly (increased temperatures and changes in precipitation) and indirectly (through climate changing the intensity and frequency of disturbances). Reduced rainfall and a hotter climate have the potential to reduce forest habitats, in turn impacting food and fodder availability for humans, livestock and wildlife. Reduction of forest habitats is also likely to reduce the value of products and services that forestry provides to GDP, and ultimately hinder the country's socioeconomic development. Other impacts associated with reduced forest habitat include induced surface water erosion and increased aridity that will affect the entire environment and community livelihoods. Socioeconomically, forest-dependent livelihoods and sources of meagre economies will be disrupted by reduced crop and livestock productivity.

Persistent drought due to a temperature increase and unreliable rainfall pattern in the country is expected to affect the lifecycle of most migratory wild species, particularly birds. It will also affect species diversity, especially in major biodiversity hotspots such as Imatong Forest, which is one

of the largest intact *Podocarpus* forests in Africa with over 2,000 vascular plant species and 500 bird species. The concentration of wildlife in protected areas surrounded by anthropogenic land use (agriculture and livestock) in South Sudan makes wildlife highly vulnerable to the impacts of climate change. Loss of wildlife will affect tourism revenues and, in turn, the national economy.

A hotter, drier climate with intermittent droughts may see a southward shift in the Sahel, leading to declines in tree density and tree species, limited tree growth and increased incidence of wildfire.[166,167] Intensification of wildfires will destroy trees and limit their regeneration capacity.

Box 4 presents a summary of the climate risks and potential impacts for the forestry sector in South Sudan.

**Box 4: Climate risks and potential impacts: forestry sector**

1. Increased temperatures and increased rainfall variability (or more generally climate change) and the overall degradation of environmental services associated with anthropogenic factors will reduce South Sudan's ability to respond to climate change impacts, resulting in land-use conflicts and competition for resources.
2. Reduced rainfall and a hotter climate will reduce forest habitats, their contribution to GDP and their resilience to climate change, leading to reduced food and fodder for humans, livestock and wildlife. This will eventually reduce the socioeconomic development of South Sudan and disrupt people's livelihoods.
3. Drought due to increase in temperature and unreliable rainfall patterns will affect the lifecycle of most migratory wild species, and species (both flora and fauna) diversity and populations, with considerable impacts on tourism and the national economy.
4. A hotter, drier climate (associated with high temperatures and intermittent droughts) may see a southward shift in the Sahel, leading to a decline in forest density and an increased incidence of wildfires.

## Livelihood zone impacts and vulnerabilities

South Sudan's seven livelihood zones (i.e. Eastern Flood Plains, Green Belt, Hills and Mountains, Ironstone Plateau, Nile-Sobat Rivers, Pastoral and Western Flood Plains) have different livelihood patterns and ecologies. Climate change impacts therefore vary between zones. A stakeholder workshop conducted as part of the INC process in Juba established (through a structured livelihood zonal analysis) that climate change will reduce crop and livestock production, increase poverty, increase conflicts, reduce people's incomes and livelihoods, reduce wildlife habitats, increase incidences of pests and diseases, reduce ecosystems' ability to sustain livelihoods and potentially slow the economic development of South Sudan (see chapter 3).

## Climate risks and vulnerability

Vulnerability assessments are increasingly being used to identify climate change impact hotspots and provide input for adaptation and development planning all over the world. Effective and strategic adaptation planning targets those systems and areas that will be most affected by adverse climate change impacts. Vulnerability is a function of exposure, sensitivity and adaptive capacity. Exposure is the only vulnerability factor that is directly linked to climate parameters (temperature and rainfall), that is, the character, magnitude and rate of change and variation in the climate. Sensitivity is typically shaped by the system's natural and/or physical attributes, but it also refers to human activities that affect the physical constitution of a system, such as tillage systems, water management, resource depletion and population pressure. Exposure and sensitivity in combination determine the potential impact of climate change. Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential. Adaptive capacity is shaped by many factors, including the socioeconomic conditions of a country. This chapter highlights the socioeconomic conditions of South Sudan, describes the links between climate change, sector impacts and socioeconomic conditions and presents the findings of a vulnerability, climate risks and resilience assessment.

### Overview of South Sudan's socioeconomic conditions

As the world's newest nation, the economy of South Sudan is one of the world's weakest and most underdeveloped. Socioeconomic development and other non-climatic factors in South Sudan such as a fragile economy, internal conflicts, reliance on agriculture as a livelihood, population growth, low levels of education, poverty and weak institutions have a significant influence on vulnerability to climate change.

South Sudan has a double challenge of dealing with more than 50 years of conflict and continued instability, along with huge development needs. It has vast and largely untapped natural resources and is the most oil-dependent country in the world, with oil accounting for almost the totality of exports, and around 60 per cent of its GDP. Apart from oil, livelihoods are concentrated in low productive, unpaid agricultural and pastoral work, accounting for around 15 per cent of GDP.

The ongoing political conflict is undermining development and has led to both internal and external displacement of people. Prior to the start of the current conflict, South Sudan's development was heavily impacted by previous wars between 1955 and 1972, and between 1983 and 2005. Without conflict resolution and a framework for peace and security, the country's longer-term development and prosperity are threatened. As a result of the many years of conflict, poverty levels in South Sudan are high. The incidence of poverty has also worsened, from 44.7 per cent in 2011 to 65.9 per cent in 2015.[168] It is highest in the states of Northern Bahr el Ghazal (where 76 per cent of the population live below the poverty line), Unity (with 68 per cent below the poverty line), and Warrap (with 64 per cent below the poverty line). The lowest incidence of poverty is in the Upper Nile, where 26 per cent of the population live below the poverty line.[169]

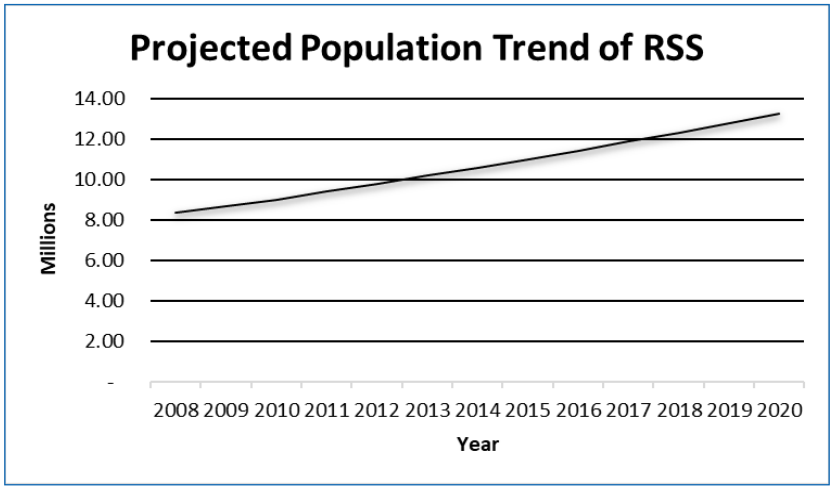
The current conflict has contributed to an increase in food prices, food shortages and hunger. Rising food prices have put many households in both urban and rural areas in a very difficult position, as they are unable to afford the minimum food basket.

Compared to many countries in the region, the population of South Sudan is low – estimated at 11.4 million in 2016. There is substantial variation among the states, ranging from a low of four persons per $km^2$ in Western Bahr el Ghazal to a high of 26 per $km^2$ in Central Equatoria where the capital, Juba, is located. The total fertility of women of childbearing age in South Sudan is estimated at 6.2, compared with an average of about 5 for Sub-Saharan Africa as a whole. The analysis of demographic trends suggests that the population will continue to increase rapidly, reaching about 14 million by 2020. The population trends in Figure 3.16 illustrate how the South Sudanese population is projected to increase until 2020, with an annual growth of about half a million people per year.

The education level of a majority of the population is low, with a literacy rate of 27 per cent among the population aged 15 years and above. The infant mortality rate is 105 (per 1,000 live births), the maternal mortality rate is 2,054 (per 100,000 live births), and only 17 per cent of children are fully immunized. While 55 per cent of the population has access to improved sources of drinking water, around 38 per cent of the population has to walk for more than 30 minutes each way to collect drinking water, and some 80 per cent of South Sudanese do not have access to a toilet facility.[170]

Many years of war have limited investments in institutional development. As explained in chapter 5, formal institutions are being built from a very low base and the capacity of government to formulate policy and implement programmes is limited, albeit growing.

**Figure 3.16: Projected population trend, South Sudan, 2008–2020**




Source: South Sudan, National Bureau of Statistics.

## Description of linkages between climate change, sector impacts and socioeconomic conditions

The key socioeconomic baseline conditions either affected or impacted by climate change in the most vulnerable sectors in South Sudan that are analysed in this section are:

- a weak and fragile economy
- insecurity and conflicts
- reliance on agriculture
- poor infrastructure

- poor agricultural practices
- population dynamics
- low levels of education and high levels of poverty.

**Fragile economy** - Over 95 per cent of government revenue comes from oil. The drop in oil revenues (as a result of the current conflict and the drop in international prices) has therefore led to a sharp reduction in the Government's income, preventing investment in development activities. The current conflict has had a significant financial impact on South Sudan, with 2015/16 GDP contracting by 6.3 per cent (World Bank, 2018).[171] Institutional capacity (human, capital and financial) is a major gap in climate change adaptation and mitigation. These low levels of capacity, the overdependence of the economy on oil within the context of the current economic circumstances (current conflict and the long history of war) and limited availability of climate technologies increase South Sudan's fragility and vulnerability to external shocks such as climate change.

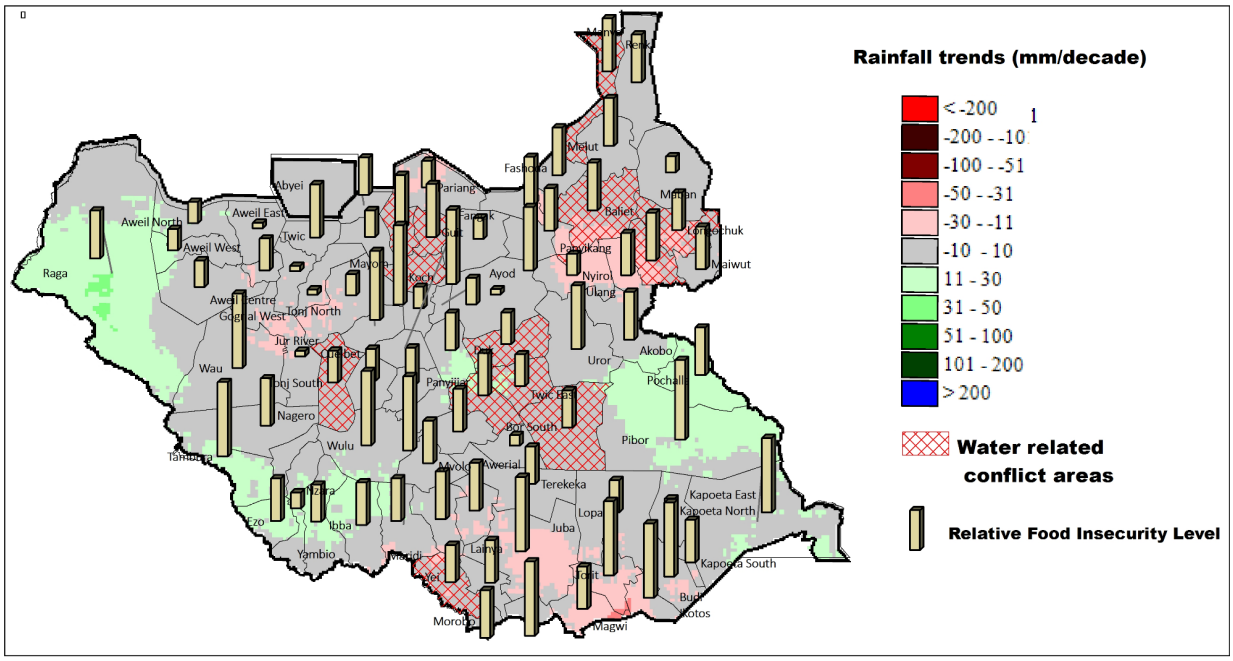
**Security and conflicts** - Security is a key factor that drives economic development in many countries. The ongoing conflict has had a significant financial impact on the economy of South Sudan, which is expected to contract further in FY2016/2017 as a result of the current oil production disruptions and below-average agricultural production associated with the conflict. The consequences of insecurity include large numbers of displaced persons, continuing food insecurity, increased poverty, and disruption to markets, trade routes and other social services. Large portions of the population in the conflict-affected states are either minimally or completely unable to undertake agricultural activities in a particular season due to displacement, violence and uncertainty. With limited resources, the intensive use of natural resources as a result of conflict has led to deforestation and soil degradation, among other negative environmental impacts. Over time, this has increased flood vulnerability. These effects will be exacerbated by climate change impacts if there is no relative political stability and peace in the near future.

More than 5 million people are estimated to be facing high levels of food insecurity as a result of the conflict. Recurrent annual floods, coming on the back of conflict-induced displacement, will exacerbate the levels of food insecurity and livelihood disruption, thereby putting additional populations at risk in the country. According to the recent estimates by FAO, 4.9 million people were severely food insecure between February and April 2017, with this rising to 5.5 million people (almost 50 per cent of the population) by the peak of the lean season in July.[172] Most rural households (subsistence farmers) in the conflict-affected former states of Jonglei, Upper Nile and Unity usually miss the planting season due to displacement and insecurity, a factor that increases the agricultural sector's vulnerability to climate change impacts. Furthermore, ongoing inter-tribal conflict in Lakes State has diverted critical labour for planting and weeding as men concentrate on security issues. Seasonal patterns of the pastoralists are also altered and over 10 million livestock were displaced in 2015. The result is reduced agricultural productivity, further compounding the vulnerability of households to food insecurity. Climate change is likely to make this scenario worse.

Many conflicts in South Sudan are also attributed to cattle raiding and food scarcity, especially during droughts and flood periods. Swampy areas have been the location of inter- and intra-ethnic cattle raids as livestock keepers move their herds into the floodplains during the dry season, chasing the retreating water. Analysing conflict patterns in relation to climate variability and

impacts on food insecurity shows mixed outcomes. Figure 3.17 shows the relationship between rainfall trends, water-related conflict-prone areas and relative food insecurity.[173] It depicts drying areas to be in close proximity to conflicts and thus contributing to relative food insecurity. Frequent conflicts affecting states such as Jonglei, Unity and Upper Nile make households perpetually food insecure with weak resilience to climate change impacts.

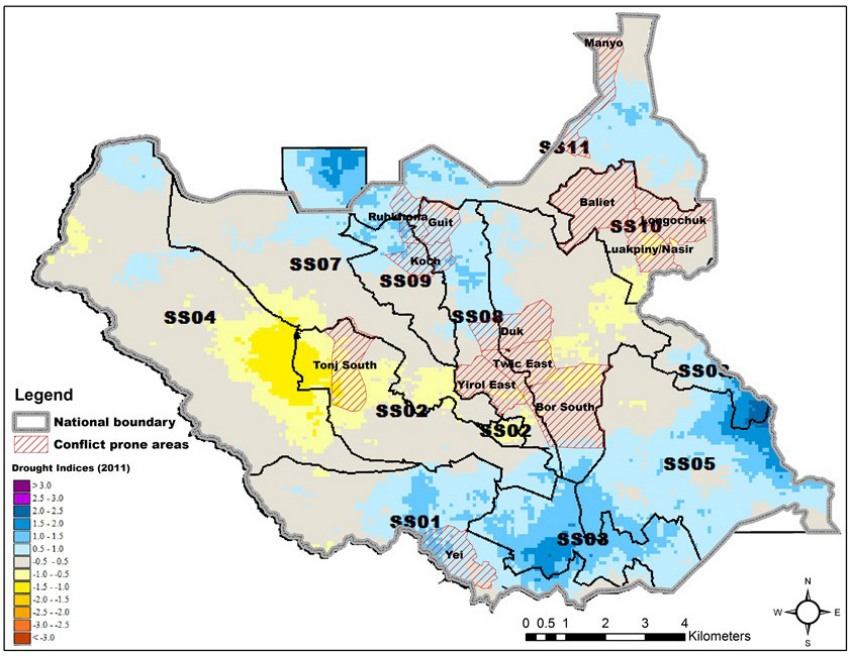
**Figure 3.17: Rainfall trends, water-related conflict-prone areas and relative food insecurity**




Source: World Food Programme.

Conflicts over pasture are prone to escalate during dry periods. One of the current adaptive practices of pastoralists is to start moving from high to lower ground in search of pasture, but if this movement begins earlier in the year due to climate change effects (e.g. one to two months earlier than usual), it may lead to more conflicts as others do the same. Actions that contribute to the resilience of one group can therefore undermine the resilience of another. A prolonged dry season usually leads to more conflicts and adverse impacts on food security and vice versa. Figure 18 indicates the impact of prolonged dry spells computed by the Standardized Precipitation Index (SPI) for the drought of 2011 on conflict over the same period. It shows that areas with intense dry spells had high cases of conflict.

**Figure 3.18:** Impacts of prolonged dry spell on conflict (a case of 2011 drought)




Source: World Food Programme.

Conflicts therefore substantially increase people's vulnerability to climate change impacts since they usually result in severe and persistent levels of food and nutrition insecurity in the country. The cumulative effect of repeated shocks can have disastrous effects on communities whose pre-2013 crisis capacities were already too compromised to absorb additional shocks such as those brought by climate change.

**Reliance on agriculture** – In the non-oil sector, subsistence agriculture, forestry and fisheries account for 14.5 per cent; government services, 9.1 per cent; trade, hotels and restaurants, 5.9 per cent; manufacturing and mining, 3.6 per cent; transport and communication, 3 per cent; construction, 2.2 per cent and other services, 2 per cent.[174] The rain-fed agricultural sector is the most vulnerable sector in South Sudan since it mainly relies on climatic factors. Crop production in South Sudan is not optimal because of many factors, ranging from conflicts to poor farming methods. The associated impacts of high temperatures, altered patterns of precipitation and possibly increased frequency of extreme events such as drought and floods, will combine to depress the already low cropland and livestock yields and reduce the sector's contribution to GDP, with negative implications for the livelihoods and resilience of many people in South Sudan.

Most communities in South Sudan value animals, which are kept as a sign of wealth, prestige and for marriage. The more cattle a household has, the more powerful and wealthy it is. With such high value attached to animals, impacts on the livestock population as a result of climate change will be severe since household livelihoods will be threatened. Loss of livelihood will further reduce people's resilience to the impacts of climate change.

**Poor infrastructure** – The road infrastructure in South Sudan is underdeveloped and some rich agricultural zones such as the Green Belt Zone are unable to supply food to areas in need. Climate-related disasters such as floods can destroy the limited road infrastructure, further limiting physical access to markets and thereby exacerbating an already bad situation.

**Poor agricultural practices** – Bush fires in South Sudan are mainly caused by slash and burn agriculture, pasture renewal or hunting. Grass burning starts two to three weeks after the end of the rains in November and again in March/April/May. In an average year, fires affect about 70 per cent of the open rangelands. In the high-rainfall savannah ecosystems of southern South Sudan, fires kill certain species of trees such as *Isoberlinia doka* and *Daniellia oliveri* and reduce the growth of other species. They may also reduce gum yields from *Acacia senegal* by up to 50 per cent. Fire therefore reduces the ability of the ecosystem and communities to be resilient to the effects of climate change.

**Population dynamics** – As population density is low in South Sudan, it is not a major socioeconomic driver of climate change. However, as South Sudan becomes more stable, a large population of people displaced by war will return. This population increase will put more pressure on natural resources, causing substantial environmental degradation, particularly deforestation. This will accelerate the impacts of climate change.

**Education** – The 2009 National Baseline Household Survey reveals that the country faces several human development challenges, including low levels of education and a large gender disparity. For example, the literacy rate for males is 40 per cent compared with 16 per cent for females. Less than half of children aged between 6 and 13 years are enrolled in primary school. Access to, and quality of, formal education plays a role in people's capacity to adapt to climate change, with women being at a disadvantage, as illustrated by their much lower literacy rates. In addition, women's rights to own property and inheritance are strongly limited by customary law, making them more vulnerable than men to climate change impacts.

**Poverty** – Most of the poor households in the central parts of the country that depend on rain-fed agriculture and related activities and those in the northern part of the country have poor resilience to climate change due to chronic poverty and very low diversity of livelihoods. These households do not have the financial capacity to cope with climate change. Furthermore, these households are often compelled to live in high-risk areas that are prone to flooding and drought.[175] Climate variability and climate change disproportionately affect the poorest and most food-insecure households through a combination of decreasing crop production, increasing human and animal diseases, flooding, inter-communal conflicts over resources, dry spells and unpredictable weather.

Poverty and inequality expose the South Sudanese to climate risk hazards, rendering them vulnerable to climate change. According to the IPCC Working Group II Fifth Assessment Report, poverty and inequality are the most salient conditions that shape climate-related vulnerability. Poverty affects livelihood options and creates conditions where people have few assets to buffer extreme events. Climate change is therefore an additional burden to the poor (chapter 1 of this report).

## Vulnerability assessment in South Sudan

Although climatic factors are the main drivers of climate change, natural ecosystem conditions, human activities and low adaptive capacity in South Sudan will aggravate climate change impacts. Fragile land and water resources coupled with resource mismanagement and poor land-use practices are key sensitivity factors that will influence climate change. The low adaptive capacity attributed to a lack of diversified sources of income, food insecurity, political conflicts,

high incidences of poverty, poor infrastructure and limited government capacity to manage fragile natural resources coupled with climate change variability will worsen the situation. Table 3.3 illustrates factors that determine climate change vulnerability in South Sudan.

**Table 3.3: Factors determining vulnerability in South Sudan**

| Vulnerability factors |
|---|
| **Exposure factors**<br>1. Increase in temperature<br>2. Rainfall variability associated with floods and drought |
| **Sensitivity factors**<br>1. Fragile land and water resources, e.g. sandy soils and black cotton soils that pre-disposes the flood plains to flooding.<br>2. Resource mismanagement such as rampant clearing of forests. Increase in deforestation to meet the increased demand for fuelwood and land for agricultural and residential purposes associated with a growing human population. This increases the vulnerability of rural communities to climate variability, as the goods and service provided by these ecosystems buffer communities against the crop failures associated with erratic rainfall, floods and droughts.<br>3. Soil erosion. Soil erosion in South Sudan is increasingly becoming a problem. Consequently rivers, lakes, dams and irrigation canals are silting up, reducing the supply of water for drinking and irrigation. Soil quality is also declining, which negatively affects agricultural productivity.<br>4. Poor land-use practices, including widespread use of fire in livestock grazing areas. |
| **Adaptive capacity**<br>1. Lack of diversified sources of income to accommodate change. There is heavy overdependence on climate-sensitive sectors, such as agriculture, livestock and fisheries. As a result, many people in areas with low rainfall (Hills and Mountains Zone and Pastoral Zone) are more vulnerable to climate change.<br>2. Food insecurity, primarily among agro-pastoralists, located in the drier parts of Jonglei and Eastern Equatoria.<br>3. Conflicts that often reduce food production, leading to food insecurity in states such as Jonglei, Lakes and Upper Nile. Conflicts also displace people (2.1 million are currently internal refugees).<br>4. Extreme poverty level: Poverty is a determining factor of climate change vulnerability in South Sudan. As a result of the many years of wars, many people in South Sudan are poor and access to financial resources to buy agricultural inputs and purchase food, especially in food-insecure areas, is limited.<br>5. Poor infrastructure: only about 200 km of roads are paved. Northern Bahr el Ghazal is one of the states furthest away from import trade routes, exposing its households to the impacts of high food prices.<br>6. High food prices, mostly influenced by conflicts and infrastructure. Relative prices of food have increased and food shortages and hunger are the most alarming signals of the country's larger economic collapse. Rising food prices have put many households in both urban and rural areas in a very difficult position, as they are unable to afford the minimum food basket. Recent surveys in South Sudan indicate that foo[176]d accounts for 79 per cent of household expenditure on average. With such a large share of expenditure allocated to food, many households are vulnerable to food price inflation and food shortages (AfDB, 2013). |

| Vulnerability factors |
|---|
| 7. Limited technical capacity to understand and[177] predict climate change. The prolonged period of civil war in South Sudan caused, inter alia: i) insufficient investment in education, particularly at the tertiary level; and ii) skilled professionals to leave the country. These factors have contributed to a general lack of technical capacity within the country to understand and predict the effects of climate change. This situation is exacerbated by the limited availability of necessary technologies, such as weather stations and geographic information systems (GIS), to measure and monitor climate variability. The limited technical capacity to predict climate variability and change constrains efforts to reduce the vulnerability of poor communities. |
| 8. Limited institutional capacity to cope with climate variability.[178] Climate change is not well articulated in government policies. Institutional arrangements for climate change coordination, planning and financing are inadequate, as presented in chapter 5. These institutional capacity constraints limit the integration of climate change adaptation into national policies and development planning processes in South Sudan.[179] |

## Assessment of climate risk exposure and resilience

### Climate change risk exposure

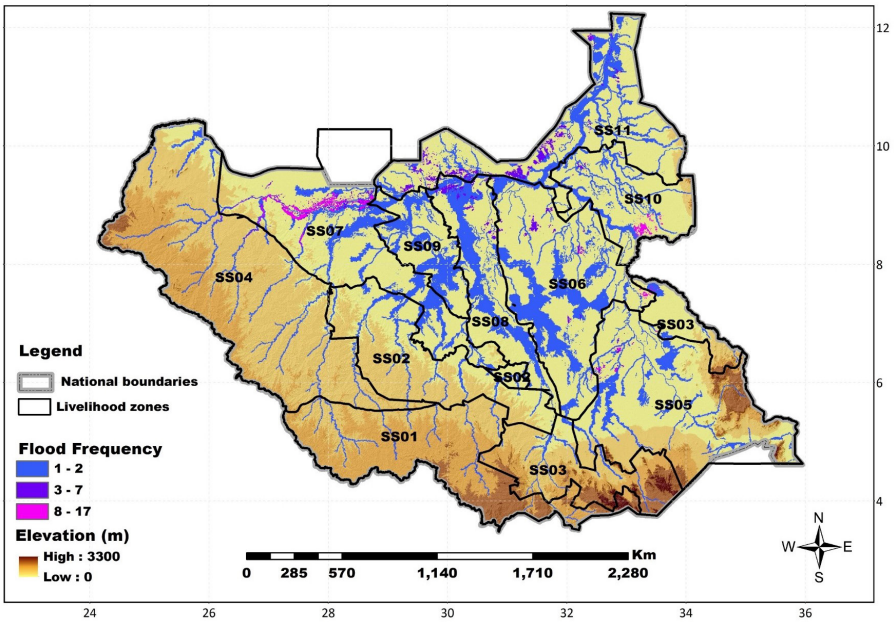
South Sudan is exposed to a number of climate-related hazards, including floods, droughts, land degradation, livestock diseases and crop pests. These hazards have detrimental effects on livelihoods. A climate change risk analysis by WFP in 2013 indicates that floods have the most devastating impact compared to other hazards. It also shows that the livelihood zone most exposed to drought, flooding and land degradation is the eastern Arid Pastoral Zone, where dry spells occur more frequently (WFP, 2014). With only one cropping season, this area is food deficient most of the time. It relies heavily on livestock and exclusively on livestock trade for other food commodities. The most affected states in the Pastoral Zone are Upper Nile, Jonglei and Eastern Equatoria. Temperature increases, along with decreases in rainfall, might lead to longer and more severe droughts in these states with significant consequences for livestock production, the main livelihood in this zone. Increases in droughts might force pastoral groups to migrate permanently out of their home regions, which will have economic and social implications for deserted areas, as well as newly settled areas.[180,181]

The Nile and Sobat River Zone is highly exposed to flooding and land degradation (Figure 3.19). The Western and Eastern Flood Plains are also exposed to flooding, especially during the heavy rains in August and September that cause the Nile River and its tributaries to flood. Settlement in these floodplains increases the severity of flooding and vulnerability. During the wet season, many parts of the country are also prone to flooding, including Jonglei, Unity State, Upper Nile, Warrap, Northern Bahr el Ghazal and parts of Western Equatoria and Eastern Equatoria.[182]

The livelihood zone least exposed to climate change impacts is Green Belt Zone due to its moderate exposure to hazards and low food insecurity. The rich western and south-western parts of the country in the Green Belt Zone are generally exposed to little flooding, little drought and medium land degradation. Green Belt Zone has a bimodal rainy season and relies heavily on agriculture and livestock. Food is always in surplus but poor infrastructure and access to markets is a disincentive to farmers.

Increases in temperatures may accelerate and contribute to the spread of epidemics. While South Sudan benefits from the Nile River ecosystem, several disadvantages are associated with it, including the widespread prevalence of diseases such as malaria and bilharzia. In the south-western agricultural belt, the humid environment is favourable to tsetse flies, which cause sleeping sickness, while the extensive acacia and savannah grasslands of the Eastern Flood Plains are affected by sand fly infestations, which cause leishmaniasis.[183]

**Figure 3.19: Frequency and flood-prone livelihood zones**




Source: WFP, 2014.

### Climate change resilience

Resilience refers to the capacity of livelihood groups, households, communities and individuals to manage stressors and shocks with no long-lasting adverse effects on development. Livelihood groups that have chronic food insecurity are exposed to high levels of poverty and in the face of regular shocks, their resilience capacity is drastically reduced. Risk exposure to shocks reduces resilience among vulnerable households. Livelihood groups that depend on climate-sensitive activity may be unable to meet their livelihood needs when a significant climatic shock (such as a bad season exacerbated by floods or dry spells) impacts their primary activity. Conversely, livelihood groups that have a wide range of activities to fall back on can withstand the impact of certain climatic shocks. Conflict is the most damaging hazard for livelihoods and basic food security in South Sudan. Its attendant consequences have continually undermined access to markets and migration, and denied households the opportunity to effectively address structural seasonal food deficits.[184]

WFP has categorized most parts of South Sudan as having between poor and low resilience, considering a combination of access to a diversity of income and food sources, low inter-communal and political conflicts, relative low food insecurity levels, relatively good access to markets and economic centres. Based on WFP analysis, the most resilient livelihood groups are those in the Green Belt Zone where maize and cassava are grown, and the Ironstone Plateau Zone where

groundnuts, sesame and sorghum are grown. Households that depend on livestock keeping in the northern part of the country (Eastern Flood Plains, for example) have poor resilience as they have limited livelihood diversity and are often affected by conflict, livestock diseases and cattle raiding. Most of the poor households in the central parts of the country that depend on rain-fed agriculture and related activities have poor resilience due to chronic poverty and very low diversity of livelihoods. Furthermore, since they do not have access to different livelihoods, they may be unable to manage the impacts of large-scale shocks such as floods and difficulty accessing markets. These zones, spread over the Eastern and Western Flood Plains, and wet climatic zones, are also highly sensitive to climate variability given the high reliance of households on rain-fed agriculture. However, climate change and other socioeconomic dynamics may challenge this resilience in the future.[185] Table 3.4 is a summary of the analysis of the climate risks and climate change resilience profile of each of the seven livelihood zones.

**Table 3.4: A summary of livelihood climate risks and resilience in South Sudan**

| Livelihood zone | Climate change risk exposure to drought, flooding and land degradation | Resilience profile |
|---|---|---|
| **Green Belt Zone** | The main hazards are prolonged dry spells, crop pests, livestock diseases, localized seasonal floods and limited access to market because of poor road infrastructure. Generally, the zone's exposure to floods is low, with low to medium exposure to drought and land degradation. | **This livelihood zone is considered to have high resilience** due to its moderate exposure to hazards and its low food insecurity level. Although most households' income is highly climate-sensitive, seasonal rains rarely fail. Poorer households subsist from their own crop and livestock production supplemented by food obtained from hunting, fishing and foraging, and food purchased using income from agricultural and casual labour. The better off are largely self-sufficient in food, with saleable surpluses in years of good rainfall, and they do not purchase staples from the market. |
| **Ironstone Plateau** | This livelihood zone has low exposure to floods and land degradation. Some areas are exposed to droughts. Crop pests and diseases are common. | **This zone can be categorized as a medium-resilience livelihood zone**. Although a large part of this zone is regarded as a food-sufficient area, the reliance on rain-fed crop production, the low level of income diversification and restricted access to reliable markets mean that there is a risk of food insecurity in years of low production, especially during droughts. |

| Livelihood zone | Climate change risk exposure to drought, flooding and land degradation | Resilience profile |
|---|---|---|
| **Hills and Mountains** | The main areas of this livelihood zone are categorized as having medium exposure to floods and land degradation but high exposure to droughts. Common hazards include dry spells, mudslides and floods causing crop failure. There is no seasonal livestock movement in this highland zone leading to minimal animal diseases, however, livestock-keeping households face continuous conflicts over cattle and associated resources. | **This livelihood zone has low resilience** due to its over-reliance on rain-fed crop farming and sedentary cultivation, with less reliance on livestock. Due to favourable climatic conditions, this zone usually has good harvests, but lacks access to local markets that have good trade linkages with neighbouring zones. |
| **Pastoral / Arid Zone** | The livelihood zone is categorized as having high exposure to drought, low exposure to floods and moderate land degradation. This is a high-risk food security area, due to semi-arid conditions, livestock diseases and periodic conflicts with other pastoral groups. Inter-communal conflicts and cattle raiding occur during dry seasons and livestock diseases are endemic across the zone. | **Resilience in this livelihood zone is low**. Income is highly climate-sensitive, with many poorer households unable to secure steady income due to periodic conflicts with other pastoral groups making seasonal movements in search of water and pasture. Cattle raiding and poor relations with neighbouring zones, civil insecurity and the unreliability of markets contribute to the low resilience. |
| **Nile and Sobat Rivers** | This zone is exposed to multiple hazards but mainly floods, which tend to limit fishing activities and reduce crop, livestock and wild food production leading to loss of income, putting poor households at greater risk of food insecurity. Inter-communal conflicts/ cattle raiding occur annually during the dry season. | **This livelihood zone is considered to have low resilience** due to its vulnerability to multiple hazards and civil unrest. The zone is predominantly occupied by agro-pastoralists, while crop production is rain-fed. It has moderate diversification into other livelihood activities such as fishing. During good years, this is a food-secure zone with surplus maize production sold in external markets. |

| Livelihood zone | Climate change risk exposure to drought, flooding and land degradation | Resilience profile |
|---|---|---|
| **Western Flood Plains** | This zone is affected by floods, livestock diseases, dry spells, inter-communal conflicts and cattle raiding during the dry season. High-risk food insecurity is caused by recurring floods and drought hazards. | **This livelihood zone is considered to have low to moderate resilience** due to vulnerability to typical flood and drought hazards and because survival options have become increasingly dependent on fish and wild foods due to the impact of prolonged conflict. The zone is characterized by small holder rain-fed agriculture, with high diversification into other livelihood activities.<br>The northern part of this zone has low resilience due to high-risk food insecurity, with semi-arid conditions and frequent flooding in every rainfall season. Seasonal movements are the source of frequent conflict over pastures, water and cattle raiding. |
| **Eastern Flood Plains** | Hazards are from inter-communal conflicts and cattle raiding, floods, livestock diseases, pests and drought. These reduce crop and livestock production and chiefly affect the poor, who are least resilient. Flooding occurs on an annual basis during the seasonal rainfall period. Livestock diseases and crop pests and diseases are common during the rainy season. | **This is one of the zones with relatively poor resilience.** The poor resilience stems from being highly exposed to hazards, high food insecurity with low livelihood diversity. Livelihood activities are adversely affected by inter-communal conflicts. |

Source: Adopted from WFP, 2014.

## Climate change adaptation in south sudan

The Government of South Sudan, alongside a wide range of development partners and NGOs, is supporting climate change adaptation in South Sudan at different levels including policy, institutional and community actions. The Government has also prioritized climate change and identified measures needed to address climate change impacts now and in the future. The policies and institutional arrangements for their coordination have been discussed under chapter 5 below. This section gives an overview of the Government of South Sudan's priority adaptation actions and its ongoing and planned adaptation actions.

### Institutional Capacity Assessment

Several institutional capacity constraints in South Sudan limit the Government's ability to reduce climate change vulnerability. Firstly, as a new country, many policies and strategies related to environmental management and agriculture are emerging, but they do not explicitly include climate variability and climate change. Secondly, there are inadequate institutional arrangements

at the national, state and county levels for effective coordination, planning and implementation of climate change adaptation interventions. Finally, many of the institutions have been weakened by a lack of technical know-how and financial resources. As a result, very few programmes aimed at reducing vulnerability to climate change are being implemented.[186] A review of the national budgets for the past few years suggests that there is no budget line item for climate change adaptation and mitigation in South Sudan in many of the government ministries. A rapid assessment of some of these institutions reveals the following:

**Ministry of Environment and Forestry:** The Ministry has established a climate change unit that is not operating to its full capacity due to a lack of financial and human resources.

**Ministry of Agriculture and Food Security:** The Ministry has a very important role to play in climate change adaptation, since agriculture is the main livelihood-supporting sector for over 80 per cent of people in South Sudan. Although the Ministry is involved in researching drought- and flood-resistant crops through its research institutions, it does not have a specific climate change resilience department or unit for crops, livestock and fisheries.

**Ministry of Irrigation and Water Resources:** The Directorate of Irrigation in the Ministry has an important role in monitoring water levels to predict floods. Many of the 73 hydrology stations previously operational were destroyed during the war and only a few are still operating. Specifically, the Ministry has little capacity in terms of hydrological testing and monitoring equipment, and human and financial resources. The Directorate of Irrigation can be a key partner in climate change adaptation through irrigation in times of droughts and less rainfall. However, South Sudan does not have well developed irrigation programmes to take advantage of the rich water resources that are available.

**Ministry of Petroleum and Ministry of Mining:** Fossil fuels are one of the biggest contributors of GHGs. These two ministries should therefore be at the centre of climate change adaptation and mitigation, but they currently do not have dedicated units and are not linked to any climate change adaptation and mitigation institution.

**Ministry of Finance and Economic Planning and Ministry of Commerce and Trade:** These ministries can play a key role in mobilizing funds for climate change adaptation. Currently, the ministries do not have specific budget lines or funds for climate change, although they do provide allocations for disasters and emergencies.

**South Sudan Meteorological Service (SSMS):** SSMS can play a crucial part in climate change adaptation due to the technical role it has in forecasting and predicting weather and seasonal climate. The SSMS faces challenges related to the lack of weather and climate change forecasting equipment, adequate and conducive office facilities, international network connection and trained personnel. Most of the 43 stations throughout South Sudan were destroyed by consecutive wars.

**South Sudan Relief and Rehabilitation Commission (SSRRC)**: SSRRC is in the process of establishing an early warning technical unit at the national and state levels, a process that started in September 2013, and which is yet to be completed.

**South Sudan Wildlife Service (SSWS):** SSWS is an important institution in terms of climate change adaptation and mitigation, as wildlife species and their habitats are vulnerable to climate shocks and stresses. Nevertheless, SSWS does not have a climate change resilience department or unit.

## Adaptation priorities in South Sudan

The draft 2013 Environment and Protection Policy recognizes climate change as a global phenomenon that equally affects South Sudan and that — without adaptation and mitigation measures — "may adversely impact on the environment and livelihoods of most South Sudanese". The draft policy proposes the development of a national strategy and mechanisms for climate change adaptation and mitigation. In pursuit of this policy, the Government of South Sudan launched its NAPA in February 2017, which lists priorities and sets out guiding principles for adaptation projects to address the urgent and immediate climate change concerns in South Sudan. It has identified a total of 28 priority projects designed to help the country adapt to changing weather patterns in five thematic adaptation areas; environment, water resources, agriculture, disaster risk reduction, and policy and institutional framework (Table 3.5).

**Table 3.5: Priority adaptation projects in South Sudan**

| Thematic area | Priority adaptation projects | Priority geographical area |
|---|---|---|
| **Environment** | 1. Promotion of reforestation and agroforestry to reduce vulnerability to droughts and floods | Eastern Equatoria |
| | 2. Introduction of climate change resilient, participatory and sustainable forest management | Central, Eastern and Western Equatoria, Western Bahr el Ghazal |
| | 3. Promotion of renewable energy | Nationwide |
| | 4. Integrating climate change into biodiversity conservation and planning | Nationwide, but particularly Eastern Equatoria, Western Equatoria, Jonglei/ Greater Pibor Administrative Area (GPAA) and Western Equatoria (biodiversity hotspots areas) |
| | 5. Expansion of the protected areas in South Sudan | Jonglei, Lakes, Eastern Equatoria, GPAA and Central Equatoria |
| | 6. Landscape approach to wildlife conservation and management | Jonglei, Lakes, Eastern Equatoria, GPAA and Central Equatoria |
| | 7. Creating resilience in mountain communities in the face of climate change | The Imatong Massif, Aloma Plateau, Upper Boma |

| Thematic area | Priority adaptation projects | Priority geographical area |
|---|---|---|
| **Water resources** | 1. Sustainable management and conservation of wetlands in South Sudan | Nationwide |
| | 2. Introduction of rainwater harvesting techniques to increase water supply under conditions of climate change | Jonglei, Lakes and Eastern Equatoria |
| | 3. Introduction and expansion of irrigated agriculture (for crop and livestock production) | Nationwide (Upper Nile, Eastern Equatoria, Western Equatoria, Northern Bahr el Ghazal states) |
| | 4. Enhancing resilience to rainfall variability through rangeland rehabilitation and water resources management | Eastern Equatoria and Northern Bahr el Ghazal |
| | 5. Community-based sustainable utilization and management of wetlands in selected parts of South Sudan | Jonglei and Upper Nile states |
| | 6. Protection of water resources through improved waste management | Nationwide (Bahr el-Jebel Basin, White Nile Basin) |
| **Agriculture** | 1. Promotion of climate-smart agricultural techniques to improve livelihoods and food security under changing climatic patterns | Nationwide |
| | 2. Enhancing agricultural production under climate change conditions through infrastructural development and strengthening of agricultural extension services | Nationwide |
| | 3. Development of the livestock sector through enhanced rangeland management, increased knowledge and improved animal health systems to reduce pastoral communities' vulnerability to climate change | Lakes, Jonglei, Eastern Equatoria (Kapoeta, Torit), Upper Nile, Unity, Central Equatoria (Terekeka), Northern Bahr el Ghazal |
| | 4. Enterprise and value chain development in the fishing industry to improve livelihoods and reduce vulnerability to climate change | Riverine area (Bor, Terekeka, Kodok, Lake No, Adok et al) |
| | 5. Diversifying livelihood options to cope with a changing climate by introducing aquaculture away from riverine areas | Non-riverine areas (Maridi, Yei, Kajo-Keji et al) |

| Thematic area | Priority adaptation projects | Priority geographical area |
|---|---|---|
| **Disaster risk reduction** | 1. Establish improved drought and flood early warning systems in South Sudan through improved hydro-meteorological monitoring network | Nationwide |
| | 2. Reforestation and tree planting to combat desertification | Nationwide (priority being Lakes, Upper Nile, Unity, oil-producing areas) |
| | 3. Increasing knowledge on climate change and environmental issues through a national awareness-raising campaign and inclusion into school curricula | Nationwide |
| | 4. Reduction in waterborne diseases due to flooding and river overflow resulting from extreme climate events | Nationwide, priority areas being the most vulnerable areas (Jonglei, Rumbek, Bentiu, Central Equatoria, Upper Nile) |
| | 5. Improved environmental management in the oil industry to reduce the impact of floods and droughts | Oil-producing areas |
| **Policy and institutional framework** | 1. Building institutional arrangements for climate change adaptation at the state, county, payam and boma levels | State, county, payam and boma levels |
| | 2. Establishing institutional mechanisms for climate change adaptation financing/funding | Nationwide |
| | 3. Integrating climate change adaptation and mitigation measures into all sectoral policies in South Sudan | Nationwide |
| | 4. Building or strengthening institutional arrangements to develop climate change resilience | Nationwide |
| | 5. Support for an enabling policy environment on climate change | Nationwide |

The NAPA further prioritizes five key adaptation projects as the most urgent and immediate adaptation needs in the country. These projects are presented in Table 3.6.

Table 3.6: Most urgent and immediate adaptation projects in South Sudan

| Thematic area | Priority adaptation projects | Project area |
|---|---|---|
| **Environment** | Promotion of reforestation and agroforestry to reduce vulnerability to droughts and floods | Eastern Equatoria |
| **Water resources** | Sustainable management and conservation of wetlands in South Sudan | National (Sudd Wetland, Machar Marshes Wetland, Bahr el Ghazal Wetlands, Kineti Wetlands) |
| **Agriculture** | Promotion of climate-smart agricultural techniques to improve livelihoods and food security under changing climatic patterns | National |
| **Disaster risk reduction** | Establish improved drought and flood early warning systems in South Sudan through improved hydro-meteorological monitoring network | Nationwide |
| **Policy and institutional framework** | Strengthening the institutional capacity of the Government of South Sudan to integrate climate change into national policies and planning processes | Nationwide |

Besides the priorities identified in the NAMA, insurance can help people, especially smallholders, by enhancing their resilience and reducing their risk when they invest in crops. However, success will require public and private support and initiatives. Only a new and comprehensive approach to investment, better public policies and strong farmer organizations will bring about the required changes.

## Ongoing and planned climate change adaptation initiatives

The previous section has looked at the priority adaptation activities in South Sudan presented in the NAPA. In order to identify the measures needed for adaptation, it is important to analyse these priorities against the ongoing and planned adaptation initiatives. For this reason, an assessment was conducted to assess the current and/or planned climate change adaptation-related programmes and activities that are supported by the Government of South Sudan, development partners and NGOs. The findings of this assessment are presented in this section.

### Government supported initiatives

The Government of South Sudan has initiated several initiatives to address climate change. These include the following:

- Through various ministries, departments and agencies, the Government is implementing a broad range of activities that directly or indirectly address climate change, as already outlined in the preceding sections of this report.
- In collaboration with its development partners, the Government of South Sudan has prepared its NAPA and is in the process of preparing its National Biodiversity Strategy and Action Plan (NBSAP), National Adaptation Plans (NAP) and REDD+ Readiness supported by the GEF through UNEP.

- The Government is collaborating with a number of partners, including the World Bank, Egypt, and the Intergovernmental Authority on Development (IGAD) to build the capacity for hydrological monitoring in the country.
- The Government is working with the Government of Japan to develop irrigation capacity in the country. The Department of Irrigation in the Ministry of Irrigation and Water Resources is drafting the Irrigation Development Master Plan.
- South Sudan is a member of the Nile Basin Initiative (NBI), which is a regional body of nine countries working together to address water issues in the Nile Basin. NBI activities help build resilience to climate change in the Nile Basin by: 1) using variability in river flows as one way of understanding climate change impacts and planning how to respond to these impacts, (2) developing this understanding and putting it into use. Through this initiative, the member countries are currently working to establish a regional hydro-meteorological system. There are also proposals to roll out climate change initiatives. For example, the NBI's 2014 Environmental and Social Management Framework (ESMF) has proposed climate change projects that need to be supported by the initiative. These include the Nile Basin Climate Resilience Project (also referred to as The Sudd Initiative, 2015).

### Donor financed initiatives

Development partners are supporting several programmes related to climate change. Given the insecurity in the country, most of these programmes are directed towards food security, emergency response, peacebuilding, governance, infrastructure and health. The most relevant donor-funded initiatives in relation to climate change adaptation include the following:

**UNEP:** UNEP is a major donor in terms of environmental and climate change programming in South Sudan. It has provided critical policy guidance to the Government and key ministries since the country was founded. These include the formulation of new environmental regulations, such as the draft Environmental Protection Bill 2013. UNEP's environmental programmes include the following:

- GEF Climate Change Enabling Activity Project: Since joining the GEF in 2013, UNEP has been supporting the country in preparing the NAPA, NBSAP, NAP and the UNFCCC INC so that it is able to access international climate change finance. Once ready, these documents could lead to up to US$40–70 million of climate financing in the coming years.[187]
- Development and implementation of environmental improvement projects, including building communities' resilience to climate change and other natural disasters, such as floods, extreme weather and desertification.
- Conservation of biodiversity by strengthening both wildlife conservation programmes and protected area management initiatives.
- Integrated water resource and wetlands management.
- Wider stakeholder engagement in forest resource management and utilization through the up-scaling of community management of natural forests on communal lands.

**Department for International Development (DFID):** Through its BRACED programme,[v] DFID is supporting over 390,000 vulnerable farmers and agro-pastoralists, particularly women and girls, in South Sudan to become resilient to climate stresses and shocks. This programme is implemented by a consortium of Concern Worldwide, ACTED, FAO and the Sudd Institute. Together with the Government of South Sudan and UNEP, the programme is building the resilience of flood and drought-prone communities in Northern Bahr el Ghazal, Warrap and Lake States.

**Africa Development Bank (AfDB):** The African Water Facility of the AfDB has been supporting the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) to implement a programme aimed at increasing water availability for multiple purposes in the Nyimur region of South Sudan.

**Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ):** GIZ is supporting the Ministry of Agriculture and Food Security to implement a programme on food security and developing agricultural markets in South Sudan. The project supports the efforts of smallholder farmers to improve their production of the chief staple foods and vegetables. The main focus is on:

- reducing post-harvest losses and supporting crop diversification
- improving farmers' basic business skills and providing financial assistance to small-scale enterprises and start-ups
- strengthening market relations
- encouraging more value creation in agricultural production
- working to build or restore infrastructure such as warehouses and abattoirs
- providing training to young people on craft trades.

These measures are strengthening the viability of the rural economy. The project is also supporting the establishment of savings and loan groups to increase social security, and the rehabilitation of wells to improve access to drinking water. It complements these activities with awareness-raising and education campaigns on improved hygiene, food storage and nutritious food preparation. GIZ is running the project in seven of South Sudan's states on behalf of the German Federal Ministry for Economic Cooperation and Development. Co-financing is provided by the Delegation of the European Union to South Sudan, DFID and the Australian Department of Foreign Affairs and Trade.[188]

**Canadian International Development Agency (CIDA):** CIDA is supporting a programme on building resilient agricultural production in South Sudan. The programme objective is to increase agricultural production and food security in two counties of Warrap State through improved, increased and diversified food production (agriculture and fishing), as well as by building the productive asset base of food-insecure households (e.g. by distributing livestock, such as goats and chickens). The programme is implemented by Agriteam Canada and its activities include:

- women farmer-to-women farmer training
- increasing and diversifying vegetable production during seasonal dry periods through training
- distributing small livestock and poultry
- developing small multipurpose ponds for irrigation and to sustain livestock.

[v] Building Resilience and Adaptation to Climate Extremes and Disasters.

**Netherlands Ministry of Foreign Affairs:** The International Fertilizer Development Center is being supported by the Netherlands Ministry of Foreign Affairs to implement the "Towards Strategic Clusters in Agribusiness through Learning in Entrepreneurship" (2SCALE) programme in South Sudan. This programme is designed to help rural smallholders move from subsistence to farming as a business through a sustainable improvement in productivity and quality, leading to marketable surpluses to increase family incomes.

**FAO:** For over 40 years, FAO has been helping strengthen food security and build sustainable, agriculture-based livelihoods in South Sudan through the following mechanisms:

- Working with the relevant ministries and local institutions to ensure a reliable and stable supply of veterinary drugs, vaccines and equipment to safeguard livestock production.
- Providing the most vulnerable farmers (particularly those in conflict-affected areas and women-headed households) with quality seeds and tools through seed fairs or direct distribution, along with training in good agronomic practices. In areas less affected by the ongoing crisis, FAO supports resilience-building through farmer field schools in South Sudan. Seed multiplication is also being promoted in these areas, where selected farmers are provided with quality seeds and trained in production, conditioning, storage and marketing.
- Strengthening national capacity for food security data collection, analysis and coordination, resilience analysis, livestock conflict analysis, crop assessments and market monitoring. When analysed and disseminated widely, food security data are critical in providing an accurate picture of the evolving food security and livelihood situation – helping to focus assistance in communities that need it most.
- Supporting relevant government institutions to enhance the collection, analysis and reporting of agro-meteorological information in order to produce a stream of data on elements such as precipitation, temperature and wind speed. This information is vital in guiding agricultural planning and operations, and informing timely livelihood support and resilience programming, as well as food assistance targeting.
- Systematic identification and categorization of existing meteorological equipment in South Sudan, rehabilitating existing equipment, installing new rain gauge equipment and training local government focal persons in data collection and equipment maintenance.
- The reparative activities of the South Sudan Resilience Strategy that covers the period between 2016 and 2018. The strategy builds the foundations for a resilient and peace-conducive agricultural sector that will ensure food security and sustainable livelihoods for households relying on it, especially the most vulnerable.

**United Nations Development Programme (UNDP):** UNDP, in collaboration with WFP, FAO, the Food Security & Livelihoods Cluster, the Protection Cluster, local and international NGOs and the South Sudan Red Cross Society, is implementing a Food Security, Emergency Flood Response and Recovery Project in South Sudan. The project aims to respond to, and mitigate the immediate impact of, floods and food insecurity, with a specific focus on conflict-induced internally displaced persons (IDPs) and host communities. This is expected to strengthen the institutional and community capacity to reduce disaster risks and to prepare and respond to flooding and food insecurity.

**Ministry for Foreign Affairs, Finland:** The second phase of the Promoting Adaptation to Climate Change through Improved Services project, planned jointly by the Finnish Meteorological Institute and its Sudan and South Sudanese counterparts, supports poverty reduction and

resilience-building, by strengthening the abilities to adapt to climate change and extreme weather phenomena. Phase II of the project focuses on institutional capacity-building, and particularly on strengthening the two governments' observation and analysis services related to the effects of climate change and changing weather patterns. Through strengthening the institutions' capabilities to forecast natural disasters caused by weather or climate-related factors, and through improving sharing of related information to the wider public, it is also possible to prevent and reduce loss of lives and material damage caused by such phenomena. As the second phase of an earlier Promoting Adaptation to Climate Change through Improved Services project (2011–2015), it builds directly on the first phase's achievements, also taking notice of the recommendations and lessons learned from the first phase.

**European Commission:** Since 2014, the European Commission has made more than €173 million available to respond to the humanitarian crisis in the country, covering among others the provision of food aid, clean water and sanitation – with the aim of reducing mortality due to waterborne diseases.

**Overview of ongoing and planned adaptation activities in the seven livelihood zones**

As part of this assessment, the stakeholders' workshop held in February 2017 identified specific ongoing and planned activities in each agroecological zone. An overview of these activities is presented below.

**Green Belt Zone:** As a rich agricultural zone, most of the ongoing activities are focused on agriculture. These activities are aimed at addressing deforestation, reduced crop yields, increased poverty and loss of income, health hazards and diseases and biodiversity loss. They include the promotion of good agricultural practices, irrigation, agroforestry, distribution of early-maturing and drought-resistant crop varieties, income-generating activities, extension services and technical capacity-building on climate change, formation of village saving associations and Savings and Credit Cooperative Societies (SACCOs), value chain development, activities enabling access to market, and the creation of small agri-businesses supported by business skills training. Although the Green Belt Zone has a favourable climate for agriculture, its poor infrastructure is a major barrier to accessing agricultural markets. Policy development, urban planning, general environmental awareness, creation of more natural resource protected areas, lawful enforcement of disease surveillance to reduce disease incidences, and training are other ongoing activities in this zone. These activities are envisaged to continue in the future alongside a few additional activities such as: promotion of keeping of small livestock, bees, chicken and fish; commercialization of farming; creation of climate change management systems; and improvements to legal and institutional frameworks.

These activities are supported by a wide range of stakeholders, including the Government of South Sudan, Swedish Free Mission, Catholic Relief Services (CRS), Norwegian Peoples Aid (NPA), FARM Yei, GIZ, UN Women, ACROSS, Action Africa Help (AAH) International, United Methodist Committee on Relief (UMCOR), CARITAS International, SNV Netherlands Development Organisation, Plan International, SPARK, Alliance for a Green Revolution in Africa (AGRA), FAO, Famine Early Warning Systems Network (FEWS NET) and the World Food Programme (WFP), among others.

**Ironstone Plateau:** As this area is also rich in agriculture, programmes that increase agricultural productivity (for instance, by providing agricultural inputs and implements) have been prioritized. To increase people's livelihoods and reduce poverty, the Ministry of Agriculture and Food Security and the Ministry of Animal Resources and Fisheries are supporting sustainable development initiatives such as integrated soil management and climate-smart agriculture. Water pollution and increased incidences of waterborne diseases sometimes associated with poor sanitation and flooding (among other causes) are being addressed by Water, Sanitation and Hygiene (WASH) and awareness-raising and advocacy programmes initiated by the Ministry of Health, the United Nations Children's Fund (UNICEF), Adventist Development and Relief Agency International (ADRA), Malaria Consortium, WHO and Oxfam (UK). Egypt and Sudan have also constructed a dam at Jur River to mitigate flooding. To reduce biodiversity loss and the spread of wildfires, the Ministry of Environment and Forestry – working with other organizations such as the Wildlife Conservation Society (WCS), Fauna & Flora International (FFI) and African Wildlife Foundation (AWF) – has initiated wildlife and biodiversity programmes, including in protected areas such as Southern National Park. Additional activities planned in the future include: establishment of early warning systems, development of an integrated health strategy, provision of resilient crops, crop diversification, better farming methodologies, improved water catchment management, promotion of agribusiness and access to finance, infrastructure improvement, sanitation improvements, biodiversity enrichment and restoration, in situ and ex situ conservation, advocacy and awareness-raising campaigns, and law enforcement.

**Hills and Mountains Zone:** The most common activities carried out in this zone are in the areas of agriculture, health and environmental conservation. They are aimed at addressing issues related to reduced agricultural productivity, drought and famine, soil degradation, disease and pest incidences and loss of biodiversity. The activities are supported by the Ministry of Agriculture and Food Security, the Ministry of Wildlife Conservation and Tourism, the Ministry of Environment and Forestry and the Ministry of Health; development partners such as USAID and FAO; and NGOs, the most notable of these being the South Sudan Nature Conservation Organisation (SSNCO), WCS, AWF, WFP, Plan International, Mott MacDonald and the Red Cross. At the community level, food security programmes, like the South Sudan Agriculture Development and Food Security project are being promoted to address drought, which is common in lowlands. Further examples of these activities include poultry husbandry, growing high-value crops, alternative livelihood projects, vegetable production and use of mulching, terracing and green and animal manure in farming practices. The Ministry of Health is promoting disease and pest control methods, especially in areas prone to malaria. The Ministry of Environment and Forestry, WCS, AWF and SSNCO are supporting sustainable forest management through forest concessions, afforestation and reforestation, the creation of wildlife reserves to reduce biodiversity loss and water catchment programmes to protect critical water catchment areas such as the Imatong Mountains. AWF is implementing an integrated watershed management programme focused on the Imatong Mountains and the transboundary Imatong-Kidepo landscape where they are located. Local communities, business groups, the Government and NGOs are promoting sustainable production of charcoal and firewood and alternative livelihood activities. There are also plans to improve food production through research and the introduction of ecological farming. Other planned activities include developing integrated pest and disease management, establishing village clinics and improving health and medical services. To conserve biodiversity, plans are under way to establish gene banks, strengthen conservation policies, create more protected areas, and to promote the planting of indigenous trees and traditional conservation knowledge.

**Pastoral Area Zone:** This is a dry zone and its main livelihood is livestock production. As such, this zone is prone to droughts and water scarcity, leading to livestock losses. Most of the ongoing activities are therefore geared towards improving livestock production and strengthening the resilience of the ecosystem to address land degradation, desertification, loss of biodiversity and drying of water bodies (rivers, wells and streams). Through the ministries of Irrigation and Water Resources, Health, Agriculture and Food Security and Education; development partners such as the FAO and NGOs such as the Association of Volunteers in International Service, UNICEF, WFP, Caritas, the Catholic Relief Service and GIZ, the Government is supporting water conservation and access programmes to address drought-related livestock impacts. These include borehole drilling and promoting water harvesting methods. Food aid and agricultural inputs are provided during drought periods, especially when people are migrating from affected areas. Holistic land management, livestock restocking during droughts and the provision of veterinary services are other important ongoing activities in this area. Crop production is promoted through the provision of agricultural inputs, water and the strengthening of extension services. Environmental programmes on water management, soil conservation, reforestation, agroforestry, tree planting and conservation of natural resources in general have been initiated to address loss of biodiversity, land degradation, desertification and drying of water bodies. These activities are envisaged to continue in future.

**East and West Flood Zone; Nile and Sobat Rivers Zone:** This zone is prone to flooding and displacement of people as a result of the current conflict. These conditions have a knock-on effect on agriculture and livestock. The main impacts include reduced crop yields and fish production, loss of livestock pasture, drought and loss of jobs and livelihoods. Other impacts include disease outbreaks, soil erosion, land degradation and deforestation. Ongoing adaptation actions are more focused on the impacts of the current conflict, agricultural production and environmental conservation. The main activities addressing the current conflict are the provision of security, food aid and seeds, as well as conflict resolution and peacebuilding. Water harvesting programmes, borehole drilling and range management policies have been initiated to address drought and loss of pasture. Food for assets, for work and for education, as well as cash and seed vouchers, food, extension services and livelihood kits, such as fishing kits, are provided. To address diseases and pollution, health and water, sanitation and hygiene (WASH) services are provided, with dykes being constructed in flood-prone areas. To address environmental conservation issues, environmental awareness-, training- and extension-service programmes have been initiated. Most of these activities are expected to continue in future. In addition, there are plans to mechanize agriculture, promote agribusiness, construct strategic grain reserves, improve fodder production and cattle breeding, establish dairy farms, promote fish farming and diversify sources of income. The above activities are supported by a range of stakeholders that include the Government, United Nations Mission in South Sudan (UNMISS), WFP, FAO, WHO, UNICEF and NGOs.

## Recommended measures for climate change adaptation in South Sudan

The previous sections of this chapter have provided an overview of how climate change adaptation actions are currently coordinated and have identified gaps. They have also outlined the climate change adaptation priorities of the Government of South Sudan, as provided in the NAPA, explaining the current and planned adaptation activities by the Government, development partners and NGOs in South Sudan. Based on the findings of the preceding sections of this chapter, this section presents recommendations on measures needed to integrate climate change adaptation into national plans and strategies at the policy and institutional levels, as well as at the sector level.

### Policy and legal framework recommendations

The Government of South Sudan has put in place well-articulated and robust policies that address climate change either directly or indirectly. The NAPA outlines three policy priorities:

- establishing institutional mechanisms for climate change adaptation financing/funding
- integrating climate change adaptation and mitigation measures into all sectoral policies
- supporting the creation of an enabling policy environment.

The NAPA has also stressed the need for all projects to contribute to further development of legislative and regulatory frameworks in South Sudan. In view of this, and considering the gaps identified in the preceding analysis in this chapter, the following measures are recommended:

**Formulation and implementation of climate change adaptation policies, legislation, strategies and plans**

South Sudan has prepared the NAPA and sector plans, such as the Comprehensive Agriculture Master Plan and the Irrigation Development Master Plan (that is still in development), all of which support climate change adaptation. If implemented, these plans will help the Government to address some of the impacts of climate change.

South Sudan has not yet developed specific climate change policies, strategies or an overall climate change action plan. It is critical that a climate change policy and plan is developed, as this will enable South Sudan to put in place a high-level institutional and coordination mechanism to enhance the intersectoral adaptation response to climate change, as well as a technical institutional framework to guide policy and the functional implementation of the legal obligations of the Government of South Sudan regarding climate change. A climate change bill is also necessary, as it will provide a legal institutional framework for climate change adaptation and mitigation, once enacted into law. There is also a need to formulate an overarching strategy on climate change and/or a green growth strategy, to enhance South Sudan's appeal to climate financiers. These will provide methods of responding to climate change challenges in the country, with a view to supporting climate-resilient development. Formulating and implementing climate change policies, strategies and plans will demonstrate South Sudan's commitment to the Paris Agreement. Adopted at the United Nations Climate Change Conference in Paris (COP21), the Paris Agreement sets out a global action plan to put the world on track to avoid dangerous climate change by limiting global warming to well below 2°C. In the context of South Sudan, the

Paris Agreement is important, because one of the major contributors of carbon emissions is the oil sector.

**Establishment of clear mechanisms to address climate change adaptation in sectoral policies and regulations**

A review of policies for sectors that need to respond to climate change impacts indicates the need to strengthen the Government's capacity to deal with climate change at the policy level. As an example, the South Sudan National Electricity Policy does not contain any mechanism for climate change mitigation or adaptation and lacks the mechanisms that enable the energy infrastructure and the population to stay resilient to climate change induced floods and related extreme weather events, such as storms. The 2011 Electricity Corporation Act, which is responsible for the generation of electricity and transmission systems in South Sudan, also has no provision on climate change adaptation and mitigation. Some of the policy measures and actions that are needed to enhance the Government's capacity at the policy level to respond to climate change through adaptation include the following:

- incorporating new climate change adaptation policy mechanisms or provisions into existing and upcoming policies to enable sectors such as agriculture, energy, forestry, tourism, livestock and fisheries to become resilient to climate change induced droughts and floods
- raising awareness of mainstream climate change adaptation thinking in policymaking in all sectors
- establishing regulations and mechanisms, and identifying incentives that promote climate change adaptation, the achievement of sustainable development and the minimization of GHG emissions in particular, in all sectors and industries
- establishing climate change finance policies that would enable South Sudan to not only tap into international, domestic and private sector funding but also to establish a specific climate change fund to support the Government of South Sudan's climate change adaptation efforts.

## Institutional framework recommendations

Strong institutions are good foundations for enhancing the capacity of many governments to respond to the impacts of climate change. It is therefore critical that climate change adaptation measures in South Sudan address the institutional capacity gaps identified in this chapter. In line with this, the NAPA has given priority to the action of strengthening the institutional capacity of the Government of South Sudan to integrate climate change in policies in order to develop climate change resilience. This can be achieved by taking the following measures:

**Build the capacity of relevant institutions in climate change**

The main actions that are needed are:

- **Fast tracking the implementation of mechanisms to address climate change adaptation**: The implementation of government policies and plans is dependent on the capacity of the responsible institutions, on ownership and on political will, as well as on having cross-sectoral institutional arrangements. Therefore, the successful implementation of these mechanisms requires this capacity to be built and the transfer and sharing of knowledge and capacity to be enhanced across all sectors.

- **Institutionalization of climate change in relevant institutions, accompanied by capacity-building**: The institutionalization of climate change in the relevant ministries, clear legal mandates of climate change institutions and well streamlined coordination arrangements are critical in the implementation of climate change adaptation policies and plans. It is therefore important to strengthen the climate change unit at the Ministry of Environment and Forestry to enable it to effectively play its role in climate change coordination.
- **Establishment of climate change units and departments across ministries**: Some ministries with a crucial role in climate change adaptation do not have climate change units or departments. This affects the way they respond to climate change impacts, as they do not have adequate technical capacity or financial resources. Establishment of climate change units or departments in these ministries will strengthen their capacity to respond to climate change impacts. Where climate change units are not a priority, establishing partnerships and linkages between these institutions and other institutions is necessary. The Ministry of Petroleum and Mining, for example, can establish a climate change linkage with the Ministry of Environment and Forestry, to enable it to establish climate change industry regulations.
- **Development of South Sudan's capacity to generate and use climate-related information**: This should include setting up and running a Monitoring, Reporting and Verification (MRV) system covering adaptation, mitigation and synergies between them. Such a system would help South Sudan measure and report information on GHG inventories for both domestic and international purposes, which would help South Sudan to not only fulfil its international reporting obligations but also help the country to adapt to a changing climate. It would also help it to measure and monitor performance of climate mitigation and adaptation actions.

### Mainstream climate change adaptation in planning and budgeting

Measures are needed to mainstream climate change into government planning and budgeting. Tools to effectively respond to climate change mainstreaming challenges are also necessary to equip various coordinating and sector agencies of the Government of South Sudan with the necessary capacity to integrate climate change adaptation into planning and budgeting at the national, state and county levels. This is not only a way of safeguarding investments in vital livelihood resources and infrastructure but also a cost-effective measure for the future.

### Mainstream traditional methods of adaptation in national planning

The integration of traditional mechanisms into the climate change impact response is also important in climate change adaptation planning. Droughts, floods and water scarcity have posed challenges to South Sudanese communities since time immemorial. As a result, communities have devised means to stay resilient in the midst of threats to resources.

Most communities have put in place traditional governance structures to manage their livelihood and socioeconomic activities, such as crop and livestock production and fishing. For example, traditional political power and governance among the Dinka and Nuer people are vested in small units of their societies, usually in the forms of clans and territorial settings. Unlike the Dinka and the Nuer, the Shilluk have a centralized monarchy with sections and clans run by chiefs who play key roles in resource use and governance. These structures are recognized by the 2011 Local Government Act. National, state and county climate change adaptation planning processes

should be cognisant of – and accommodate – these structures and traditional means of coping with disasters in the adaptation and resilience-building planning activities.

### Mobilize climate finance in South Sudan for adaptation

Climate finance is essential to South Sudan in order for it to meet the national goals for adapting to climate change. Public sources of international finance come from bilateral development partners and multilateral agencies. This is a complex problem to overcome. As a new nation, South Sudan does not have many sources of climate finance from international public and private sources, domestic public and private sources or carbon finance, because policy frameworks to facilitate this funding are not well developed. Institutional and capacity barriers also prevent South Sudan from securing the finance that the country needs to address climate change effectively. In many countries, the ministries responsible for finance and planning play an important role in mobilizing climate finances by designing climate change adaptation and mitigation financing mechanisms and instruments. Some of the financial mechanisms and instruments which have been used to address climate change include national climate change funds, loans, grants, debt swaps, carbon markets and insurance instruments. South Sudan's Ministry of Finance and Economic Planning can play an important role in designing and meeting the requirements for these mechanisms and instruments. At the county level, establishment of county adaptation funds can provide a good opportunity to respond to climate change impacts, especially in climate-risk counties. These funds can enable counties to develop resilience to impacts of climate change.

There are many government proclamations on climate change that also need to be built into the planning and budgeting of the Ministry of Finance and Economic Planning. This includes the manifesto of the ruling party, the Sudan People's Liberation Movement, which promotes the creation of a green economy.

### Harness NGO and civil society support

Beyond purely government institutional architecture, there are further opportunities to harness support from both NGOs and civil society to facilitate climate change adaptation. Since there is a thriving NGO sector in South Sudan and some of their work – especially on food security, emergency and infrastructure – has helped the country respond to current political crises, food insecurity, flood and drought disasters, the individual capacities of non-state actors could be further harnessed to support the implementation of climate change policies, strategies and plans. Capacity-building and information sharing activities by these NGOs has been central to understanding climate change impacts and adaptation/coping mechanisms used by local communities.

## Sector-based recommendations

Climate change impacts at sector level are explained in detail earlier in this chapter. The chapter has also presented the Government's priorities in response to climate change, as well as having identified some of the ongoing and planned adaptation activities in these sectors and in the seven livelihood zones of South Sudan. It is critical that support is provided to strengthen the elements that enable individuals, households and communities to absorb shocks, adapt and transform to changing environments. This section presents the climate change adaptation measures that are needed in sector strategies, based on the Government's priorities and ongoing activities.

## Agricultural sector

### Crop and livestock production

#### Diversify sources of income and livelihood

Households rely on limited livelihoods and have low levels of diversification in crops, fisheries and livestock production. Supporting alternative livelihoods and income-generating activities can reduce the impacts of climate change on agricultural production and enhance households' ability to absorb shocks and adapt to a changing environment.

#### Improve access to improved agricultural inputs and techniques through extension-services support

Adapted seed varieties (drought-tolerant, early-maturing, disease-resistant and adapted to local agroecological zones) and improved seeds will increase agricultural production and enhance community resilience during droughts. Support should be provided to farmers to enable them to access locally multiplied, improved varieties of seeds (e.g. maize seeds such as Longi 5 and improved groundnut varieties such as Red Beauty). FAO has been at the forefront of providing assorted seeds. In 2015 alone, FAO provided about 2,270 tons of assorted seeds (mainly sorghum, maize and groundnuts, with lower quantities of sesame and cowpea) to partner NGOs, who were then responsible for distribution to the end users. These types of arrangements would enable the majority of farmers in South Sudan to access improved seeds.

Farmers should also be supported to overcome constraints and challenges related to poor farming and social and cultural barriers. This support should include promoting the use of appropriate tools and expanding areas where animal traction and irrigation is being promoted, such as in drought-prone and water-scarce areas. The development of agricultural extension services is critical to this support, which is currently not well established in South Sudan. Strengthening extension services will enable most communities to get the best and appropriate crop and livestock inputs and services.

#### Establish and build capacity on early warning systems

Establishing early warning systems will reduce the impacts of climate change in South Sudan. Currently, these systems are not well established. The early warning system and programmes should be developed at the grass roots levels to inform farmers and livestock keepers of looming flood and drought disasters. To be effective and sustainable, they must actively involve the at-risk communities. Local governments and communities also need to be able to predict weather changes through the early warning system. Capacity-building will entail mobilizing communities around the use of climate change data generated by weather stations. This will require a mechanism for distributing the information to these communities and also the creation of response strategies.

### Improve access to markets and value chain development

Access to markets is important for food security in South Sudan. This is especially the case in the agropastoralist and agricultural areas, where households depend heavily on markets during the agricultural lean seasons, yet road infrastructure to access markets is very poor. Poor accessibility to markets has also led to a lack of value-addition to agricultural products in agriculture-rich areas such as the Green Belt Zone. Road infrastructure improvement will lead to increased access to markets for farming communities, increased production, improved community services (including for disaster risk reduction) and value-addition at each stage of agricultural production. Value chain development and marketing of agricultural, livestock and fisheries products in South Sudan (currently promoted in the Green Belt Zone area) will stimulate economic development and thereby improve people's livelihoods while reducing their risks and increasing their resilience.

### Promote traditional conflict management systems

Conflicts are projected to increase as a result of climate change. Currently, there are traditional conflict management systems in place. These should be promoted, as they are critical to mitigating resource-based conflicts while ensuring access to natural resources, migration routes and resolution of disputes over access and control of productive resources such as fertile and productive land.

### Encourage traditional crop and livestock production mechanisms

Communities in South Sudan have devised strategies to enhance food production. These have enabled them to adapt to a changing climate. Such measures include using traditional methods to store and preserve seeds for planting in the next season and the traditional construction of dykes in the event of floods, using traditional tools. Although traditional dykes are not very effective and are being replaced by improved modern dykes, they provide an important entry point to communities and also facilitate further climate change adaptation awareness. In many communities, livestock grazing is regulated by elders and clans. Some clans control territories on the banks of rivers and lakes, which provide better pastures and access to water during droughts. As a means of adaptation, a clan would migrate to these territories during the dry season and migrate back to highlands during the rainy season. These practices that enable livestock to have access to green pastures and water during the dry season, ensuring continued milk production, should be promoted.

Seasonal migration is also another important coping strategy in South Sudan in order to search for pasture, grazing land, water and other natural resources in times of distress (e.g. seasonal dry spells). These mechanisms help households to mitigate the negative effects of shocks and stressors.

### Promote sustainable land management practices

Sustainably managed access to land is important in determining resilience at the household and community levels, as it underpins peoples' ability to produce sufficient food, diversify production and overcome certain shocks and stressors. Adaptation strategies that focus on raising yields in wetter areas may be a more viable option than extending agriculture into more marginal areas.

However, rapid population growth makes it difficult to slow the process of agricultural expansion. Sustainable agricultural practices such as mulching and the use of organic manure, climate-smart and conservation agriculture should be promoted. Measures that improve livestock production and increase its resilience, such as holistic land management, should be promoted.

**Enhance knowledge and technical skills**

The literacy level in South Sudan is very low. Knowledge and technical skills often enable households to access salaried and skilled labour that, in turn, determine their access to important income sources in sectors other than agriculture, livestock or fishery. These alternative income sources are less prone to climatic or natural hazards and therefore should be promoted to improve people's adaptive capacity in times of shocks.

**Facilitate access to formal credit and financial systems**

The overall lack of such systems in South Sudan dramatically constrains business and market opportunities, reducing employment opportunities for youth, women, returnees and internally displaced persons, who struggle to access the labour market and reliable income sources. Access to credit and finance will stimulate socioeconomic development and enhance the adaptive capacity of households to impacts of climate change.

**Promote development of grass-roots informal social networks**

Household reliance on borrowing and gift-receiving from members of self-help groups, relatives, neighbours, families and communities is a highly relevant coping strategy in South Sudan and strongly determines the ability of households to better cope with shocks. These informal social networks should be promoted.

**Fish production**

If well exploited and managed, fisheries can be one of the greatest contributors to poverty alleviation, food security and improved nutrition in South Sudan. This potential has been recognized in the South Sudan Vision 2040. Some of the adaptation measures needed to build resilience and improve livelihoods in the fishery subsector are presented below.

**Strengthen the Government's capacity to realize fishery production potential**

A large potential for aquaculture development in Central Equatoria, Eastern Equatoria, Western Equatoria, Northern Bahr el Ghazal, Western Bahr el Ghazal and Warrap State has been identified.[189] However, the Government currently has inadequate capacity to realize this potential. Interventions are needed in the following areas:

- Determining the productive capacity of the lakes and rivers and the tools, equipment and infrastructure needed to exploit this potential
- Providing seeds (fingerlings), feed production and the appropriate tools and equipment
- Developing infrastructure

### Establish or strengthen appropriate fishery policies, regulations and institutions to improve fish production

Most policies promote subsistence fish farming and there are limited good-quality fingerlings, feed and skills to develop aquaculture. Most producers therefore depend on imported tilapia fingerlings and feed from Uganda. Fish production is also not well regulated and, in most cases, is open, with no prevention controls on numbers of fishers or entry. Apart from rudimentary licensing mechanisms, there is no institutional organization or capacity to collect, analyse and process data. Policies that promote quality fish production and regulations to control fishing, together with the institutional capacities to implement the policies and regulations, are needed.

There is also a need to adhere to good practices such the FAO Code of Conduct for Responsible Fisheries and other related guidelines. These guidelines cover, inter alia, fisheries, aquaculture, trade, the environment, climate change, wetlands management, provision and recommendations, protecting the rights of communities, gender issues, HIV/AIDS, disposal of hazardous wastes, desertification, biosafety, transfers and introductions of species.[190]

### Promote traditional fishing regulations

Sustainable fishery control regulations, such as the existing traditional fishing rotation regulations, should be promoted. Under these regulations, fishing communities usually establish a fishing rotation system where restrictions are placed on fishing territories to allow the ecological balance to be replenished and maintained. This practice is common among the fishing communities around the Sudd Wetland. Traditional authorities also play an important role in South Sudanese fishing society through traditional regulations that include the obligation to return any small fish caught to the water.

### Improve fishery production infrastructure

Fishery production infrastructure, storage and transportation conditions are generally poor. As a result, fish losses are very high. Overall losses of fresh fish between capture and landing are probably comparable with or higher than those of most countries in East Africa, reaching up to 50 per cent. Post-harvest losses exceed 60 per cent in some areas and the fish sold is of very poor quality.[191]

### Promote use of improved fishing equipment and preservation techniques

To fish, communities use spears, hooks and fishing nets, especially during floods because the number of fish is high. Communities also lack preservation capacities and, in most cases, use traditional preservation techniques. Modern fishing and fish preservation techniques can improve fishery productivity in South Sudan.

### Support the commercialization of fisheries and develop the requisite capacity

There is very little large-scale fish commercialization. There is also limited institutional capacity to develop markets for fish. The commercialization of the fishing industry and development of institutional capacity to access markets can substantially improve fish production. Creating

community fish associations, as is the case in Kenya and other neighbouring countries, can enhance the institutional capacity of communities in South Sudan to engage in commercial fish enterprises.

### Hydrology and water resources sector

#### Build institutional capacity in water resource management

Water resources are not well developed in South Sudan. Water resource development will entail strengthening institutional capacity in water resource management, planning and governance at the national, county and state levels. There is a strong need to conduct on-the-ground assessments to inform decision-making processes used to manage this important, largely undeveloped resource. There is also a need to promote the formulation of water resource management plans, such as the Irrigation Development Master Plan that is currently being prepared.

Institutional capacity-building should also include improvement in water management structures, such as the construction of dykes in flood-prone areas to protect communities and businesses from floods.

#### Promote sustainable and equitable access to water mechanisms

Water access is a major issue in South Sudan, especially during periods of drought. Boreholes, rainwater harvesting structures and restored natural drainage systems will improve access to water for people, agriculture and livestock during dry spells and in the midst of decreasing rainfall. Coupled with improved agricultural management practices, water accessibility could contribute to offsetting climate induced changes.

#### Protect and restore important watersheds

Climate change has been shown to lower water tables and reduce water flow in rivers. Measures should be taken to improve water level balance to avoid conflicts brought about by limited water supply, especially in dry areas. These measures should include protection and restoration of watersheds and water catchment areas. Important regional water towers, such as the Imatong Mountain Watershed, should be protected so that they continue to contribute to the sustainability of ecosystems and resilience against climate change shocks.

#### Promote and support climate change resilient technologies for water and soil conservation

Efforts should be made to set up demonstrations at learning centres for farmers to adopt water harvesting technologies and trenches for soil and water conservation. These measures will mitigate the impacts of flooding.

### Forestry and environment sectors

#### Promote measures that protect biodiversity and increase ecosystem resilience

Climate change has been shown to contribute to biodiversity loss, especially when important ecological niches of species are modified. This report has identified a few mechanisms that have been put in place by various agencies to conserve biodiversity in South Sudan. However, because of the limited area that is currently protected, biodiversity continues to be lost through unsustainable practices. Efforts should be made to promote biodiversity conservation by increasing the size of the protected biodiverse area. There is also a need to scale up biodiversity conservation projects in South Sudan with the primary objective of reducing the threats posed to biodiversity by anthropogenic factors and climate change and of strengthening resilient and sustainable management of important ecosystems.

#### Promote and support landscape restoration and ecosystem-based adaptation

Forested landscapes and important wetlands in South Sudan have been degraded through clearing and resource extraction, exposing this area to impacts of climate change. Landscape restoration and ecosystem-based adaptation through the scaling up of current afforestation and reforestation efforts should be promoted. Wetland wise-use principles should be applied in wetland resource management to enable people to adapt to the adverse effects of climate change and to promote the sustainable development of wetland resources. Projects that place strong emphasis on ecological and nature solutions and the maintenance of genetic diversity should be promoted as part of the solution to impacts of climate change.

#### Promote energy-saving technologies like improved charcoal stoves, biogas and solar

Over-reliance on biomass for energy has contributed greatly to vegetation loss and degradation. Efforts should be made to identify and promote suitable energy-saving technologies. This will entail supporting institutions to install such technologies, examples of which include energy-efficient stoves and solar, biogas and efficient charcoal production kilns. Promotion of improved biomass conservation measures should go hand in hand with building the capacity of local artisans to install some of the affordable technologies.

#### Promote community-based natural resource management approaches

At the community level, traditional authorities play an important role in natural resource management. In South Sudan, traditional regulations are often used to regulate the use of forest fires and protection of certain wildlife and tree species. These community-based approaches should be an integral part of natural resource management in South Sudan.

The above recommendations have been summarized in Table 3.7.

**Table 3.7: Summary of measures needed for integration of adaptation in national strategies**

| Category | Recommended measures | Priority geographical area |
|---|---|---|
| **Policy and legal framework** | Formulate and implement climate change adaptation policies, legislation, strategies and plans. These include the fast tracking of the implementation of NAPA, the Comprehensive Agriculture Master Plan, the Agriculture Development Master Plan, the Irrigation Development Master Plan and other climate change policies and plans needed for adaptation. | National |
| | Establish clear mechanisms to address climate change adaptation in sectoral policies and regulations. These may include specific adaptation provisions for climate change resilience in policies and laws, such as in the electricity, agriculture, energy, forestry, tourism, livestock and fisheries sectors. | National |
| **Institutional framework** | Build the capacity of relevant institutions in climate change. This should include improving the transfer and sharing of climate change knowledge and capacity across all sectors, policy-level awareness, institutionalization of climate change in relevant institutions, establishment of a climate change department and climate change units in government ministries and agencies. | National |
| | Mainstream climate change adaptation in planning and budgeting at the national, state and county levels. | National |
| | Mainstream traditional methods of adaptation in national planning to enhance resilience. | National |
| | Mobilize climate finance for adaptation in South Sudan from international public and private sources, domestic public and private sources and carbon finance. At the local level, this may also include the establishment of County Adaptation Funds. | National |
| | Harness NGO and civil society support in the implementation of climate change policies, strategies and plans. | National |

| Category | Recommended measures | Priority geographical area |
|---|---|---|
| **Agricultural sector** | Diversify sources of income and livelihoods to reduce the impacts of climate change on agricultural production and to improve households' ability to absorb shocks. | Zones with low levels of diversification such as the Ironstone Plateau, hills and mountains |
| | Improve access to improved agricultural inputs (e.g. improved seed varieties that are drought-tolerant, early-maturing, disease-resistant and adapted to local agroecological zones) and techniques provided through extension-services support. | High-potential agricultural areas in all zones |
| | Establish and build the capacity of early warning systems and design response strategies. | National, with priority given to drought and flood-prone areas |
| | Improve access to markets and value chain development. | Agro-pastoralist and agricultural areas with limited access to markets such as the Green Belt Zone, the Ironstone Plateau, hills and mountains |
| | Promote traditional conflict management systems to mitigate resource-based conflicts. | National, with priority given to conflict-prone areas such as the Pastoral/arid zone, western and eastern flood zones |
| | Encourage traditional crop and livestock production mechanisms to enable communities to adapt to impacts of climate change. | National |
| | Promote sustainable land management practices such as climate-smart agriculture, conservation agriculture and holistic range management. | National |
| | Improve people's knowledge and technical skills to increase their adaptive capacity when faced with climate change impacts. | National |
| | Facilitate people's access to formal credit and financial systems to stimulate socioeconomic development and improve the capacity of households, in order to mitigate the impacts of climate change. | National |
| | Promote the development of grass-root informal social networks to enhance people's ability to cope with climate change shocks. | National |

| Category | Recommended measures | Priority geographical area |
|---|---|---|
| | Strengthen the Government's capacity to realize its fishery production potential by developing infrastructure and providing seeds (fingerlings) and equipment. | Fish-producing areas in the Nile and Sobat Rivers, Western and Eastern Flood Plains and other areas with a potential for aquaculture development, such as Central Equatoria, Eastern Equatoria, Western Equatoria, Northern Bahr el Ghazal, Western Bahr el Ghazal and Warrap States |
| | Establish or strengthen suitable fishery policies, regulation and institutions to improve fish production. | National |
| | Promote traditional fishing regulations, such as fishing restrictions that allow the ecological balance of the Sudd Wetland to be replenished and maintained. | All fishing areas |
| | Promote the use of improved fishing equipment and preservation techniques to improve fishery productivity in South Sudan. | All fishing areas |
| | Obtain support for the commercialization of fisheries and development of the requisite capacity in order to improve fish production. | All fishing areas |
| **Hydrology and water resources** | Build institutional capacity in water resource management, planning and governance at the national, county and state levels. | National |
| | Promote sustainable and equitable access to water mechanisms to offset climate induced changes. | National |
| | Protect and restore important watersheds so that they continue to contribute to the sustainability of ecosystems and become resilient to climate change shocks. | All zones, with priority given to hills and mountains and other forested water catchment areas |
| | Promote and support climate change resilient technologies for water and soil conservation. | National, with priority given to flood-prone areas |

| Category | Recommended measures | Priority geographical area |
|---|---|---|
| **Forestry/ Environment** | Promote measures that protect biodiversity and increase ecosystem resilience. These include expansion of protected areas, scaling up of biodiversity conservation projects and strengthening resilient and sustainable management of important ecosystems. | All biodiversity rich areas |
| | Promote and support landscape restoration and ecosystem-based adaptation. These measures include applying wetland-use principles and promoting projects that promote maintenance of genetic diversity. | National, with priority given to biodiversity rich areas |
| | Promote energy-saving technologies like improved charcoal stoves, biogas and solar power. | National |
| | Promote community-based natural resource management approaches. | National |

CHAPTER 4

# PROGRAMMES CONTAINING MEASURES TO MITIGATE CLIMATE CHANGE

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## Introduction

Articles 4.1 and 12.1 of the UNFCCC commit Parties to developing national and, where appropriate, regional programmes and measures that will result in the mitigation of human-induced climate change. Such measures may either reduce the increase in GHG emissions (abatement) or increase terrestrial storage of carbon (sequestration). All the measures have to comply with the applicable national and international agreements, policies and legislation.

South Sudan views undertaking climate change mitigation as a means of achieving sustainable development. For the country, undertaking mitigation analysis also facilitates the implementation of mitigation projects, the strengthening of institutional and human capacities and the prioritization and evaluation of social, economic and environmental programmes.

This chapter presents South Sudan's mitigation assessment, describing the low-carbon assessment undertaken in the following eight economic sectors:

- Energy
- Transport
- Industrial processes
- Agriculture
- Land use, land-use change and forestry (LULUCF)
- Electricity generation
- Residential and commercial (energy demand)
- Fossil fuel petroleum production
- Waste management

The development of the baseline business-as-usual emissions trajectory and the analysis of the development scenarios have been carried out with limited information on the Government of South Sudan's future plans and historical data and will need improvements in future as more and better information becomes available.

Despite the absence of adequate data, the analysis attempts to apply both a bottom-up assessment of mitigation opportunities and a top-down economy, energy and emissions model examining the economy as a whole. The analysis provides the evidence base for prioritizing low-carbon development opportunities and, ultimately, developing investment proposals to attract international climate finance through various strategies such as Nationally Appropriate Mitigation Actions (NAMAs) and reducing emissions from deforestation and forest degradation plus the role of conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+).

Due to a lack of adequate data, no estimation was made for the projected investment costs related to the priority mitigation measures.

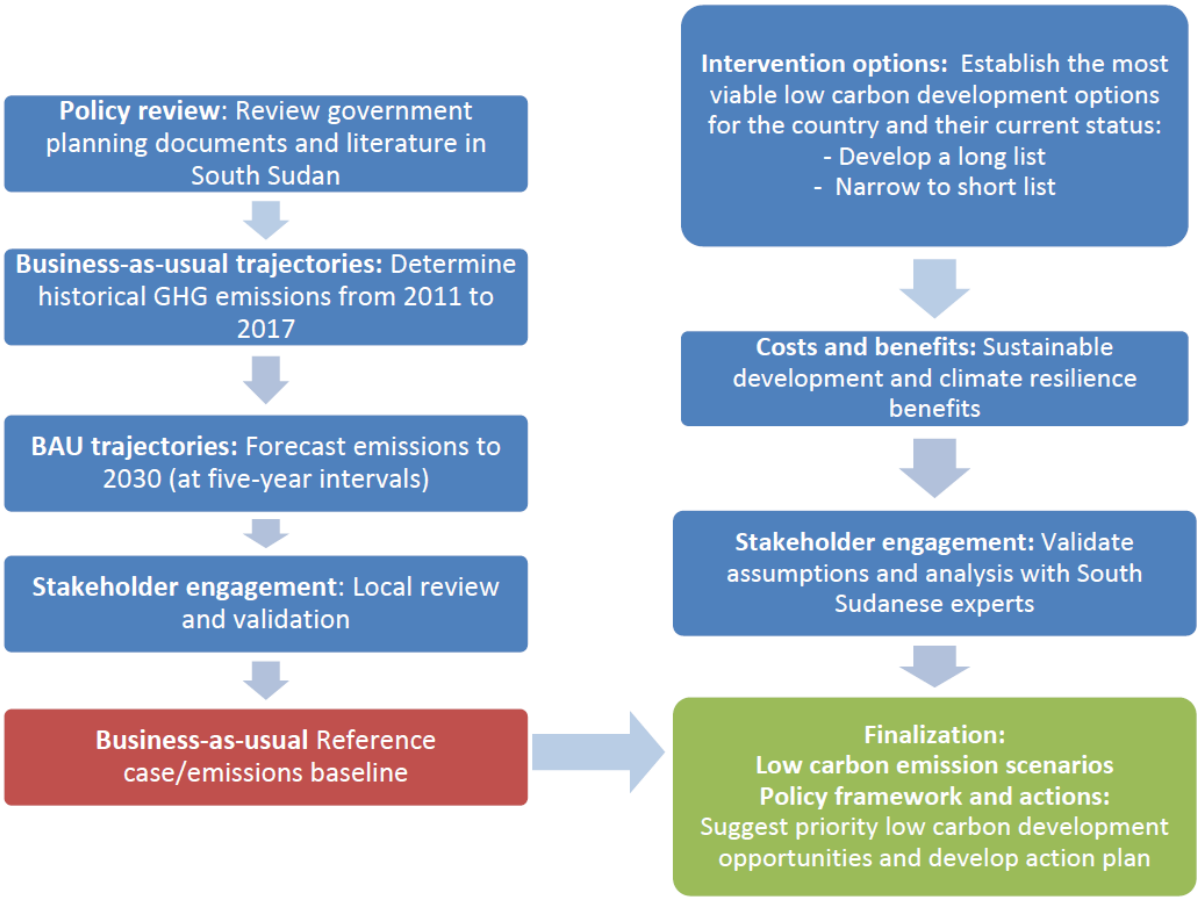
## Methodology for the mitigation assessment

Based on the national circumstances and sustainable development objectives of South Sudan, together with socioeconomic and environmental considerations, the country has used available and appropriate methods to formulate and prioritize programmes containing measures to mitigate climate change. Besides mitigation benefits, the measures proposed have the potential to make significant contributions to socioeconomic and sustainable development.

The mitigation assessment conducted by South Sudan entails generating information regarding the impacts of the various technologies and practices to mitigate climate change, which are relevant for sustainable development and useful for policymaking when formulating and prioritizing mitigation programmes. Due to the lack of required data, it was not possible to carry out cost estimations.

Significant data will have to be collected in future to undertake a detailed technical analysis that will both identify the main elements of a low-carbon development pathway and acknowledge that this pathway needs to emphasize sustainable development and climate resilience co-benefits. A more extensive review undertaken by the key stakeholders and experts by means of an extensive consultation and validation process would also be required. The extent of a bottom-up consultation process has been severely limited by the conflict and insecurity in the country. However, available information and experience elsewhere demonstrate that, if carefully selected and prioritized, mitigation actions can contribute to low-carbon climate-resilient development pathways with significant sustainable development benefits. The methodology applied identifies the emission reduction options and their estimated potential. The general methodology used to develop the low-carbon scenario assessment is outlined in Figure 4.1.

**Figure 4.1:** General methodology used to develop the low-carbon scenario assessment




In the methodology, the baseline emissions reference case or business-as-usual scenario is developed using the historical GHG emissions, developed and presented in chapter 2, from 2012 to 2016. This is then projected to 2040, during which policy and development plans are taken into consideration and several political and economic assumptions are made, a key one being that conflict and insecurity will have significantly reduced by the end of 2018.

The impacts of various mitigation measures are then assessed in the context of a low-carbon climate-resilient development pathway. The sustainable development benefits of the measures have also been identified. The 'big wins' will not only lower national emissions in the future but will also have significant impacts on sustainable socioeconomic development and climate change adaptation in South Sudan.

## Baseline emission projection

An assessment of mitigation options to be undertaken as part of appropriate mitigation programmes requires a projection of expected baseline or business-as-usual emissions into the future. This projection should account for existing government policies from which to consider the impact of individual mitigation measures. It is important that these projections reflect only existing policies, regulations and financial commitments and that they exclude any potential

new policies or financing that is speculative in nature. However, being a young country that is facing many development challenges as well as political conflict and insecurity, South Sudan has been unable to formulate adequate policies that could solidly be applied to establish the baseline emissions. However, there are enough documented policies, bills, drafts and stated intentions to give an indication of the general intentions and provide a basis for estimating the business-as-usual trajectory. For this reason, targets and goals expressed by the Government of South Sudan in Vision 2040, and elsewhere, have not been considered as constituting the baseline, **unless** appropriate policies have been put in place and funds committed to reach them.

This section describes the methods used to project baseline emissions for South Sudan out to 2040 by sector and also for the entire economy and then presents the results. Although every effort was made to apply the latest available data and information, the process was limited by both inaccurate and inadequate data and information. The business-as-usual trajectory was assessed using the following emission sectors:

- **Agriculture:** Of all sectors, the agricultural sector is currently the largest source of GHG emissions. More than one-third of total national emissions are from this sector alone. Despite its important contribution to overall emissions, data required to calculate GHG emissions is lacking and there is significant uncertainty associated with the emission estimates of this sector, among others. The main drivers of emissions in South Sudan's agricultural sector include enteric methane emissions from livestock, savannah burning, agricultural residues and rice cultivation. This does not include the conversion of land uses from non-agricultural to agricultural or the management of plantations, which are considered in the forestry sector.
- **Land use, land-use change and forestry (LULUCF):** This includes estimates of emissions and removals of GHGs associated with increases or decreases of carbon in living biomass as land-use changes occur over time, such as when a forest area is converted to cropland, or when new forest lands are established through reforestation or afforestation. Projections for land-use changes and biomass removals that impact emissions and removals linked to LULUCF between 2012 and 2040 are based on a number of different assumptions affecting land use, forest fires and forest product utilization.
- **Fossil fuel production:** This includes emissions associated with crude oil production, including fugitive emissions.
- **Waste:** Through the processes of disposal, treatment, recycling and incineration, wastes produce GHG emissions. Two major sources of this type of $CH_4$ production are the disposal of solid wastes on land and wastewater treatment. Waste incineration, like other forms of combustion, generates $CO_2$, as well as smaller amounts of $CH_4$ and $N_2O$ emissions, depending on the composition of the waste. The breakdown of human sewage can also lead to significant amounts of indirect $N_2O$ emissions. In South Sudan, waste projections are closely linked to projected population growth and urbanization.
- **Transportation:** The future growth in petroleum product consumption for road transportation (gasoline, light diesel oil and additives) was determined based on projected GDP growth rates, passenger and freight growth rates, the growth rate in the overall vehicle stock, the growth rate in the use of vehicles (demand for services) and the change in average fuel efficiency over time. There were no known projections that indicated any growth in this in South Sudan and the transport sector is currently experiencing a period of intense suppressed demand. The analysis applied a flat rate of growth over the period.
- **Residential and commercial energy (energy demand):** This includes fossil and biomass fuels consumed by the residential, commercial, industrial, agriculture, forestry and fishing sectors,

and all fuel combustion emission sources that are not related to the electricity generation sector or the transport sector.

- **Electricity generation:** Developing a baseline projection for South Sudan's electricity sector is challenging because there is considerable uncertainty regarding how the sector may grow to meet a large suppressed demand for electricity.
- **Industrial processes:** The main industrial process emission sources are processes that chemically or physically transform materials and produce $CO_2$, $CH_4$, $N_2O$, hydrofluorocarbons or perfluorocarbons. In South Sudan, there are no such industries and only the gases used in refrigeration and air conditioning have been included.

Final projections of the baseline emissions for each sector out to 2040 are illustrated in Figure 4.2 and Table 4.1.

**Figure 4.2: Emission baseline projection for South Sudan in MtCO2e (2012–2040)**

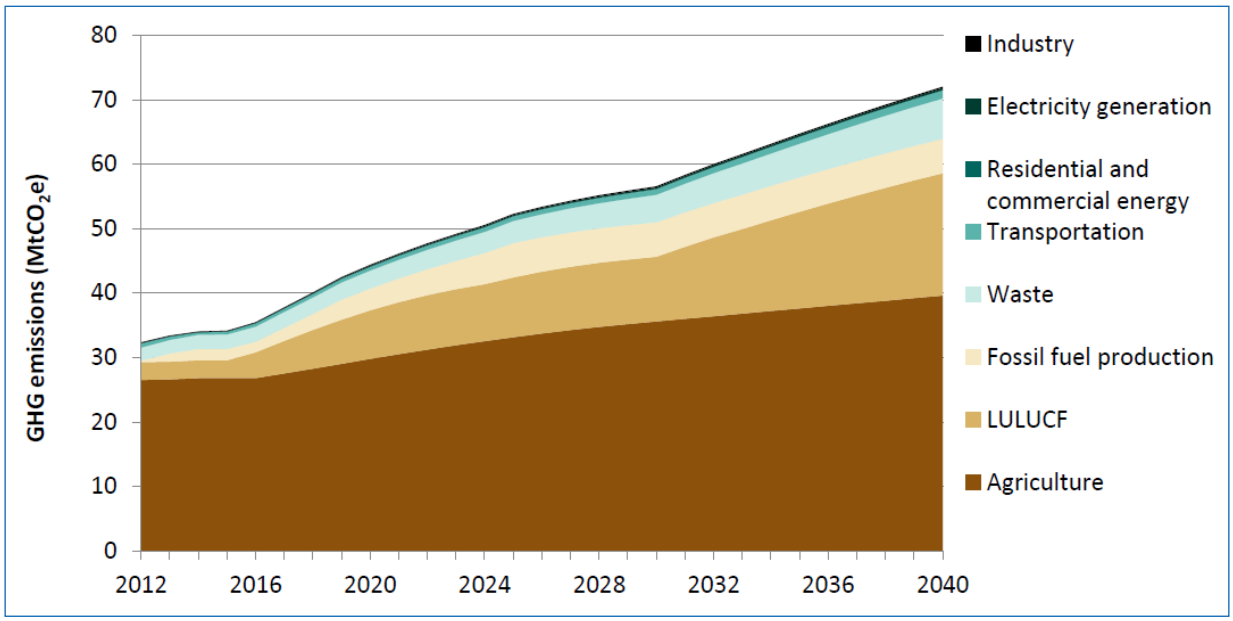



**Table 4.1: Emission baseline projection for South Sudan in $MtCO_2e$ (2012–2040)**

| | Annual emission reductions ($tCO_2e$) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sector** | **2012** | **2015** | **2020** | **2025** | **2030** | **2035** | **2040** |
| Agriculture | 26.5 | 26.8 | 29.8 | 33.2 | 35.6 | 37.6 | 39.6 |
| LULUCF | 2.8 | 2.8 | 7.5 | 9.3 | 10.0 | 15.0 | 19.0 |
| Fossil fuel production | 0.2 | 1.7 | 3.4 | 5.3 | 5.3 | 5.3 | 5.3 |
| Waste | 2.0 | 2.3 | 2.8 | 3.4 | 4.3 | 5.2 | 6.3 |
| Transportation | 0.7 | 0.4 | 0.6 | 0.8 | 0.9 | 1.1 | 1.3 |
| Residential and commercial energy | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 |
| Electricity generation | 0.1 | 0.0 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 |
| Industry | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 |
| **Total annual emissions** | **32.7** | **34.5** | **44.8** | **52.7** | **57.0** | **65.3** | **72.6** |

In the reference case, total annual emissions increase by about 122 per cent (from 32.7 million tons of carbon dioxide equivalent ($MtCO_2e$) in 2012 to 72.6 in 2040) and in all sectors, including LULUCF. The following can also be determined from this annual emission reductions analysis:

- Fossil fuel production emissions are likely to grow the most, by about 2,093 per cent, from 0.2 $MtCO_2e$ in 2012 to 5.3 in 2040. Much of this increase is attributed to the projected increased activity in the oil and gas sector.
- LULUCF sector emissions are likely to progressively increase by nearly 600 per cent by 2040, mostly due to forecasted increased deforestation.
- The agriculture and LULUCF sectors are the largest emitters, accounting for approximately 90 per cent of emissions in 2012 and 81 per cent in 2040, mainly due to emissions from livestock (enteric fermentation and manure management), prescribed burning of savannahs and deforestation.
- Emissions in other sectors grow significantly, with electricity generation and waste management emissions almost tripling between 2012 and 2040, and emissions from the transportation, energy demand and industrial processes sectors doubling in the same time period.

## Mitigation scenario

### Description of greenhouse gas mitigation options

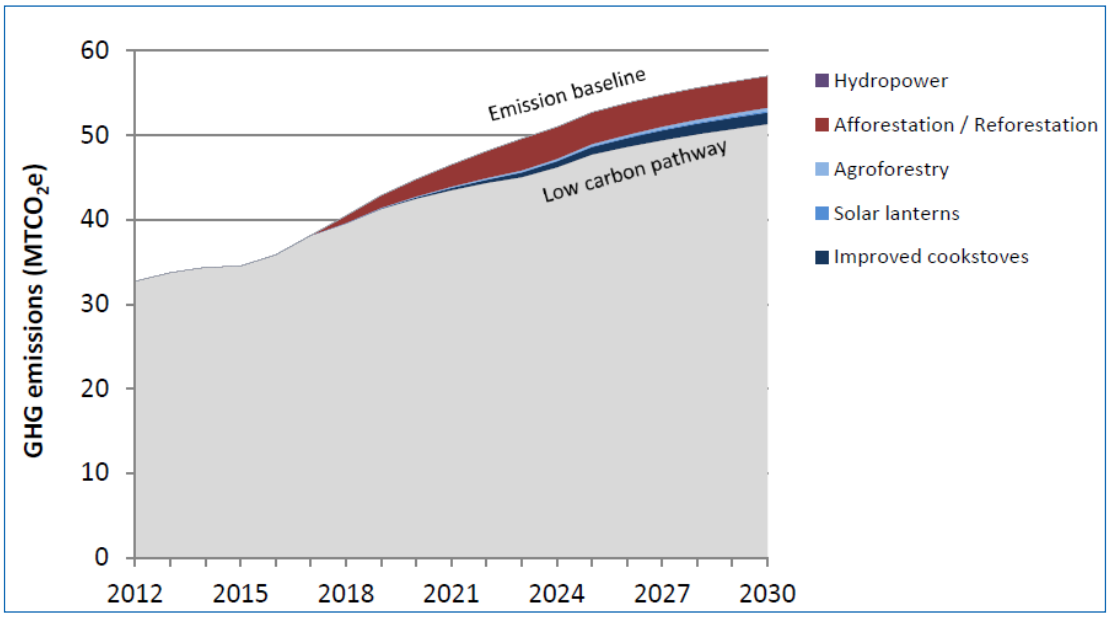
Mitigation measures were identified based broadly on the following criteria:

- They address South Sudan's GHG emissions
- They support sustainable development in South Sudan, including climate resilience
- They have already been identified as existing government priorities

These are voluntary options that will likely require significant international finance, technology and capacity-building support.

A total of five mitigation options were modelled. Two of the options focus on energy demand, one focuses on energy production and the other two are related to land use, land-use change, forestry and agriculture. Figure 4.3 and Table 4.2 show the composite emission abatement potential of the low-carbon development opportunities within the five options over time, up to 2030. The biggest GHG emission reduction potential is in the forestry sector, followed by energy demand (improved cookstoves).

**Figure 4.3:** Composite abatement potential for the five options in $MtCO_2e$ (2012–2030)




A description of the options and a first-order estimate of potential GHG emission reductions follows.

## Improved cookstoves

Biomass provides over 90 per cent of South Sudan's domestic energy requirement and the majority of this requirement is for cooking. Across the country, simple cookstoves using either wood or charcoal are predominant, with the traditional open three-stone fires commonly used in rural areas, as well as in towns. The use of these cookstoves produces considerable negative environmental, social and health effects, including the considerable cost in terms of money and time spent acquiring or collecting biomass fuels, as well as health hazards for women due to incomplete combustion and smoke.

As well as having fuel requirements that are roughly 30 to 50 per cent less than traditional cookstoves, improved cookstoves can lead to direct emission reductions. In addition to burning less fuel, they can contribute to a reduced demand for wood and charcoal, which can slow the rate of deforestation and improve the overall sustainable supply of wood from forests.

The improved cookstove option considers a programme that would distribute a million improved cookstoves between 2018 and 2030. The programme proposes the distribution of improved cookstoves at a low level of 15,000 per year, starting in 2018, increasing gradually to 100,000 units per year by 2024 and maintaining this level of distribution until 2030. A cookstove lifetime is estimated to be seven years.

Emission reductions are estimated to be 1.75 $tCO_2e$ per cookstove annually. This is based on typical household energy demand (approximately 1.24 tons of dry wood per household), a reduction in fuel use of 20 per cent over traditional stoves and emission reductions related to direct $CH_4$ and $N_2O$ emissions from combustion, as well as the decreased demand for baseline biomass wood withdrawal from forests for both fuelwood and charcoal.

The annual abatement potential and distribution of cookstoves per year is provided for select years in Table 4.2.

**Table 4.2: Annual abatement potential for improved cookstoves and their distribution up to 2030**

| | 2018 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Improved cookstove annual distribution (Units per year) | 15,000 | 45,000 | 100,000 | 100,000 |
| Abatement potential ($tCO_2e$) | 26,000 | 158,000 | 903,000 | 1,386,000 |

The estimated total GHG emission reduction rises to 1,386,000 $tCO_2e$/year in 2030 for a total emission reduction of 9.3 $MtCO_2e$ in the 2018–2030 period.

## Solar lanterns

Distributed solar lanterns can provide a cost-efficient and practical alternative to kerosene lamps and biomass lighting in areas that are currently non-electrified, which is the case of most parts of South Sudan. These are stand-alone rechargeable lighting appliances that are easy to install and use. Kerosene is the fuel of choice for non-electrified households that can afford lighting costs. It generates high levels of indoor air pollution, as well as an increased risk of burns, fires and poisoning from the fumes produced. Importing this fuel also has negative macroeconomic effects on the South Sudanese economy, with foreign exchange effects being a leading cause. While the overall consumption of kerosene fuels is small and, as a result, the GHG abatement potential is insignificant, there are still considerable sustainable development benefits associated with solar lantern distribution.

The solar lantern scenario considers a programme that would distribute a million solar lanterns between 2018 and 2030. The programme proposes the distribution of solar lanterns at a low level of 15,000 units per year, starting in 2018, increasing gradually to 100,000 units per year by 2024 and maintaining this level of distribution until 2030. A solar lantern lifetime is estimated to be eight years.

Emission reductions are estimated to be 65 $kgCO_2e$ per solar lantern annually. This is based on typical household energy demand (approximately 20 per cent of households using kerosene lighting and an average consumption of 40 litres of fuel per year) and a reduction in fuel use of 100 per cent over traditional kerosene lamps.

The estimated annual abatement potential and distribution of solar lanterns annually is provided for select years in Table 4.3.

**Table 4.3: Scale and abatement potential of solar lanterns (in $tCO_2e$)**

| | 2018 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Solar lanterns annual distribution (Units per year) | 15,000 | 45,000 | 100,000 | 100,000 |
| Abatement potential ($tCO_2e$) | 1,000 | 10,000 | 38,000 | 64,000 |

The total GHG abatement rises to 64,000 $tCO_2e$/year in 2030 for a total emission reduction of 400,000 $tCO_2e$ in the 2018–2030 period.

## Agroforestry

Agroforestry is the bridge between the agriculture and forestry sector and encompasses mixed land-use practices. The term typically refers to land-use practices in which trees and other woody perennials are on the same cropland as crops and livestock, in some form of spatial arrangement or temporal sequence. It involves a combination of agricultural and forestry techniques, aiming to build more robust, productive, resilient and diverse agroecological systems.

The main agroforestry technique proposed in this measure is one that focuses on food security and the growth of trees that provide food and income diversity to farmers. This technique would mostly involve fruit trees, but it could also be applied to trees used for on-farm timber or fuelwood harvesting. Whatever its eventual form, the agroforestry programme seeks to increase both biomass density on cropland and the canopy cover. In this regard, the scenario considered is 2,500 hectares of increased tree cover on arable lands per year in the 2018–2030 period. This could take many different forms, such as a 20 per cent additional tree cover on 12,500 hectares of land per year, as long as the overall impact is to increase overall canopy cover by 2,500 hectares per year.

The relevant literature reports a wide range of abatement potential in agroforestry systems and practices. Low-density interspersing of trees with crops will have a lower abatement potential than the planting of fast-growing trees in woodlots. An average of four different regionally appropriate studies, discounted by 20 per cent to account for some uncertainty, was used to determine an abatement potential for South Sudan. This corresponds to a value of 11,400 $tCO_2e$ per hectare per year for a period of at least 13 years.

The estimated annual abatement potential of the agroforestry option is provided for select years in Table 4.4.

**Table 4.4: Scale and abatement potential of agroforestry (in $tCO_2e$)**

| | 2018 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Hectares per year of cropland where agroforestry practices are adopted (assumes complete land coverage) | 2,500 | 2,500 | 2,500 | 2,500 |
| Abatement potential ($tCO_2e$) | 29,600 | 88,800 | 237,000 | 384,000 |

The total GHG abatement rises to 64 $KtCO_2e$/year in 2030 for a total emission reduction of 400 $tCO_2e$ in the 2018–2030 period.

## Afforestation/reforestation

The goal of this mitigation option is to both reduce the current baseline rate of deforestation and carry out reforestation in former forest areas that have been degraded, either due to unsustainable harvesting or due to land-use pressures. The rate of deforestation in South Sudan has been increasing and it is estimated that between 2005 and 2015 over 592,000 hectares of forests and roughly 3,700,000 hectares of wooded lands (with lower biomass density) have been degraded or converted to other land uses such as cropland. This rate of deforestation leads to significant net emissions of GHGs in South Sudan.

The objective of the afforestation/reforestation option is to significantly reduce the net loss of forest cover and biomass expected in the baseline between 2018 and 2030. While even the baseline forecast expects the rate of deforestation to decrease significantly by 2030, the overall total forest loss is expected to be at least another 700,000 hectares (approximately 10 per cent). Losses from lower = biomass density wooded lands may be as high as 2,400,000 hectares (approximately 7 per cent). The scenario considered is that about half of this biomass loss, which is approximately equivalent to an increase of 695,000 hectares of forest canopy over the baseline between 2018 and 2030, is mitigated through afforestation and reforestation measures. The measure would begin gradually, with 15,000 hectares targeted in 2018, increasing to 65,000 hectares per year by 2024 and remaining at that level until 2030.

Based on approximately 58 $tCO_2e$/ha, the estimated annual abatement potential of the afforestation/reforestation option is provided for select years in Table 4.5.

**Table 4.5: Scale and abatement potential of afforestation/reforestation (in $tCO_2e$)**

| | 2018 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| Hectares per year of afforestation/reforestation per year | 15,000 | 35,000 | 65,000 | 65,000 |
| Abatement potential ($tCO_2e$) | 870,000 | 2,030,000 | 3,770,000 | 3,770,000 |

The total GHG abatement rises to 3,770,000 $tCO_2e$/year in 2030 for a total emission reduction of 40,300,000 $tCO_2e$ in the 2018–2030 period.

## Hydropower

Currently, all electricity in South Sudan is produced using fossil fuels and diesel generators. While the total amount of current electricity production is quite small and, as a result, GHG emissions from electricity production are insignificant, it is expected that demand for and supply of electricity will increase dramatically in the baseline. The baseline developed shows electricity production increasing fivefold from 2016 to 2030, at a rate of approximately 13 per cent per year. Even this significant increase is well below expected demand, as demand is currently significantly suppressed and increased electricity generation and availability is a national priority.

The scenario considers the construction and operation of a 40 MW hydro plant by 2024 and of a second 60 MW hydropower plant by 2030. The assumption is that the hydropower plants

could take on at least 60 per cent of capacity and that there would be sufficient infrastructure to distribute the electricity. Emission reduction estimations do not assume that all of the supplied electricity would replace diesel generation. Instead, they assume that only half of the new electricity generated would replace diesel generation in the baseline. This is because the total generation from these two hydropower plants is significantly higher than the total generation in the baseline, and the effect of building the plants would be to provide significantly more electricity for distribution.

Based on an estimated emission factor of 0.771 $tCO_2$/MWh for diesel generation, the annual abatement potential of the hydropower option is provided for select years in Table 4.6.

**Table 4.6: Scale and abatement potential of hydropower (in $tCO_2e$)**

| | 2018 | 2020 | 2025 | 2030 |
|---|---|---|---|---|
| MW of hydropower installed | 0 | 0 | 45 MW (operating in 2024) | 100 MW (additional 60 MW in 2030) |
| Abatement potential ($tCO_2e$) | 0 | 0 | 81,000 | 203,000 |

The total GHG abatement rises to 203,000 $tCO_2e$/year in 2030 for a total emission reduction of 689,000 $tCO_2e$ in the 2018-2030 period.

CHAPTER 5

# OTHER INFORMATION CONSIDERED RELEVANT FOR IMPLEMENTATION OF THE CONVENTION

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## Introduction

This chapter provides other information considered relevant to the achievement of the objectives of the United Nations Framework Convention on Climate Change (UNFCCC, or "the Convention").

## Steps taken to integrate climate change into relevant policies

South Sudan faces several development challenges due to decades of political instability, poverty and persistent food insecurity, all of which are exacerbated by climate change. Despite these challenges, the country is one of the richest agricultural areas of Africa, with fertile soils and abundant water. However, frequent flooding, droughts, ongoing conflict and the displacement of millions of people have drastically reduced food production, to the point where an estimated 7.5 million people are currently considered food insecure.[192]

Although South Sudan has little historical or current responsibility for global climate change, and its emissions are small relative to global emissions, the country is highly vulnerable to its impacts, due to the dependence of its population on climate-sensitive natural resources for their livelihoods. Adaptation to climate change is therefore the main priority of the country, despite its current lack of institutional and technical capacity, appropriate technologies and financial resources to support the implementation of interventions for adaptation to climate change.[193]

The long conflict destroyed the limited infrastructure and governance structures that existed prior to the conflict. Thus, South Sudan is the one of the least developed countries in Africa, and, as such, is highly vulnerable to climate change.[194]

### International obligations

Since gaining independence in 2011, South Sudan has made considerable efforts to participate in the multilateral environmental agreements (MEAs) and has joined global efforts to address environmental issues by becoming a Party to the following three Rio Conventions:

- United Nations Convention on Biological Diversity (CBD)
- United Nations Convention to Combat Desertification (UNCCD)
- United Nations Framework Convention on Climate Change (UNFCCC),[195] to which South Sudan acceded on 18 May 2014. As part of this process, the young country signed the Paris Agreement in April 2016.

However, the country has formulated neither a national biological diversity strategy nor a plan of action for the CBD. It has also not developed a national plan of action to combat desertification. South Sudan joined the Global Environment Facility (GEF), which finances the implementation of the three conventions, in April 2013. As a result, the GEF is supporting enabling activities to allow the country to access a number of its key funds: the GEF-6 allocation, the Least Developed Countries Fund (for climate change adaptation), the Adaptation Fund and the Special Climate Change Fund. Some of the activities supported by GEF include the following:

- preparation of the NAPA, which has been completed and launched
- preparation of the National Biodiversity Strategy and Action Plan (NBSAP)
- preparation of the INC, which is in its final stages – INC work has built on the work done under the NAPA, the National Report on the Convention of Biological Diversity, the South Sudan Development Plan: Medium-term Capacity Development Strategy and South Sudan's Vision 2040
- Reducing Emissions from Deforestation and Forests Degradation (REDD+) Readiness – South Sudan has not yet completed enabling activities to qualify for REDD+ related funds[196]
- the national capacity self-assessment.

## Relevant policy and legal frameworks

As a new country, legal policy frameworks on climate change are just emerging in South Sudan. However, the Government has made considerable efforts to address climate change in various policies, with a view to enabling the country to mitigate climate change and adapt to its impacts. Currently, there is no stand-alone policy, law or strategy on climate change. A specific provision on climate change is also absent from the overarching Transitional Constitution of the Republic of South Sudan of 2011, but it indirectly addresses climate change issues by committing all levels of government in South Sudan to sustainable development in order to ensure that reasonable legislative action and other measures protect the environment. Article 41 of the Constitution also showcases the important place that South Sudan's environment has in the lives of its citizens. It states that "every person or community shall have the right to a clean and healthy environment" and that right should be protected for the benefit of present and future generations through reasonable legislative action and other measures that:

- prevent pollution and ecological degradation
- promote conservation
- secure ecologically sustainable development and use of natural resources while promoting rational economic and social development so as to protect genetic stability and biodiversity.

In conjunction with a wide range of development partners and NGOs, the Government of South Sudan is supporting climate change adaptation in its country at different levels, including policy and institutional and community actions. The Government has also prioritized climate change and has identified measures needed to address climate change impacts now and in the future.

Climate changes issues are partly covered in sectoral policies and laws, the most important being the 2013 draft Environment Policy that specifically calls for the formulation of appropriate strategies, policies and mechanisms on climate change. Through the Ministry of Environment and Forestry, the Government has developed an Environment Policy Framework and Environmental Bill that will regulate the exploitation of natural resources and all forms of socioeconomic development in the country. When implemented, the policy and bill will address the drivers of environmental degradation and contribute to the mitigation of climate change, while ushering the country towards a path of environmentally sustainable development.[197]

To respond to the negative impacts of climate change, the Ministry of Environment and Forestry, other line ministries and civil society stakeholders have developed a National Adaptation Programme of Actions (NAPA) (2015) with the support of the United Nations Environment

Programme (UNEP). This will form the basis for the country's adaptation to the new realities of climate change impacts.[198]

In the South Sudan Development Plan (SSDP) 2011–2013, protection of the environment during periods of rapid economic, agricultural and urban growth was identified as a key policy area and the Government of South Sudan has a responsibility to reflect this fact in legislation, as well as in policy development and implementation. The development plan emphasizes the need for agencies to continue to take into account Environmental Impact Assessments (EIAs) as appropriate in their mandates and activities. It empowers the South Sudan Legislative Assembly to enact environmental policy and laws for sustainable natural resource management. In the SSDP 2011–2013, the Government of South Sudan commits to accede to and ratify applicable and beneficial multilateral environmental treaties, conventions and agreements. Finally, it will promote inclusive participation, access to information and good governance in sustainable natural resources management and environmental protection.

Climate change strategies and plans have also been incorporated into country development plans such as the Comprehensive Agriculture Master Plan (CAMP) 2015–2040.

South Sudan is at a nascent stage of developing key policies addressing climate change. Institutional frameworks in relation to response to climate change, environmental and natural disaster risk management are also at the budding stage. The majority of these policies focus on climate change mitigation, adaptation and disaster risk reduction in various degrees in the areas of food security, environment, forestry, fisheries, wildlife and disaster management. The policies have been developed in recognition of the serious threats posed by climate change and the need to implement the Convention to which the country acceded by becoming a Party in 2014. Table 5.1 presents the most important policies, laws and plans relevant to climate change.

**Table 5.1: Policies, laws and plans relevant to climate change in South Sudan**

| Policies, laws and plans | Relevant climate change provisions |
|---|---|
| **Intended Nationally Determined Contribution (INDC) to the UNFCCC, 2015**[199] | The INDC recognizes that South Sudan is vulnerable to climate change and related socioeconomic losses and damages, due to its populations' dependence on climate-sensitive natural resources. The INDCs are based on a cross-sectoral consultative process, with the objective of contributing towards the attainment of South Sudan's Vision 2040 and the South Sudan Development Plan, both of which aim to, among other objectives, ensure that economic development is environmentally sustainable. The country aims to undertake actions in various sectors with the intention of tackling climate change, including energy generation and use, land use, land-use change and forestry (LULUCF), transport, agriculture and livestock, assisting vulnerable communities in their adaptation to the effects of climate change, biodiversity, infrastructure ecosystems, infrastructure and institutional policy and actions. |

| Policies, laws and plans | Relevant climate change provisions |
|---|---|
| **Transitional Constitution of the Republic of South Sudan, 2011** | The Transitional Constitution commits all levels of government in South Sudan to sustainable development in order to ensure that the environment is protected for the benefit of both present and future generations, through reasonable legislative action and other measures that: (1) prevent pollution and ecological degradation; (2) promote conservation; and (3) secure ecologically sustainable development and the use of natural resources while promoting rational economic and social development, so as to protect genetic stability and biodiversity. |
| **South Sudan Vision 2040** | "Vision 2040: Towards freedom, equality, justice, peace and prosperity for all" aims at transforming the country into an economic powerhouse through the creation of a diversified economy driven by agriculture, industry, mining, manufacturing, tourism and services, among other drivers. |
| **Draft Environmental Protection Policy, 2013** | Provides policy guidance on how to address climate change issues by developing a national strategy and climate change policy, as well as mechanisms for adaptation and mitigation. It encourages the formulation and enactment of laws that maintain and preserve ecological functions and the integrity of forests, conserve biological diversity, the water and soil resources of fragile ecosystems and promote passive and non-invasive forest management activities as alternative sources for income-generation (livelihood improvement). |
| **Draft Environmental Protection and Management Bill** | Aims to protect the environment in South Sudan and to promote ecologically sustainable development that improves the quality of life. It provides for the preparation of a national environmental action plan and the designation of Environmentally Sensitive Areas (ESAs) for the actual or prospective habitat of any environmentally sensitive species required to be protected for the purpose of meeting the Government's international obligations under any of the multilateral environmental agreements (MEAs). |
| **Draft Disaster Risk Management, 2015** | Provides for capacity-building for disaster (local conflicts, civil wars, drought and floods) risk reduction in South Sudan. |
| **Policy on Food Security, 2012** | Supports policy measures and strategies aimed at mitigating the adverse effects and impacts of climate change in the medium and long-term. These include the development of adaptive capacity for climate change in the community through the development of crops that can resist droughts and floods. |
| **Agricultural Sector Policy Framework, 2012–2017** | Provides for the protection of plants, seed management and development of a plant genetic resources conservation programme and a biosafety framework. This includes promoting in situ and community conservation and management of plant genetic resources and creating awareness of plant genetic resources. |
| **Policy on Agriculture and Livestock Extension Services, 2012** | Aims to transform agriculture and livestock from traditional/subsistence systems to achieve food security, wealth creation and national economic growth through science-based, market-oriented, competitive and profitable agricultural systems. |

| Policies, laws and plans | Relevant climate change provisions |
|---|---|
| **Fisheries Policy 2012–2016** | Aims to respond to climate change and natural disasters through research and development of strategies. Provides a foundation for a framework to manage the fishery resources of the country so as to maximize production, avoid overfishing, prevent destruction of wetlands and promote their conservation. |
| **Draft Wildlife Conservation and Protected Area Policy, 2012** | Recognizes climate change as a global reality with serious implications for natural ecosystems and wildlife resources. The policy calls for coping strategies to be designed to address the impacts of climate change on habitats and the population of wildlife species. |
| **Wildlife Conservation and Protected Areas Bill, 2015** | Aims to regulate wildlife conservation through establishment and management of protected areas and the sustainable management and conservation of South Sudan's natural heritage and wildlife for the benefit of its citizens. |
| **Forest Policy, 2014** | Recognizes the critical role played by forests in providing "critical environmental services, water catchment and mitigating climate change". The Forest Policy proposes the ratification of the UNFCCC so that the country can benefit from the clean development mechanism (CDM). It also proposes the establishment of a designated national authority "to facilitate the flow of climate change benefits to South Sudan". The policy also emphasizes the need to implement measures "so that South Sudan can access financing under REDD". It calls for the delineation and gazettement of forests to attain a national forest cover of 20 per cent of land area. |
| **Forest Bill, 2009** | Aims to operationalize the Forest Policy, covering all matters concerned with all forests and woodlands and all forest reserves in the country. It provides for a governance structure for all the forests in the country, national sustainable forest management standards, certification systems and schemes, private and voluntary standards, procedures, decision-making processes and complaints and appeals mechanisms. |
| **Water Bill, 2013** | Aims to provide mechanisms to protect water sources from pollution, erosion or any other adverse effects by creating protected zones within a catchment area or draining basin to, or above, any water facility forming part of a water supply or any catchment area, lake, reservoir, aquifer, wetland, spring or other source of water. It also aims to conserve available water resources to manage water quality and to prevent pollution of ground and surface waters, to manage floods and droughts and mitigate water-related disasters and to establish appropriate management structures, including mechanisms for intersectoral coordination and stakeholder participation. |
| **National Petroleum Policy, 2013** | Calls for environmental protection in the petroleum industry through an environmental and social impact assessment, an environmental audit and environmental management plan, among other strategies. |

| Policies, laws and plans | Relevant climate change provisions |
|---|---|
| **Petroleum Act, 2012** | Provides that Environmental and Social Impact Assessments must be undertaken by oil contractors or licensees in compliance with international standards to determine any present environmental and social damage and to establish the costs of repair and compensation. It obligates the sector to take necessary measures to ensure that their activities do not harm the environment. |
| **Mining Policy** | Recognizes the need to ensure that mining operations are conducted in a socially and environmentally responsible manner by minimizing the harmful impacts of mining while also ensuring that the interests of local communities are fully considered and protected. |
| **Mining Act, 2012** | Provides a framework for the management of the mining sector that is consistent with international standards, including licensing, environmental protection guidelines and the use of technology, to ensure as many mineral resources as possible are recovered from the ground. |
| **Ministry of Animal Resources and Fisheries Policy Framework and Strategic Plan, 2012–2016** | Aims to promote best animal husbandry practices to reduce environmental degradation and promote sustainable management of rangelands and pastures through integrated rangeland management practices. |
| **Comprehensive Agriculture Master Plan, 2015–2040** | Aims to end hunger, achieve food security and improve nutrition. It promotes sustainable agriculture in terms of crop husbandry, animal husbandry, forestry management, fisheries development, water resources, irrigation management and electricity and dams. |
| **Proposed Policy on Seeds** | Supports the improvement of agricultural productivity, household income-generation and food security through adequate, timely and sustainable supplies of well-adapted, high-quality seed at competitive prices. |
| **Proposed Land Policy** | Addresses issues such as displacements due to civil wars, natural disasters, land-rights conflicts and conflicts over pastures and water points. |
| **National Adaptation Programme of Actions (NAPA), 2016** | Lists priorities and spells out guiding principles for adaptation projects to address the urgent and immediate climate change concerns in South Sudan. |

Source: Sudd Report, 2015 and Sudan National Circumstances Report, 2016.

The collaboration between the Government of Seychelles, United Nations Development Programme and the GEF, together with the preparation of the NAPA, are explained in detail in the next section.

### South Sudan's collaboration with the Global Environment Facility and United Nations Environment Programme

In 2013, South Sudan joined the GEF, becoming its 183rd Member. The GEF has played an important role in facilitating South Sudan's foray into international efforts to tackle climate change and environmental and biodiversity loss issues. Two national focal points were nominated and endorsed by the GEF.

The GEF offered funds to the country to implement enabling activity projects, namely:
- the NAPA in Response to Climate Change
- the NBSAP
- the National Capacity Self-Assessment for Global Environmental Management
- the INC
- The Biennial Update Report to the UNFCCC.

UNEP has also continued to offer the Government of South Sudan essential policy guidance on environmental legislation and policies. This also encompasses the draft environmental bill, which sets out the basis for sustainable development in the country and the agreement to MEAs.

### Development of the National Adaptation Programme of Actions[200]

South Sudan's NAPA has been developed by its Ministry of Environment and Forestry, with support from the GEF, as a blueprint mapping out priority areas for immediate response to climate change, with a focus on adaptation. The preparation of the NAPA is a major step in addressing immediate priority areas that could increase vulnerability to the effects of climate change. The NAPA addresses the current and urgent adaptation needs of the country and will inform policy-level decision makers and other stakeholders. Development of the NAPA involved public participation and in-depth evaluation of available information and vulnerability to climate change. It highlights the priority areas of urgent action while identifying priority areas for adaptation measures. The main priority adaptation projects identified in the NAPA include:
- strengthening of policy and institutional frameworks
- disaster risk reduction
- promotion of climate-smart agricultural techniques
- environmental conservation through promoting reforestation and agroforestry
- sustainable management and conservation of wetland resources.

The NAPA preparation phase identified several issues in, but not limited to, the following broad areas:
- policies on water resource management and agriculture
- policies and strategies that guarantee food security
- strategies that enhance agricultural productivity
- development of early warning systems
- adoption of a national land-use plan
- policies and strategies pursuing optimal environmentally friendly utilization of natural resources.

Completion of the NAPA document means that South Sudan will be eligible to benefit from a 40-million-dollar fund set aside to assist developing countries in dealing with the effects of climate change.[201]

## Current institutional frameworks

South Sudan has adopted a federal government structure that is comprised of the national, state and local levels. The institutional structures and mandates for implementing policies are comprised of the National Government of South Sudan, 32 state governments and local governments, which includes the county, payam, boma and town council levels in the states. These structures are all assigned roles and responsibilities for forestry, biodiversity and ecosystem protection and management. Most of the institutions responsible for climate change are at nascent stages of formation. The key relevant institutions and their roles and responsibilities are presented in Table 5.2.

**Table 5.2: Key institutions responsible for climate change in South Sudan**

| Institution | Roles and responsibilities |
|---|---|
| **Ministry of Environment and Forestry** | The technical and operational focal point for climate change matters. It has created a climate change unit that is not yet operational. It is tasked with the development of policy and regulatory framework on environment and forestry. The Directorate of Climate Change and Meteorology in the Ministry develops and implements programmes to address issues of climate change and coordinates the implementation of South Sudan's obligations under the UNFCCC and CBD.<br>The Directorate of Forestry is responsible for establishing and rehabilitating forests or woodlands to ensure the sustainable utilization and management of industrial and non-industrial plantations to meet the growing demand for timber and non-timber products at the local, regional and international levels. |
| **Ministry of Wildlife Conservation and Tourism** | Established to manage protected areas (national parks and game reserves) and is the lead agency with the main role of protecting, conserving and managing wildlife resources in South Sudan through the South Sudan Wildlife Service (SSWS). |
| **South Sudan Wildlife Service** | Has given the Wildlife Service the mandate to protect the country's wildlife and to preserve and conserve the natural habitat of flora and fauna. |
| **Ministry of Agriculture and Food Security** | Has a mandate to develop and implement policies, objectives and strategies to develop the agricultural sector in South Sudan, in order to improve food security and contribute to economic growth and environmental sustainability and also to facilitate and encourage equitable and sustainable development, aiming to improve livelihoods. It has two directorates: the Directorate of Research and Training and the Directorate of Agriculture and Extension Services. They deal with crop production, plant protection, horticulture, post-harvest activities, home economics, mechanization, extension services, research and training. |

| Institution | Roles and responsibilities |
|---|---|
| **Agricultural Research Institutes** | Have been established under the Ministry of Agriculture and Food Security, the main ones being the Yei Agricultural Research Centre (YARC), the Palataka Agricultural Research Centre (PARC) and the Halima Agricultural Research Centre (HARC). These centres are involved in testing seed varieties, including seeds that can resist droughts. |
| **Ministry of Finance, Commerce and Economic Planning** | Allocates financial resources to government ministries and agencies, enabling them to respond to disasters such as floods and drought. It plays an important role in climate change adaptation. |
| **Ministry of Electricity and Dams** | Plans and provides electricity generation facilities, transmission and distribution of power to industrial and domestic consumers through the South Sudan Electricity Corporation (SSEC) – the implementing body of the Ministry – with a mandate to execute the Ministry's policies, strategies and plans for the availability, accessibility and affordability of electricity. |
| **Ministry of Water Resources and Irrigation** | Responsible for managing water resources and developing water policies, strategies and plans, for example, the Irrigation Development Master Plan and the Water Resources Utilization and Development Master Plan. |
| **Ministry of Animal Resources and Fisheries** | Responsible for livestock and fishery policy development. The Directorate of Veterinary Services in this Ministry is tasked with preparing and enforcing laws governing livestock disease control and eradication and also the safety of foods of animal origin. This includes safeguarding public health by tracking animal diseases transmissible to humans, as well as domestic animal disease control. |
| **Universities and other training institutions** | Offer degree and certificate courses in agriculture, natural resource management, forestry and fishery, among other disciplines. Universities include the Dr. John Garang Memorial University of Science and Technology and the Upper Nile University. Diploma and certificate training institutions include the Padak Fisheries Training Centre and the Kagelu Forestry Training Centre. The fishery centre focuses on development of fishery resources through training and research, while the forestry centre provides practical skills for the sustainable management of forests. |
| **Ministry of Humanitarian Affairs and Disaster Management (MHDM)** | Responsible for policy decision-making on disaster risk reduction at the national level. |
| **South Sudan Relief and Rehabilitation Commission (SSRRC)** | The operational arm of the MHDM, responsible for implementing policies made by this Ministry under the Directorate of Disaster Management at the national level and through SSRRC's representatives at the state and county levels. It is involved in establishing an early warning system at the national and state levels. |
| **Ministry of Petroleum and Mining** | The most significant mandate of this Ministry is oil exploration, which is mainly carried out in the central flood plains of Jonglei, Lakes and Upper Nile States. The Ministry has developed a petroleum bill to guide the sector. |

| Institution | Roles and responsibilities |
|---|---|
| **Ministry of Transport and Roads and Ministry of Roads and Bridges** | These ministries oversee the construction and maintenance of roads and bridges throughout the country, as well as overseeing the South Sudan Road Authority. |
| **Ministry of Foreign Affairs and International Cooperation** | The political focal point for international environmental conventions and treaties. It is therefore the link between international efforts on climate change and the Government of South Sudan. |
| **South Sudan Meteorological Service (SSMS)** | Has re-established climate stations to deliver information on forecast weather, actual weather, the seasonal outlook and the climate. |
| **South Sudan Seed Council** | Has been proposed to coordinate the implementation of the seed policy. |
| **South Sudan Food Security Council** | Has been proposed by the National Policy on Food Security to implement, monitor and evaluate the implementation of the food security policy. |
| **South Sudan Forestry Commission** | Has been proposed by the national Forest Policy to administer, regulate and supervise forestry activities in South Sudan. |
| **Community-based organizations (CBOs)** | Are expected under the National Environment Policy and should play a pivotal role in advocacy for the sustainable management of biodiversity and ecosystems through mobilizing and sensitizing local people and ensuring that the concerns of the underprivileged are integrated into the national development plans. |

Source: South Sudan's Fifth National Report to the Convention on Biological Diversity 2015; 2015 Special Report, the Sudd Institute.

### Institutional capacity assessment

There are several institutional capacity constraints in South Sudan that limit the ability of the Government to reduce climate change vulnerability. Firstly, as a new country, many policies and strategies related to environmental management and agriculture are currently emerging and do not explicitly include climate variability and change. Secondly, there are inadequate institutional arrangements at the national, state and county levels for effective coordination, planning and implementation of climate change adaptation interventions. Finally, many of the institutions have been weakened by a lack of technical know-how and financial resources. As a result, there are very few programmes aimed at reducing vulnerability to climate change that are being implemented.[202] A review of the national budgets for the last several years suggests that there is no budget line item for climate change adaptation and mitigation in South Sudan in many of the Government ministries. A rapid assessment of some of these institutions reveals the following:

**Ministry of Environment and Forestry:** The Ministry has established a climate change unit, but it is not operating to its full capacity due to a lack of financial and human resources.

**Ministry of Agriculture and Food Security:** The Ministry has a very important role to play in climate change adaptation, since agriculture is the main livelihood-supporting sector for over 80 per cent of people in South Sudan. Although the Ministry is involved in flood and drought-resistant crop research through its research institutions, it does not have a specific climate change resilience department or unit for crops, livestock and fisheries.

**Ministry of Water Resources and Irrigation:** The Directorate of Irrigation and Drainage in the Ministry plays an important role in the monitoring of water levels to predict floods. Many of the 73 hydrology stations previously operational before the war were destroyed during the war and only a few are currently operating. Specifically, there is little capacity in terms of both hydrological testing and monitoring equipment and human and financial resources in the Ministry. The Directorate of Irrigation and Drainage can be a key partner in climate change adaptation through irrigation during periods of droughts and less rainfall. However, irrigation programmes are not well enough developed in South Sudan to take advantage of the rich water resources that are available.

**Ministry of Petroleum and Mining:** One of the greatest contributors of GHGs is fossil fuel. This Ministry should therefore be at the centre of climate change adaptation and mitigation. Currently, the Ministry does not have a climate change mitigation and adaptation unit and is also not linked to any climate change adaptation and mitigation institution.

**Ministry of Finance, Commerce and Economic Planning and Ministry of Commerce, Industry and Investment:** These ministries can play a key role in mobilizing funds for climate change adaptation. Currently, the ministries do not have a specific budget line or fund for climate change, although there are allocations made for disasters and emergencies.

**South Sudan Meteorological Service (SSMS):** SSMS can play a crucial part in climate change adaptation, due to the technical role it has in forecasting and predicting weather and seasonal climate. The SSMS faces challenges related to a lack of weather and climate change forecasting equipment, adequate and conducive office facilities, international network connections and trained personnel. There used to be a total of 43 stations all over South Sudan, but most of them were destroyed by consecutive wars.

**South Sudan Relief and Rehabilitation Commission (SSRRC)**: SSRRC is in the process of establishing an early warning technical unit at the national and state levels, a process that started in September 2013 and is yet to be completed.

**South Sudan Wildlife Service (SSWS):** SSWS is an important institution in terms of climate change adaptation and mitigation, as wildlife species and their habitats are vulnerable to climate shocks and stresses. However, SSWS does not have a climate change resilience department or unit.

# Technology transfer

## Status of South Sudan's Technology Needs Assessment

Climate change is progressively being recognized as a major challenge to environmental health, human well-being and economic development. Article 4.5 of the UNFCCC states that developed countries shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of environmentally sound technologies and know-how to developing country Parties, to enable them to implement the provisions of the Convention.

Since 2010, the UNEP Technical University of Denmark Partnership (UNEP DTU Partnership) has offered technical and methodological support to developing country Parties to undertake Technology Needs Assessments (TNAs). TNAs help developing country Parties to the UNFCCC to determine their technology priorities for mitigation and adaptation actions on climate change. TNAs are central to the work of Parties to the Convention, supporting national sustainable development, building national capacity and facilitating the implementation of prioritized climate technologies.[203]

Since South Sudan is yet to have carried out any TNAs, and since Sudan had carried out a TNA which included South Sudan before it gained its independence, reference has been made to the TNA conducted by Sudan. As part of adaptation measures to reduce Sudan's vulnerability and increase its resilience to climate change impacts, Sudan had undertaken several assessments of vulnerability and adaptation needs to develop their National Adaptation Programme of Actions (NAPA) and National Adaptation Plans (NAP), adaptation being the first and main priority for developing countries in responding to climate change. The country deployed a systematic approach in identifying, evaluating and prioritizing technologies for adaptation to achieve the SDGs. Two main sectors of focus, agriculture and water, have been recognized as the most important contributors to sustainable livelihoods in local communities, especially in rural areas.

The first TNA for the Republic of Sudan was carried out in 2013, funded by the GEF and implemented by UNEP and the UNEP DTU Partnership (known as UNEP Risoe Centre at the time) in collaboration with the Regional Centre, Environmental Development Action in the Third World (ENDA). This was a fully country-led process aimed at prioritizing technologies suitable for reducing GHG emissions and enhancing adaptation to the negative effects of climate change in the Republic of Sudan.

As a country that is highly vulnerable to climate change due to its fragile ecosystem, the TNA concentrated on the agriculture and water sectors, which have also been mentioned in South Sudan's NAPA as priority areas which are most vulnerable to climate change and variability. Climate variability is likely to negatively impact agriculture, while climate change induced increases in rainfall intensity may increase the risk of floods and waterborne diseases. Farmers who rely on rains for agricultural production, small-scale farmers and pastoralists are the groups with the least capacity to cope with climate-related shocks. Pastoral and nomadic groups in the arid and semi-arid land regions of Sudan are also negatively impacted by changes in rainfall. Because of climate change, there has been reduced groundwater recharge and frequent droughts that threaten cultivation activities. The detrimental impacts of climate change on the water and agricultural sectors is predicted to be severe in South Sudan, as the two sectors are climate-

sensitive. Poverty levels are high and subsistence agriculture remains the main source of income for the biggest population in South Sudan.

Although South Sudan has not yet conducted a TNA, it is recommended that a TNA should be carried out with the objectives of:

- identifying and prioritizing technologies contributing to mitigation and adaptation goals, based on country-driven participatory approaches
- identifying barriers deterring the acquisition, deployment and diffusion of prioritized technologies
- promoting the development of Technology Action Plans, highlighting prioritized technologies, overcoming the hindrances and fostering the transfer, adoption and diffusion of the technologies.

The development of the TNA would allow the country to put forward ideas for sound projects on suitable technologies for both adaptation and mitigation. This would contribute to the success of implementation of the UNFCCC, as long as the developed countries take a leading role in making use of financial and technology support to the country. TNAs are one of the crucial components of the technology network designed to promote technology transfer to developing countries.

The TNA for South Sudan would encompass all relevant sectors affected not only by current but also future changes in climate.

The analysis of priority sectors and required adaptation and mitigation TNAs for South Sudan has been undertaken in the subsequent section, borrowing greatly from the TNA that was carried out in Sudan before it split, from South Sudan's INDC to the UNFCCC and from other available literature. It is important to reiterate that no TNA has been carried out for South Sudan to date, as presented in the TNA Country Reports available.[204]

## Analysis of priority sectors and required adaptation and mitigation Technology Needs Assessments[205]

In the absence of a TNA, the following is an analysis based on the consultants' understanding of South Sudan's national circumstances. The main adaptation and mitigation actions are based on the analyses in the preceding chapters.

### Adaptation actions

South Sudan's NAPA lists priorities and spells out guiding principles for adaptation projects to address urgent and immediate climate change concern in the country. The NAPA lists priority adaptation projects in the areas of the environment, water resources, agriculture and disaster risk reduction, including policy and institutional framework, as shown in the table.[206]

| Priority adaptation projects | |
|---|---|
| **Environment** | Promotion of reforestation and agroforestry to reduce vulnerability to droughts and floods |
| **Water resources** | Sustainable management and conservation of wetlands in South Sudan |
| **Agriculture** | Promotion of climate-smart agricultural techniques to improve livelihoods and food security under changing climatic patterns |
| **Disaster risk reduction** | Establishment of an improved drought and flood early warning systems in South Sudan through an improved hydro-meteorological monitoring network |
| **Policy and institutional framework** | Strengthening the institutional capacity of the Government of South Sudan to integrate climate change into national policies and planning processes |

The following adaptations actions from the TNA have been identified as key priority areas in the different sectors:

### Agricultural sector in South Sudan[207]

In South Sudan, the agricultural sector plays a critical role in food production and sustaining people's livelihoods. The majority of livelihoods are concentrated in low productive, unpaid agriculture and pastoralists work, which accounts for about 15 per cent of the country's GDP. In fact, 85 per cent of the working population is engaged in non-wage work, chiefly in agriculture (78 per cent).[208] The agricultural production is mainly rain-fed and therefore relies on seasonal rains for optimal crop performance.

This sector faces many challenges that greatly impact food production, including frequent flooding, droughts, ongoing conflict and the consequent displacement of people. While oil exports contribute towards the majority of the GDP in South Sudan, the majority of the population still relies on climate-sensitive natural resources and rain-fed subsistence agriculture for their livelihoods. The challenges in the agricultural sector are further exacerbated by climate change impacts, rapid population growth and the expansion of farming and pastoralism.

Average temperature increases of 1°C by 2060 are expected to result in the loss of productive agricultural lands, due to desertification. Increased rainfall variability will result in reduced yields and crop failure, leading to the loss of pasture lands and reduced access to water resources for livestock. Increased incidences of drought will result in increasing conflicts between farmers and pastoralists over scarce resources, as pastoralists change their migration patterns in search of water and fodder, while farmers expand their agricultural land to areas previously used for seasonal pasture.

Agriculture and livestock farming are the mainstay of Sudan's economy. These sectors rely on indigenous knowledge to foster income-generation in the sectors. Conventional methods are deployed to increase agricultural productivity, with the exception of well-to-do farmers who have the financial resources to adopt technologies to increase their production. In the agricultural sector, the following have been identified as ways forward:

- Use of improved crop varieties (both locally bred and introduced varieties), no-till farming and livestock production are the most affordable technologies to reduce the vulnerability of local communities to climate change impacts. Traditionally, farmers have greatly depended on farm-saved seeds and have little access to commercial improved seeds.
- Use of no-till technology is also critical to adapting to climate change in the agricultural sector.
- Research on climate-resilient technologies and species is vital in identifying climate-resilient agricultural techniques.
- The use of strong early warning systems and strengthening institutions in dealing with climate change have also been highlighted as critical in adapting to climate change.[209]
- Promotion of agroforestry practices as a way of diversifying land production systems and finding alternative livelihood options.
- Promotion of aquaculture as an alternative livelihood option is useful in addressing food security issues.

## Livestock sector

Agriculture and livestock are the main livelihoods for the majority of the population in South Sudan. For livestock, embarking on a sustainable, climate-smart livestock production and management path is important in enhancing climate resilience in the agricultural sector. Tremendous steps towards tackling climate change can be made in the sector by promoting livestock improvement through use of traditional knowledge and supporting community-based adaptation strategies.

### Water sector

The River Nile is the primary source of water in South Sudan. The Nile waters are shared by 10 other countries within the Nile Basin and in recent years, there have been extreme variations in its annual river flow. South Sudan is situated in the Nile catchment area and receives water from the highlands of neighbouring countries. The water flows into the country's low and vast clay basin, which is highly sensitive to seasonal temperature variations. As a result of climate change, decreasing water levels are expected to significantly impact one-third of the population that relies on surface water for domestic use.

### Status of technologies in the water sector

In the water sector, the following technology strategies have been identified or implemented:

- Identification of rainwater harvesting technologies as the most common technology for provision of drinking water to both humans and animals beside irrigation of agricultural land. In the agriculture sector, hand-dug or natural wells are used to store water for consumption by humans and livestock. Other technologies include rainwater harvesting in small dams, reservoirs, earth embankments, earth dams and contour bands. For water intended for household use, a limited provision of pipeline water is implemented in the country.
- Development of supplementary irrigation systems in rural areas to improve agricultural production and increase food security.
- Development of regulatory frameworks to monitor water quality is essential, including penalties for pollution of water sources.
- Flood preparedness and early warning systems are also important in warning farmers and households of impending disasters.

- Promotion of greater use of effective traditional water conservation practices.
- Rehabilitation of existing dams and improvements in water basin infrastructure.
- Introduction of new water harvesting or water spreading techniques.
- Construction of dams and water storage facilities in some of the water valleys.
- Introduction of water-conserving agricultural land management practices.
- Improvement of access to groundwater supplies (water pumps).
- Enhancement of capabilities of regional meteorological stations.
- Introduction of a revolving microcredit fund to support implementation of small water harvesting projects.
- Extension services in water harvesting and storage techniques for small-scale farmers.

All the above technologies will come in handy in adapting to climate change in the water, agriculture and livestock sectors. However, these technologies must be prioritized.

### Health sector

To accurately identify climate change impacts in the health sector, South Sudan will conduct comprehensive vulnerability assessments concerning human health and well-being under current and future climate scenarios. This will inform actions to improve early warning systems for climate-related disease outbreaks (for example, malaria) and establish contingency plans to develop climate change resilient health systems. Public health systems will be strengthened by building hospitals (including regional referral hospitals) and supplying them with medicine, equipment and personnel trained in treating climate-related diseases.

### Disaster risk reduction sector

In the disaster risk reduction sector, the following technology strategies have been identified or implemented:

- strengthening and establishing early warning systems in the country – this is necessary to reduce the impact of droughts and floods on rural communities
- technologies to collect, analyse and disseminate climate-related information – these are needed to better predict weather events and are therefore of crucial importance.

### Infrastructure sector

This is a critical area for adaptation actions on climate change. Since the country is in the reconstruction phase, strategic infrastructure including communications, tourism, energy, sanitation, water and waste management need to be developed in a sustainable manner, since they are all vulnerable to the effects of climate change. As such, incorporating modern designs and technologies in their construction is critical to building durable and sustainable infrastructure. For instance, in the building industry, South Sudan has plans to invest in making existing and new buildings more climate-resilient by ensuring that land-use plans and building codes are adhered to.

## Forests, biodiversity and ecosystems

The adaptation actions in the previously discussed sectors are vital to conserve biodiversity and ecosystem services provided by the diverse ecosystems in South Sudan. These ecosystems provide society with a wide range of environmental services, including acting as carbon sinks, maintaining water resources, mitigating floods, providing food and maintaining soils. Human activities threaten the sustainability of these ecosystems. As such, ecosystem-based adaptation actions are highly necessary in integrated adaptation strategies that assist communities to adapt to the impacts of climate change.

South Sudan is home to the largest designated Ramsar wetland site of environmental importance: the Sudd, which is pivotal in regulating the weather patterns in the Sahel, the Horn of Africa and the greater East Africa region.

Given the reliance of the majority of the population on forest resources, adaptation priorities in this sector include supporting forest governance, reducing over-reliance on forest products by providing alternative income-generating activities and encouraging planting of climate-resilient tree species. This will be further supported by the development of mechanisms to ensure equitable sharing of benefits accrued from the forest resources.

Key technological needs in this area include:

- use of agroforestry technologies and practices as a way of diversifying land production systems and promoting alternative livelihood options
- promotion of afforestation practices to restore degraded landscapes
- adoption of modern alternative sources of energy to reduce over-reliance on natural resources.

Identifying priority technologies for adaptation actions is important in addressing adaptation needs in South Sudan so as to target specific climate change issues. This process allows the most urgent adaptation needs to be identified. Identifying the right and most efficient technologies will enable the fast implementation of adaptation projects to promote conflict resolution and peacebuilding, improve gender equality, address the challenges affecting the most vulnerable groups to climate change, diversify livelihood options and contribute to further development of legislative and regulatory frameworks in South Sudan.

South Sudan's INDC highlights that the country is embarking on a sustainable development path and would therefore employ the latest technologies to achieve low-carbon, climate-resilient development outcomes.

In its First National Communication (FNC), South Sudan has prepared a national GHG inventory to enable a better assessment of the mitigation potential and to quantify the emissions reductions possible through identified mitigation actions.

The main areas for mitigation have been identified in the INDC as energy generation and energy use, transport and reforestation and deforestation.

## Energy sector[210]

Presently, the predominant energy sources in South Sudan are biomass and petroleum products. South Sudan is one of the most oil-dependent countries in the world. Oil accounts for almost the totality of exports and contributes to more than 60 per cent of the country's GDP.[211]

The energy sector includes direct and indirect GHG emissions from the oxidation of carbon contained in fossil fuels during combustion, whether this occurs when generating other forms of energy, such as electricity, or in final consumption.

The energy sector also includes fugitive emissions from fossil fuel production, transportation and processing. In the case of South Sudan, this includes emissions from the refining of crude oil into petroleum products, as well as NMVOC emissions from the storage and handling of crude oil.

Tackling GHG emissions from the energy sector calls for investments in energy-efficiency technologies, which is possibly one of the most cost-effective ways to reduce emissions. The national plan aims to stimulate the deployment of existing energy-efficiency technologies and accelerating the introduction of better technologies. This will be critical to reducing emissions from the sector and enhancing the quality of life to increase productivity. Profitable energy-efficiency investments should be made in the household, commercial and industrial sectors, all of which can be used to address climate change mitigation. However, investment in these technologies is limited by lack of information, regulation and institutional infrastructure, among other barriers.

### Biomass and biofuels

Biomass resources in South Sudan include forests, animal wastes, agricultural residues and sugar cane. According to a publication by ResearchGate in 2015, only 1 per cent of the people in South Sudan have access to electricity. Therefore, the majority of the population relies on traditional biomass to meet their cooking and lighting needs.

Prior to the split with Khartoum, the Sudanese Government, in 2007, expressed an interest in specifically developing the biofuel sector and ethanol. Therefore, in the case of biomass and biofuels for household cooking, it is important to explore the possibilities and technologies in biofuel production. Biogas is another area that can be explored as a renewable source of household energy.

The country should also come up with policies and incentives that promote the switch to the use of efficient cookstoves and solar cookers should be encouraged.

### Solar power

South Sudan experiences approximately 11 hours of sunshine per day. This means that the country has a 4,183 terawatt hour (TWh) production potential at 14 per cent conversion efficiency and a solar panel national land coverage of 5 per cent. Solar panel (PV) technology provides an attractive off-grid solution, especially when this takes the form of hybrid systems. In theory, these systems are very reliable but, for a country like this, highly technically and economically complex and expensive to implement on the ground. There are no solar technology producers or

companies in South Sudan, but there are a few retailers in the capital, Juba, selling solar products – possibly from China – imported via Kenya. Solar power has a great deal of potential and a national solar technology market needs to be established through investment in and the transfer of modern, reliable and efficient solar technologies.

Exploring the possibility of using solar water pumps and solar cookers is one step closer to addressing the issue of energy in South Sudan.

To address water shortages in South Sudan, humanitarian organizations like the Red Cross have successfully used solar water pumps. However, backup generators are used to provide energy during the rainy season.

Solar cookers offer an alternative energy source that should reduce firewood consumption and protect forests and public health. Solar solutions should be integrated in a comprehensive way to effectively manage solar cooking limitations, especially during wet seasons.

### Hydropower

Hydropower has a lot of potential in South Sudan, but there is currently no installed hydropower capacity in the country. The Government of South Sudan has highlighted that small-scale hydropower stations are planned as medium to long-term solutions for the extension of national grids. Hydropower plants have low operating costs but high initial costs. As such, investing in hydropower technologies in South Sudan requires international financing to support the country's hydropower sector. This finance is essential to strengthening underdeveloped countries.

### Wind power

There are currently no large-scale wind turbines operating in South Sudan. This is due to investments in wind being deemed unattractive for commercial wind farms, because the annual average wind speed of about 2.5 m/s is considered insufficient to produce sufficient electricity for commercial use. However, the use of small turbines for pumping water and irrigation for electricity production could be considered by some landowners that are not connected to the grid and may be considered a reasonable investment.

### Geothermal power

The geothermal sector in South Sudan is underdeveloped. However, recently, the country has shown interest in partnering with Kenya to explore potential sites in the country for geothermal production. The sites, which are yet to be identified, have an estimated potential of 2,500 MW.

### Electricity

Electricity in South Sudan is mainly produced from thermal sources like diesel, as the country is heavily reliant on oil. The parastatal South Sudan Electricity Corporation (SSEC) provides electricity. No strategic fuel reserve currently exists, nor does a policy that facilitates emergency stockpiling. This represents various limitations in terms of big investments and restrictions in coverage. As such, only 1 per cent of the population has access to electricity and the supply is

usually intermittent. Investments and technologies in these areas are urgently needed to improve this situation.

### Energy efficiency

To comprehensively address the issue of energy access in South Sudan, any sustainable energy policy in the country should focus not only on energy generation but also on efficiency, as this will reduce consumption and maintain sustainability. Energy-efficiency improvement in cooking, for example, has many objectives, including improving nutrition for households, reducing drudgery and the amount of household fuel used during cooking and saving households' time and money so that it can be invested in other income-generating activities.

A sound energy policy can help drive efforts towards fuel substitution to address energy efficiency and improve resource management and public health. Passive systems for cooking and ventilation can be used in place of electric systems such as air-conditioning units, since they are relatively easy to install and would reduce dependency on thermal sources.

Any sustainable energy policy would need to increase awareness at the local level, to discuss the possibility of incorporating such technologies into the home and pastoralist lifestyle.

## Transport sector

The transport sector is one of the key sectors highlighted in South Sudan's INDC as a priority area for climate change mitigation.

The energy sector includes fugitive emissions from fossil fuel production, transportation and processing. In the case of South Sudan, this includes emissions from the refining of crude oil into petroleum products, as well as other emissions from the storage and handling of crude oil.

Demand for petroleum fuels has steadily increased since 2000 at an average annual rate of 3.4 per cent. The highest growth in demand was related to the transportation sector. Consequently, the road transportation subsector generates the largest proportion of $CO_2$ emissions (58 per cent). $CH_4$ and $N_2O$ emissions are the largest contributors in the residential subsector, accounting for more than half of its emissions.

When tackling emissions from this sector, it is important to adopt technologies and emissions standards for vehicles to curb emissions. Establishing measures to restrict the importation of vehicles that do not adhere to allowable emissions levels can also be handy in tackling emissions in the sector.

## Identified barriers to technology needs and enabling environments

An analysis of the potential barriers and proposed enabling framework to encourage the adoption of these technologies has not been carried out as part of the evaluation of identified barriers to technology needs and enabling environments, as it is outside the scope of this report. However, in LDCs such as South Sudan, the following barriers typically stand in the way of adopting new technologies for climate change mitigation and adaptation:[212]

- Lack of institutions and institutional and government capacity to formulate policy and implement programmes on climate change mitigation and adaptation.
- Limited development of infrastructure, resulting in high costs for these services. Ports, transport and trade logistics are often associated with high costs and have a serious impact on the business environment.[213]
- The high cost of purchase, installation and maintenance of new modern technologies. This is linked to the fact that in South Sudan, revenue collection is substantially lower than the actual cost of supplying power.
- Weak policies and lack of standards.
- Limited information and awareness.
- Ongoing internal conflict and political instability.

These barriers do not create an enabling environment for technology transfer into South Sudan. Inasmuch as cost is fundamental and seems to be the major barrier to the development of all the identified technologies in the country, it is well understood that it is only part of the picture. Addressing the barriers will help create an enabling environment that will facilitate the long-term development of climate change technologies for mitigation and adaptation. The private sector also plays a role in providing finance and investments for fostering the acquisition of quality technologies and spreading market awareness. A holistic approach is needed to bring together a network of players in different sectors, including importers, distributors, assemblers, technicians and marketing agents, to help understand the investment needs, technology needs and potential demand. This makes information and awareness campaigns a key measure. Therefore, outreach programmes and successful demonstration projects are considered necessary to raise awareness of the benefits.

### Current mechanism for technology transfer in South Sudan

The current mechanisms for technology transfer in South Sudan are very rudimentary and there are no adequate ways of transferring technologies into the country. This is because the country is landlocked and most of its trade involving, for example, the use of seaports, passes through other countries, with Kenya and Uganda (the Port of Mombasa) being the primary routes. South Sudan relies on Kenya for access to sea freight.

Solar technology transfer, for instance, currently involves the few solar product retailers selling their products in the capital, Juba, mainly receiving them from China via Kenya.

### Technology transfer associated with clean development mechanism projects

No CDM projects have been registered in South Sudan, as per the Africa Carbon Credit Exchange[214] and, therefore, no technology transfer could have occurred through the CDM.

### Technology transfer under the Global Environment Facility mechanism

The GEF supports technology transfer to developing countries as they move towards a low-carbon development path, including facilitation of TNAs for both mitigation and adaptation.

However, South Sudan has not carried out any TNAs on mitigation and adaptation. It is evident that the GEF has a critical role to play in assisting South Sudan in the development of its TNAs and, once complete, in finance pilot projects to carry out deployment, diffusion and further transfer of technologies. In ensuring the successful implementation of these pilot projects, the GEF will share with South Sudan the experiences and environmentally sound technology options that can be adopted in the country.

## Research and systematic observation

### Systematic observation

#### South Sudan Meteorological Service

Climate change-related research and systematic observations in South Sudan are at very nascent stages. The South Sudan Meteorological Service (SSMS) was created in 2011, after it gained its independence. The Meteorological Service is a government institution under the Ministry of Transport. The Meteorology department was built on the working meteorological instruments and weather forecasts from the old Republic of Sudan. South Sudan is starting to establish a weather forecast section of its own in Juba.[215]

Surface meteorological stations in South Sudan include:

- an agro-met station in Renk (Upper Nile State)
- irrigation stations, such as Raja (Western Bahr el Ghazal State), Bentiu (Unity State) and Rumbek (Lakes State)
- synoptic stations, such as the Juba Met Station (Central Equatorial State), Malakal Met Station (Upper Nile State) and the Wau Met Station (Western Bahr el Ghazal State).

SSMS lacks both human and technical capacity to capture and distribute adequate weather information. Required facilities include adequate office space, computer equipment and weather forecasting and communication equipment.

#### South Sudan Meteorological Authority and Finnish Meteorological Institute project (2012–2014)

From 2012 to 2014, the South Sudan Meteorological Authority (SMA) worked with the Finnish Meteorological Institute (FMI) to launch a project entitled "Promoting Adaptation to Climate Change by Reducing Weather and Climate-Related Losses through Improved Services in Sudan – FISU" that was funded by the Finnish Ministry of Foreign Affairs. The project aimed to develop and build the capacity of the SMA by supporting its organization and human resources and assisting it in its production and communication of more advanced weather and climate services in various sectors in the country. The project was also aimed at supporting the ongoing large investment project involving the modernization of the observation network in Sudan. The FMI experts would train their Sudanese colleagues in how to operate and service modern weather observation instruments, including showing them how to utilize the data obtained to supply communities and the country with better products and services. The SMA's capacity to conduct research on climate change was also strengthened.[216]

In addition to institutional capacity-building, the project included a separate segment of assistance to South Sudan which would be used to create an independent weather service – the SSMS. The SSMS was supported in the areas of observation and aviation weather service delivery. The project was established in recognition of the fact that risk management and adaptation to climate change are critical in building tolerance to impacts of extreme climate events and that reducing vulnerability and exposure to severe weather factors is important in climate change adaptation in South Sudan. In addition, in Sudan too, provision for risks related to weather and climate call for additional reforms to existing technical and administrative systems.[217]

**"Landscape Management Planning and Training for the Environment in South Sudan" project**

Prior to the FMI project, the Landscape Management Planning and Training for the Environment in South Sudan (LAMPTESS) Project[218] (worth €0.5 million) had been launched in 2008 and ran until 2010. It was financed by the Higher Education Institutions Institutional Cooperation Instrument (HEI-ICI) under the Finnish Ministry for Foreign Affairs.

This project supported the building of the capacity of one northern and southern state organization in Sudan, including supporting the forestry administration in South Sudan, assisting selected communities with sustainable land practices that increase both food production and benefits from forest resources, as well as training and extension services. Two South Sudanese universities, the Upper Nile University and University of Juba, were involved in the project as subpartners in the first phase. The Faculties of Forestry, Range Science and Agriculture at the Upper Nile University and the College of Natural Resources and Environmental Studies at University of Juba were the main South Sudanese partners, while the South Sudan Directorate of Forestry is a subpartner of LAMPTESS. The Finnish partner was the Viikki Tropical Resources Institute of the University of Helsinki (VITRI). The project's purpose was to build the capacity of the relevant Upper Nile University faculties and the relevant College at University of Juba in order to deliver informed contributions towards the improvement of South Sudanese natural resources management, rural development through better education, taking a leading role in rural development and finding solutions to the challenge of climate change.

The LAMPTESS project offered interventions for strengthening stakeholder institutions incorporating some pilot communities, with a key focus on:

- human resource capacity-building
- institutional capacity-building aimed at promoting an enabling environment to enhance the execution of various rural development projects
- promoting substantial field operations in partnership with various stakeholders to develop long-standing dialogues and joint practical planning models for rural development in the future.

**Challenges facing the South Sudan Meteorological Service**

The nascent SSMS department in South Sudan faces several challenges, including:

- a lack of essential meteorological communication networks connected to the regional distribution and international centres
- a lack of a telecommunication link between the weather forecast section in Juba and Met offices in the states

- difficulty in delivering early warning information needed by users for disaster risk management
- a lack of awareness among users of how to interpret weather information and warnings.

### The future of the South Sudan Meteorological Service[219]

Having established the National Meteorological Service, the following are needed to enhance the capacity of the SSMS in South Sudan:

- establishment of a strong database system
- improvement of the quality of weather products and services
- creation of upper-air observation stations
- creation of channels for submitting forecasts and climatological information
- installation of advanced technology to distribute and deliver weather information and extreme weather warnings through TVs, radio, mobile technologies, newspapers and online streaming.

South Sudan is classified internationally as one of the most vulnerable countries in the world to the negative impacts of climate change. According to the Climate Change Vulnerability Index (2017), South Sudan is classified among the five worst performing countries in the world alongside the Democratic Republic of Congo (DRC), Central African Republic (CAR), Haiti and Liberia. Unusually, projections show that in South Sudan, global warming will be felt 2 1/2 times more than the global average. This will exacerbate existing vulnerabilities, result in extreme climate change-related weather events and alter current rainfall patterns, including intensifying the risks of flooding and the displacement of people living along the Nile River.

The country faces a grave risk of being left behind, despite being a signatory to the Paris Agreement. Global support and action are imperative to accessing new, adequate and sustained sources of climate change finance and clean technologies to assist communities in their adaptation to the effects of climate change.

Research capacities to collect and analyse climate-related data and feed it into tailored policy responses are needed to help build community-based adaptation measures and actions in all sectors of the economy.[220] Information collected from research can be used to raise awareness of mitigation and adaptation options among the South Sudanese population.[221]

## Research institutions in South Sudan

The research and knowledge system in South Sudan encompasses:

- government institutions
- higher education institutions
- private and civil-society research organizations.

### Government research institutions

The Government of South Sudan strives to use research, policy-planning and development to effectively use its natural resources. Consequently, the Government has established various research, training and analysis centres, some of which are housed in major government departments and independent academic institutions. The centres include:

- the Government Accountancy Training Centre, attached to the Ministry of Finance and Economic Planning
- the Research and Training Division of the Central Bank
- the National Bureau of Statistics
- the National Research Council
- the National Council of Higher Education
- the Centre of Peace and Development Studies
- the National Legislative Assembly.

### Higher education institutions

There are six public universities and up to nine private universities or colleges in South Sudan. The University of Juba is the leading national university, with a full academic curriculum that covers major areas of scientific research in natural resources, the environment, technology, medicine, information and communications technology, law, social sciences and humanities. Other universities include the Upper Nile University, Rumbek University, the Dr. John Garang Memorial University of Science and Technology and the Catholic University of South Sudan, among others.

By far the most active institutions engaged in scientific research are the three major national universities in Juba, Bahr el Ghazal and Upper Nile, and to a lesser extent, the Dr. John Garang Memorial University of Science and Technology, located in Bor. The three main universities have medical schools and courses in veterinary science, environmental studies, natural resource management, architecture and geology.[222]

However, currently, the universities are underfunded and do not carry out much research.

## Private and civil-society research organizations

### The Sudd Institute

The Sudd Institute is a private and independent research organization that undertakes and facilitates research and training to inform public policy and practice, create opportunities for discussion and debate and to improve analytical capacity in South Sudan. The Institute's intention is to significantly improve the quality, impact and accountability of local, national and international policy and decision-making in South Sudan in order to promote a more peaceful, just and prosperous society. The Institute has carried out several research studies on climate change, among other areas.[vi] It offers high-quality services, has adequate means and has developed research capacity in many areas of relevance to South Sudan.

[vi] https://www.suddinstitute.org/

## Telecommunications industry in South Sudan[223]

The telecommunications industry in South Sudan is at very nascent stages of development. The industry is regulated by the National Telecommunication Council established in 1996. The regulatory framework governing telecommunications in the country is bestowed in the following Government ministries:

- Ministry of Higher Education, Research, Science and Technology
- Ministry of Information, Communication Technology and Postal Services
- National Telecommunication Council
- Telecommunications Policy.

Telecommunications has been recognized as the fastest growing sector in South Sudan, with liberalization and competition leading to growth in the coverage area.[224]

### Internet and Intranet connectivity in South Sudan

In South Sudan, the Radio Communication Services (RCS) business group – which consists of various legal entities operating in a number of African countries – offers Internet and Intranet connectivity options delivered via a variety of very small aperture terminal (VSAT) and Worldwide Interoperability for Microwave Access (WiMAX), that is limited in Juba, South Sudan, and mobile satellite platforms.[225]

The RCS initially concentrated on radio communication. Later, the addition of mobile satellite equipment broadened RCS' product offering, which is a key focus of the group to date – to assess and add the latest and best performing products and services to its portfolio. The network focuses on providing solutions for Internet connectivity, networking, radio communication and mobile satellites.

However, it is critical to note that, as the newest country in Africa, South Sudan has inherited one of the least developed telecommunications and Internet markets in the world. Mobile penetration in South Sudan is only about 21 per cent, which is one of the lowest rates in Africa.

The development of the virtually-untapped Internet and broadband market will occur once the country has access to international fibre-optic cables and a national backbone network is put in place. With these developments and advanced telecommunication solutions, dissemination of climate change information and awareness for the public will be heightened.

## Capacity-building and technology transfer[226]

### Capacity-building

South Sudan needs to make numerous capacity-building efforts. There are some civil-society, academic and research institutions, as well as private sector and individual researchers, carrying out very useful climate change research, both from inside and outside the country. Together, they create and consume climate change information and knowledge. However, lack of knowledge-sharing seems to be a constraint, as it prevents sustained implementation and diffusion from the capacity-building initiatives within the country.

An institutional arrangement to formally mainstream all the actors will bring immense benefit to the climate change agenda in South Sudan. If put into effect, it will create a comprehensive collaborative arrangement that will allow climate change information and knowledge to flow between the Government, the private sector, civil society, academic institutions and individual researchers.

In addition, an appropriate knowledge- and information-management arrangement is required for flows between the national and county governments, civil society, the private sector, research institutions, individual researchers and academic institutions. This arrangement will address the generation, capture, organization, refinement and dissemination of easily understandable and implementable knowledge products for the intended beneficiaries within an enabling environment.

Being a post-conflict country, South Sudan is one of the least developed countries in the world (LDCs) and to obtain a more resilient population and economy, its development priorities have to be combined with the climate change initiatives. As such, it is imperative to combine platforms for the exchange of climate change mitigation and adaptation knowledge and information. Consolidating networks with academic institutions and civil society is also essential. In capacity-building, it is important to factor in a gender and human rights approach, prioritizing the most vulnerable groups in the country to reduce social inequality.

Given the country's current economic circumstances, low capacity and limited availability of climate technologies, the country will only be able to implement its INDC with the capacity-building, financial and technical support from the international community. To achieve this, continuous development and strengthening of South Sudan's capacities in climate change mitigation and adaptation is needed.

Climate finance is also a critical aspect in ensuring that South Sudan is at the same level as other LDCs in the area of financial resource availability. South Sudan will obtain financial support from the international community and from other sources to design and execute activities intended to address climate change mitigation and adaptation actions, as outlined in the country's INDC. As stipulated in the submitted INDC to the UNFCCC, the country has begun unlocking climate finance sources through the preparation of the NAPA.[227] There is also the option of pursuing climate/carbon finance through the CDM and REDD+ activities.

## Technology transfer

In its INDC, South Sudan will encourage innovations in technologies that are suitable for tackling climate change at all levels and also the inclusion of climate change priorities in its development agenda.

The South Sudanese Government has already identified numerous areas where technology transfer could benefit the country and its climate change adaptation and mitigation efforts, including:

- Use of modern transport technologies that are climate-resilient, particularly roads and the mass transportation of goods. These technologies should be used to protect infrastructure, especially against the effects of climate change.
- Renewable energy technologies to steer the country towards a low-carbon development path.
- Advanced water technologies that promote water savings, recycling, harvesting, irrigation and sustainable management for agricultural purposes.
- Tools and methods that will assist the assessment of climate impacts, vulnerability and adaptation actions in specific sectors and regions.
- Use of climate information systems and technologies that can help monitor hydro-meteorological events in real time and establish early warning systems for critical economic sectors in order to avoid impending dangers and disasters.

Many African countries articulate their technology needs in their TNA reports submitted to the UNFCCC. South Sudan has yet to submit any TNAs, but the TNAs submitted to the UNFCCC by Sudan (before it was split) state that for both adaptation and mitigation actions, the country cannot protect or preserve its natural environment without financial support, capacity-building and technology transfer from developed countries. This is the case for most African countries and is articulated in article 4.7 of the Convention, which alludes to the dependence of developing countries on financial support and technology transfer to assist them to effectively implement their commitments under the Convention.

In the TNA reports, it was noted that sound and environmentally benign technologies need to be integrated into environmental conservation and poverty alleviation. Improvement and development of mutual relations with global partners is critical in enhancing a mechanism for benefiting from the latest research and expertise on technologies that can enable the country to achieve climate mitigation and adaptation goals. Each of the TNAs can move beyond prioritizing technologies towards practical approaches to spread the use of all technologies identified, overcoming the many barriers in technology transfer, such as limited resources, lack of training and poor distribution tools, among others.

## Education, training and public awareness

Climate is a complex concept and raising public awareness of the basic science, its uncertainties and the risks it poses is vital so that the public can engage in a debate about the actions needed to combat climate change and to reduce its future risks. Therefore, the country designates education, training and public awareness on climate change as an essential component of its action on climate change.

### Education

The Government has developed education policies for the provision of quality, targeted and complete education. The policies aim to address emerging issues that need to be integrated into the education system. However, none of the policies has explicitly addressed climate change issues within the education system. As such, climate change is not formally acknowledged in South Sudan's education curriculum at the primary, secondary or tertiary levels. A major concern in the country is the lack of adequate climate change information and knowledge for researchers, planners, policymakers and the general public on climate change impacts, adaptation and mitigation measures. It is therefore recommended that, during future curriculum reviews, climate change should be integrated into the South Sudan education system.

The following strategies are proposed to integrate climate change into the country's education system:

- **Primary level education**: It is recommended that the designers of the primary school curriculum make a conscious effort to introduce basic principles of climate change and its impact into primary school learning by integrating it into all subjects to the greatest extent possible. The possible entry-point courses proposed were nature study and agriculture.
- **Secondary schools:** Courses are proposed to be introduced incrementally at the secondary school level. Secondary school students need to be equipped with skills to support a future low-carbon and climate-resilient economy. Integrating climate change into secondary education is proposed to happen through the introduction of content that makes learners aware of the need to develop climate adaptation and mitigation capacities for their country.
- **Post-secondary vocational institutions**: The country is experiencing a lack of mid-level technicians. This is seen as an opportunity to train secondary school leavers in skills to support the widespread adoption of the adaptation and mitigation practices needed to support the country's development plans. For example, whereas it is desirable for the country to promote the diffusion and adoption of solar heating systems, supportive networks for installing and maintaining solar power systems are not well established nationally. This is strong leverage to support the integration of climate change into the curriculum.
- **Universities:** Whereas climate change, as a subject, is now being taught at some local universities, there is a need for these institutions to develop policies to ensure that all students trained there are familiar with climate change and its impacts, as climate change is a cross-sectoral issue. Civil engineers need to learn how to design and develop structures that can withstand climate shocks, doctors need to be aware of the effects of climate change on human health, architects should have the skills and training to design houses that only require limited energy to run and maintain and teachers ought to be equipped with knowledge about climate change so that they are able to teach a curriculum that integrates climate change across all subjects taught at schools in South Sudan. Therefore, it is proposed that the subject be incorporated into the various professions taught at universities in the country.

### Training and public awareness

#### Level of awareness and understanding of climate change issues

The level of awareness of climate change issues and impacts is low countrywide. The lack of clear, simple and relevant climate change information is one of the major hurdles affecting the country's response to climate change. Interviews and consultations conducted by the consultants as part of the INC process indicate that there is a lack of basic information to enable people to cope with climate change. Other challenges identified include:

- unavailability of information in some locations within the counties
- information not formally documented
- unreliability of available information
- high levels of illiteracy within communities, hence limiting access
- low involvement of the mass media
- lack of in-depth scientific data
- the absence of a central location or platform for climate change information.

South Sudan is yet to develop a Public Awareness and Communication Strategy for climate change. This is developed to provide a framework for creating, collecting, organizing, packaging and disseminating climate change information to diverse populations in the country. The Government of South Sudan ensures that there is effective sharing of climate change information in the country that will result in both a clear and consistent set of messages aimed at enhancing public awareness of the pertinent issues of climate change and a better adaptation and mitigation response. The strategy should provide a framework for the Government to reach all segments of the population with simplified and timely information on climate change. It will empower the citizens to enjoy their right to a healthy environment and to play a role in sustaining the environment for the benefit of current and future generations.

## Constraints, gaps and related financial, technical and capacity needs

The information in this section is drawn largely from knowledge gaps identified during the INC development process.

Like most developing countries, South Sudan faces several challenges in understanding, mitigating and adapting to predicted climate change. These challenges arise from gaps in knowledge. The country's ability to address them is constrained by a lack of capacity and research infrastructure and also by an inability to communicate effectively and facilitate the implementation of actions and solutions. In particular, there is a need to develop human capacity, generate new and relevant knowledge, facilitate the establishment of research infrastructure, and bridge the divide between research results and socioeconomic outcomes.

In the context of more frequent reporting of national GHG inventories by non-Annex I Parties, it is imperative that the preparation process shift from a project-based approach to a more internalized and institutionalized approach.[228] This shift would support the timely delivery of the required information and more efficient use of available resources by Parties. Experience elsewhere has

demonstrated that developing GHG inventories on an ad hoc basis with the use of consultants has led to "memory loss" between the preparation of the INC and the Second National Communication (SNC) and that insufficient capacity has been developed within internal structures. To resolve this issue, clear records of activity data used in the INC and the methodologies followed have been clearly documented and retained on file, which makes it easy to both validate previous assumptions and update the inventory. Specific gaps on GHG inventory preparation have been identified in chapter 2 of this report.

Insufficient evidence and documentation of QA/QC also brings into question the reliability of the GHG inventory. In addition, lessons learned from the preparation of the INC should be passed on in an effective manner, since methodological choices are not always explained.

### National Communication process constraints and needs

The Ministry of Environment and Forestry has the mandate for the preparation of the country's INC.

The process of preparing the INC has taken about 10 months and has been led by external consultants contracted to prepare the INC by UNEP, on behalf of the Government of South Sudan.

The consulting team engaged with various stakeholders and collected the necessary data and information through personal consultations. The outputs from the consultants have been reviewed and validated through multi-sectoral stakeholder workshops. While this has been efficient in enabling a broader audience to participate in the process, it has been neither effective nor efficient in its collection of data and information. In addition, the consultations have been significantly limited by the conflict and insecurity situation in the country.

The INC work has been developed mainly using secondary data from various sources, including Intergovernmental Panel on Climate Change (IPCC) work done under the draft NAPA and Vision 2040. However, several different tools and software have been used in the GHG inventory section, alongside clear technical reports for each of the UNFCCC GHG inventory chapters.

There are still significant gaps in both the quality and quantity of the data and in the methods and systems used to collect and archive them. The required quality assurance (QA) measures need to be improved. Specific needs have been discussed in detail in the National Greenhouse Gas Inventory Report.

A most critical need is the implementation of institutional arrangements, alongside supporting systems, which treat the National Communication (NC) reporting process as an ongoing activity, rather than just a project.

In order to meet the reporting requirements, both in terms of quality and frequency, the Government needs to provide a robust and continuous institutional structure for the preparation of NCs.

An institutional structure will ensure that the required continuity is maintained and that the capacities created are strengthened. One of the underlying principles here is to build on and take into account the country's planned climate change governance structures, wherever possible. The continuous institutionalization will ensure that the whole NC preparation process is maintained

and sustained. The current reactive nature of re-establishing the NC process is costly and unsustainable. As an alternative solution, the team can consider designing a governance structure to dovetail the interests, responsibilities and capacities of planned climate change governance structures. Once the institutional structure is agreed upon, the country needs to immediately commence the SNC process.

For successful implementation, access to funding remains a key necessity. Given the magnitude of the tasks, the complexities of the technological solutions and the wide range of adaptation and mitigation studies and assessments, prompt identification and release of funds will undoubtedly contribute to an enhanced and sustained capacity.

Capacity-building is required at both the institutional and personnel levels and multi-sectoral representation (i.e., energy, industrial processes, solvent and product use, agriculture, LULUCF and waste) is important. It is recommended that training workshops be conducted as part of future GHG inventory work to provide sectoral level training to both government staff and local consultants. These workshops should focus on familiarizing a wide audience of stakeholders with inventory methodologies and tools, engaging them in the data-collection process and providing them with hands-on experience with inventory data, methods and tools. The ultimate objective should be that appointed government staff can complete considerable aspects of inventory work with limited outside consultancies.

The capacity-building should be designed to establish ongoing data collection and analysis in all the relevant government ministries and departments, and should include the necessary private sector participation at both the association and industry sector levels.

## National Communication sector-specific constraints and needs

### Greenhouse gas inventories

A number of significant gaps, needs and constraints were identified during the preparation of the INC inventory for South Sudan. Gaps include not only information on activity data, but also resources and capacity. There is a strong need for institutional capacity-building and training of government staff so that they can carry out the necessary data collection and analysis required to reduce inventory uncertainties and improve the quality of activity data and emission factors used to generate the inventory.

Specific gaps, needs and recommendations associated with activity data collection, capacity-building and the development of an integrated and sustainable GHG inventory system are discussed in detail in the National Greenhouse Gas Inventory Report found in chapter 2.

The subsections below summarize specific gaps, needs and recommendations, which are discussed in detail in the National Greenhouse Gas Inventory Report:

- activity data collection
- capacity-building
- sustainable GHG inventory systems.

The following key components of a sustainable GHG inventory system, as identified by IPCC and UNFCCC guidelines, are discussed in detail in the National Greenhouse Gas Inventory Report:

- institutional arrangements
- methods and data documentation
- QA/QC procedures
- archiving
- Key Category Analysis
- inventory improvement planning.

A major point to note is that the system must be tailored to account for the specific national circumstances and constraints of South Sudan. Further details of these components are available from the United States Environmental Protection Agency's (US EPA's) "Approach to Building Sustainable Inventory Systems" and its pre-defined National System Templates.

Arrangements for continuous improvement, which have to be put in place, are described in the National Greenhouse Gas Inventory Report.

**Mitigation**

In general, there are significant gaps in both the quality and quantity of data used for mitigation assessment, including information on policies, regulations and plans to guide the forecasting and generation of projections.

In order to be able to analyse demand-side mitigation options, it is vital that fuel consumption and related emissions are allocated to end uses. Historical information on the total consumption of different energy consumers (urban households, rural households, commercial and industry) is not provided in the data on petroleum fuel sales or in a number of reports. There is little comprehensive information available on the end-use demand where these fuels are ultimately consumed, such as in cooking, lighting and heating water. There are no reports providing details on usage patterns of households and ownership of appliances that may indirectly indicate actual energy consumption. Most data – especially for biomass consumption, petroleum production and fossil fuel usage – was often found to be contradictory and therefore unreliable.

End-use allocation is based on estimates from experts and from related literature. There is no comprehensive source of information on the historical end-use consumption patterns of different consumers of biomass and fossil fuels in South Sudan. Some documents were reviewed that provided some evidence of end-use consumption patterns or ownership of appliances specific to certain fuels, but these data were seldom aggregated to the national level or they only indirectly indicated actual energy consumption.

As a result, there is a fair degree of uncertainty associated with the end-use allocation and a number of the estimates are not South Sudan-specific. The uncertainty in end-use allocation does not affect overall estimates of emissions, but it does impact the uncertainty associated with estimates of the potential for mitigation where specific end uses are targeted.

Developing a baseline projection for South Sudan's entire economic sector is challenging, because there is considerable uncertainty regarding how the sectors may grow to meet a large suppressed demand. There are generally no specific plans in place.

The future growth in petroleum product consumption for road transportation (gasoline, light diesel oil and additives) was determined based on estimates of the growth rate of the overall vehicle stock, the growth rate of vehicle use (demand for services) and the change in average fuel efficiency over time. There were no known projections of this growth in South Sudan and the analysis drew upon knowledge of historic growth to inform these assumptions.

The agricultural sector is currently the largest source of GHG emissions of all sectors. Despite its important contribution to overall emissions, there is a lack of data required to calculate GHG emissions and significant uncertainty associated with the emission estimates when compared to the energy demand, electricity generation and transportation sectors.

### Adaptation

Two knowledge gaps that directly influence climate change impacts and vulnerability have been identified:

- understanding a changing climate
- adapting to a changing climate.

### Understanding a changing climate

There is a need for deeper understanding of how the climate and related ecosystems are changing, with a particular emphasis on the local level, the speed of the change and where it is happening. Understanding of the complex interactions within South Sudan's ecosystem and how certain changes will affect other aspects is necessary. At the local level, this understanding is required to improve predictive capacity and to plan appropriate adaptive responses.

There is also uncertainty regarding the regional effects of large-scale global climate change.

Although many researchers tend to work within a single domain (land, air or sea), all ecosystems are interconnected. However, understanding how the ecosystems are linked – and how changes in one system will affect others – has been inadequate at the local level. There is a need to understand which priority types of change occurring on land, at sea or in the air will directly or indirectly affect the other ecosystems.

Current climate change predictions rely on a number of models that simulate possible future changes in the real world. However, global models focus on broad-scale changes to the Earth's climate, and their predictions are often too coarse to be useful at a regional or local level. It is also true that, by adding understanding generated at the local level, it is possible to improve global models, their predictions and, as a result of this, their usefulness. There are gaps in arrangements for understanding and incorporating local input into climate predictions.

There is a need to continue to develop climate models that are specific to South Sudan and the region in order to represent their specific climates.

### Adapting to a changing climate

It is currently understood that climate change is inevitable and that its impacts include increases in the magnitude and frequency of both floods and droughts, changes to fire regimes that will put people and property at greater risk, as well as changes to the dynamics of diseases affecting humans and livestock. However, at the local level, there is a lack of understanding of the uncertainty and the risk, of which areas are most at risk of the effects of rapidly changing conditions, of what can be done to avoid – or minimize – the adverse effects of climate change and how South Sudan's biodiversity can be protected from adverse changes.

Another gap is the lack of understanding of how the town planners can build urban resilience.

It is difficult to predict the exact effects of climate change on food security and research is needed to enable better understating of this issue. For water planners, planning has been based more on historical data than on future predictions. This has a direct bearing on future water security. There is a local knowledge gap on how this should be changed.

There is inadequate information on the potential cost of planned adaptation responses to climate change. An estimate of the average annual cost of climate-related events (storms, floods, droughts and fires) in South Sudan cannot be made with any level of accuracy, due to a lack of reliable and comprehensive data.

Like other African countries, South Sudan does not have enough adequately trained climate change professionals, and support – such as future funding to develop a sufficient amount of professionals to fulfil this role – is needed in this regard.

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