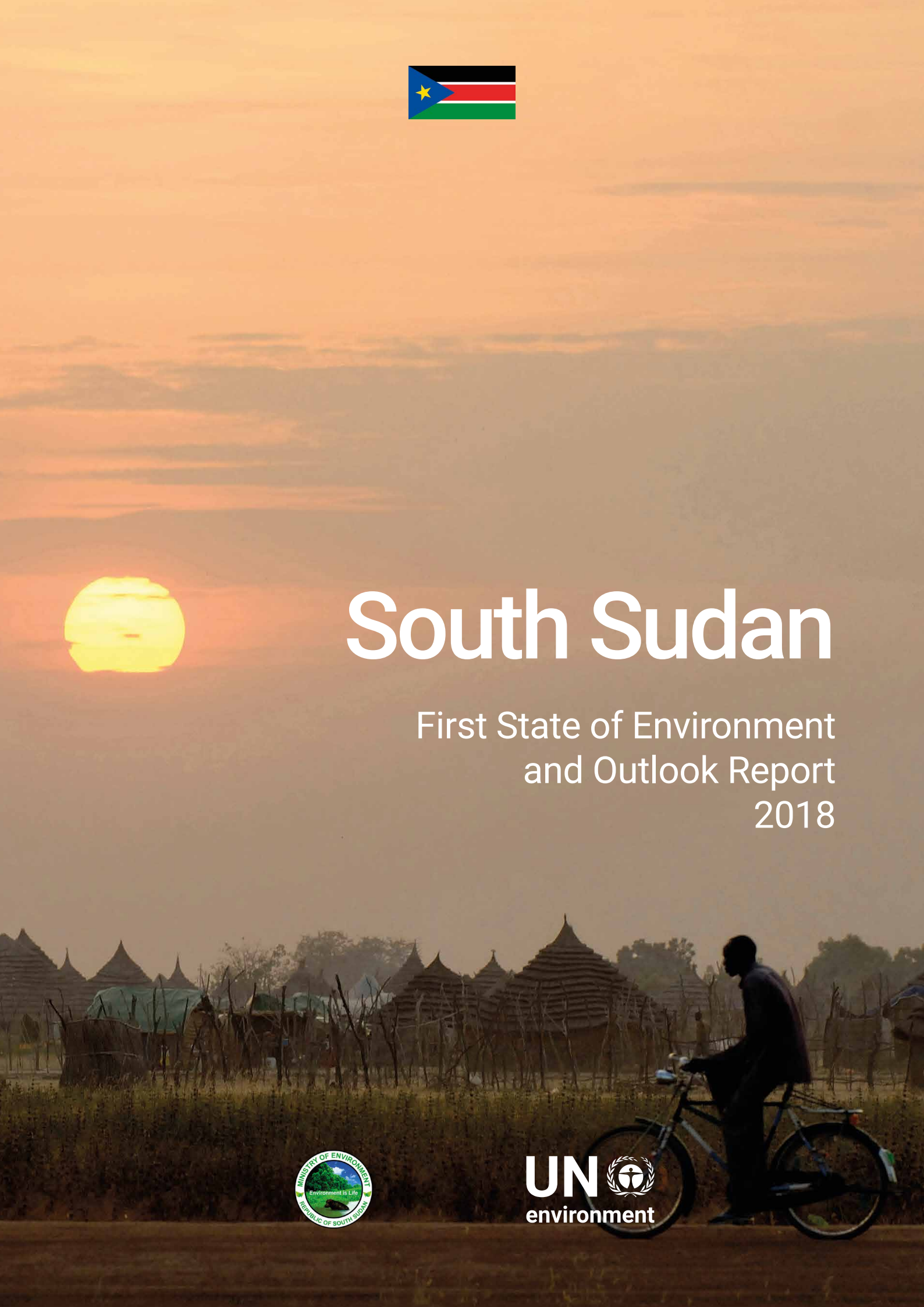

South Sudan

First State of Environment and Outlook Report 2018

UN environment

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There can be no sustainable development without peace and no peace without sustainable development.

THE UNITED NATIONS GENERAL ASSEMBLY, 2015

South Sudan

First State of Environment and Outlook Report 2018

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Foreword

South Sudan, the newest nation among the comity of nations, is endowed with vast and rich natural resources. Its natural capital includes arable land, grasslands, tropical forests, rivers, wetlands, lakes, biodiversity, minerals, oil, etc.

The economy and the livelihood of the people of South Sudan is largely dependent on the exploitation of its natural capital. The over 50 years of civil war however, hampered the development of South Sudan, thus making it one of the least developed countries in the world. Other than oil, its natural capital is barely exploited. For instance, only 4.5 percent of its arable land is currently cultivated, though its population density is one of the lowest in Africa. With the attainment of independence in July 2011, South Sudan is expected to leap frog, and become the bread basket and the economic power house in the East-Central African region.

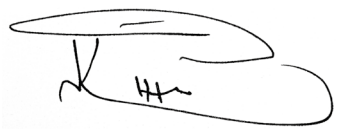
One of the top priorities of the Government of South Sudan is to develop and implement sustainable management plans in the sub-sectors of the environment sector, so that the exploitation of natural resources does not adversely impact the environment. Until that is achieved, there is enormous pressure on natural resources, especially on the forests, as over 99 percent of the population of South Sudan depends on forests as their source of energy – fuel wood and charcoal, and timber for construction and furniture.

The lack of environmental standards and guidelines to safeguard the exploration and exploitation in the extractive industry has led to pollution in the oil fields and in the surrounding areas. This trend needs to be checked through the formulation of environmental policies, standards and guidelines, and enforcement of these instruments. South Sudan needs support from the international community on this front, particularly from the countries that have successfully and sustainably managed their extractive industry and natural resources.

As in many parts of the world, particularly in Africa, climate change poses a significant threat to the environment and sustainable development in South Sudan. The Government of South Sudan has formulated its National Adaptation Programme of Action (NAPA) and Intended Nationally Determined Contributions (INDCs) to fight Climate Change. The priority projects identified in these planning frameworks, if implemented, will to an extent, insulate South Sudan from the adverse impacts of climate change. This will lead South Sudan to a sustainable, low carbon development trajectory, in which current and future generations will reap benefits from natural resources in perpetuity.

It is worth mentioning that this first ever State of the Environment and Outlook report for South Sudan will form the basis and the benchmark for assessments, inventories, mapping and valuation of our vast natural resources. The information thus generated will be used for future planning and management of natural resources and environmental protection.

I very much sense that South Sudan is on its way to the path of sustainable development.



Salva Kiir Mayardit
President of the Republic of South Sudan

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We are grateful to Mario Carbo-Penche of the Wild Conservation Society, South Sudan for reviewing the Biodiversity Chapter.

Acronyms

AA	Adjusted Area
ACAV	Associazione Centro Aiuti Volontari
AfDB	African Development Bank
AFR	Agoro-Agu Forest Reserve
AFREC	Africa Energy Commission of the African Union
AR	Autonomous Region
ASZ	Aswa Shear Zone
AU	African Union
AWF	African Wildlife Foundation
BBC	British Broadcasting Corporation
bcm	Billion cubic meters
BdNP	Bandingilo National Park
BJL	Boma-Jonglei Landscape
BMP	Strengthening Biodiversity Management in the Boma-Gambella Landscape Project
BPM	Barrels per day
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters
°C	Centigrade
CAADP	Comprehensive Africa Agriculture Development Programme
CAMP	Comprehensive Agricultural Development Master Plan
CBD	Convention on Biological Diversity
CBO	Community-Based Organization
CFR	Central Forest Reserve
CFS-FFA	Framework for Action for Food Security and Nutrition in Protracted Crises
CGIAR	Consortium of International Agricultural Research Centers
CIA	United States Central Intelligence Agency
CIESIN	Center for International Earth Science Information Network
CNPC	China National Petroleum Corporation
CO_2	Carbon dioxide
CPA	Comprehensive Peace Agreement signed in Nairobi
CTA	Civil Transactions Act
DANIDA	The Danish International Development Agency
DEM	Digital Elevation Model
DFID	United Kingdom Department for International Development
DRC	Democratic Republic of the Congo
DSMW	Digital Soil Map of the World
EAC	East African Community
EARS	East African Rift System
EGS	Ecosystem Goods and Services
EIA	United States Energy Information Administration
EPI	Elephant Protection Initiative
ESIA	Environment and Social Impact Assessments
ET	Evapotranspiration
EU	European Union
EWCA	Ethiopian Wildlife Conservation Authority
FA	Forest Act
FAO	Food and Agriculture Organization of the United Nations
FES	Fuel Efficient Stoves
FEWS	Famine Early Warning Systems
FEWS NET	Famine Early Warning Systems Network
FFS	Farmer Field Schools
FGA	Future Generation Account
FGD	Farmer Group Discussion

FIT	Feed-In Tariff
FLEGT	Forest Law Enforcement Governance and Trade
FNCA	Forests National Corporation Act
FOA	Fortune of Africa
g/kg	Gram per kilogram
GAM	Global Acute Malnutrition
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIS	Geographical Information System
GJ	Gigajoule
GLCN	Global Land Cover Network
GNI	Gross National Income
GOSS	Government of South Sudan
GSA	Global Shea Alliance
HDI	Human Development Index
HEA	Household Economic Analysis
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HoA-REC&N	Horn of Africa Regional Environment Centre and Network
HRW	Human Rights Watch
ICFR	Imatong Central Forest Reserve
ICPALD	IGAD Center for Pastoral Areas & Livestock Development
ICRAF	International Centre for Research in Agroforestry
IDMP	Irrigation Development Master Plan
IDP	Internally Displaced Person
IEA	International Energy Agency
IEP	Institute for Economics and Peace
IGAD	Intergovernmental Authority on Development
IK	Indigenous Knowledge
INDC	Intended Nationally Determined Contribution
INR	Institute of Natural Resources
IPC	Integrated Food Security Phase Classification
IPCC	Intergovernmental Panel on Climate Change
IRNA	Initial Rapid Need Assessment
IRWR	Internal Renewable Surface Water Resource
IUCN	International Union for the Conservation of Nature
IVAC	International Vaccine Access Center
JCC	Juba City Council
ktoe	Kilotonne of oil equivalent
KWh	Kilowatt-hour
LGA	Local Government Authority
LGAF	Land Governance Assessment Framework
LULUCF	Land Use, Land-Use Change and Forestry
M&A	Measurement and Assessment
MAFC&RD	Ministry of Agriculture, Forestry, Cooperatives and Rural Development
MAFTARF	Ministry of Agriculture, Forestry, Tourism, Animal Resources and Fisheries
MARF	Ministry of Animal Resources and Fisheries, Republic of South Sudan
MDAs	Ministries, Departments and Agencies
MDG	Millennium Development Goal
MDTF	Multi - Donor Trust Fund
MEA	Multilateral Environmental Agreement
MEDIWR	Ministry of Electricity, Dams, Irrigation and Water Resources

MENERGY	Ministry of Energy
MGEI	Ministry of General Education and Instruction, Republic of South Sudan
MOAF	Ministry of Agriculture and Forestry, Republic of South Sudan
MOE	Ministry of Environment, Republic of South Sudan
MOED	Ministry of Electricity and Dams
MOJ	Ministry of Justice
MOPM	Ministry of Petroleum and Mining
Mt	Metric tone
MW	Megawatts
MWCT	Ministry of Wildlife Conservation and Tourism (MWCT), Republic of South Sudan
MWh	Megawatt-hours
MWRI	Ministry of Water Resources and Irrigation, Government of South Sudan
n.d.	No date
NALEP	National Agriculture and Livestock Extension Policy
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NASA	National Aeronautics and Space Administration
NBI	Nile Basin Initiative
NBS	National Bureau of Statistics, Republic of South Sudan
NBSAP	National Biodiversity Strategy and Action Plan
NCA	National Conservation Area
NDC	Nationally Determined Contribution
NEMA	National Environmental Management Authority
NFF	National Forest Fund
NFR	National Forest Reserve
NGL	Natural Gas Liquid
NGO	Non-Governmental Organization
NLA	National Legislative Assembly
NNP	Nimule National Park
NPGC	National Petroleum and Gas Corporation
NSDS	National Strategy for the Development of Statistics
NTFP	Non-Timber Forest Product
OLS	Operation Lifeline Sudan
ONGC	Oil and Natural Gas Corporation
OWL	Other Wooded Land
P	Projected
PDOC	PETRODAR Operating Company
PEPA	Petroleum Exploration and Production Authority
PET	Potential Evapotranspiration
PFA	Provincial Forests Act
POC	Protections of Civilians
PPA	Power Purchase Agreement
PPP	Purchasing Power Parity
REDD+	Reduce Emissions from Deforestation and Forest Degradation and Foster Conservation
REEEP	Renewable Energy and Energy Efficient Systems Partnership
RMMS	Regional Mixed Migration Secretariat
ROSS	Republic of South Sudan
RSA	Revenue Stabilization Account
RWR	Renewable Water Resources
SAF	Sudan Armed Forces
SDG	Sustainable Development Goal
SE4ALL	Sustainable Energy for All
SEDC	Sudanese Electricity Distribution
SEI	Stockholm Environment Institute
SEIA	Social and Environmental Impact Assessment

SEOR	State of Environment and Outlook Report
SFR	State Forest Reserve
SiO	Silicon Monoxide
SNEL	Société Nationale d'Electricité
SPLA	Sudanese People's Liberation Army
SPLM/A	Sudan Peoples' Liberation Movement/Army
SSCCIA	South Sudan Chamber of Commerce, Industry and Agriculture
SSCCSE	Southern Sudan Centre for Census, Statistics and Evaluation
SSDP	South Sudan Development Plan
SSEC	South Sudan Electricity Corporation
SSFC	South Sudan Forest Commission
SSLC	South Sudan Land Commission
SSNFC	South Sudan National Forest Corporation
SSP	South Sudan Pound
SSWS	South Sudan Wildlife Service, Republic of South Sudan
ST	Sudan Tribune
SUWASA	Sustainable Water and Sanitation in Africa
toe	Tonne of OIL EQUIVALENT
TPES	Total Primary Energy Supply
TWh	Terawatt-hours
UKAID	United Kingdom Department for International Development (Also called DFID)
ULA	Unregistered Lands Act
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDAF	United Nations Development Assistance Framework
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNE	United Nations Environment
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commission for Refugees
UNICEF	United Nations Children's Fund
UNISDR	United Nations Office for Disaster Risk Reduction
UNITAR	United Nations Institute for Training and Research
UNMISS	United Nations Mission in South Sudan
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UN-OHRLLS	United Nations Office of the High Representative for Least Developed Countries, Landlocked Developing Countries and Small Island Developing states
UNOPS	United Nations Office for Project Services
UNOSAT	UNITAR's Operational Satellite Applications Program
USA	United States of America
USAID	United States Agency for International Development
USGS	United States Geological Survey
UWS	Urban Water System
W/m²	Watt per square meter
WASH	Water, Sanitation and Hygiene
WCMC	World Conservation Monitoring Centre
WCS	Wildlife Conservation Society
WEC	World Energy Council
WFP	World Food Programme
WHO	World Health Organization
WNR	West Nile Region
WRM	Water Resources Management
WVI	World Vision International
WWF	World Wide Fund for Nature

Executive summary

The context

South Sudan is a landlocked country that falls almost entirely (96 per cent) within the Nile River Basin in East-Central Africa. It is bordered in the north by Sudan; by Ethiopia and Kenya in the east; by Uganda and the Democratic Republic of the Congo (DRC) in the south; and in the west by the Central African Republic. It occupies an area of 658,842 km^2. The country is covered by extensive grasslands, wetlands and tropical forests. Its natural assets include significant agricultural, mineral, timber and energy resources. The climate is mostly hot and dry, with seasonal rains that allow for two or three harvests a year in the country's green belt. Apart from oil, however, its natural resources are largely unexploited and only 4.5 per cent of its potential arable land is cultivated.

South Sudan is inhabited by a number of different ethnic groups, the largest of which is the Dinka, a traditionally pastoralist people that makes up 36 per cent of the population. It is followed by the Nuer, who constitute about one-fifth. Other groups include the Zande, the Bari, the Shiluk and the Anywa (Anwak). In total there are 64 ethnic groups in South Sudan. There is also a small Arab population in South Sudan.

With less than 13 people per square kilometre, population density in the country is one of the lowest in Africa. Livelihoods in the northern dry areas are dominated by seasonal agriculture, pastoralism, fishing and hunting. The country is divided into three regions (the former historic provinces): Bahr el Ghazal in the northwest, Equatoria in the south and Greater Upper Nile in the northeast. There were ten states, which are now divided into thirty two.

The socioeconomic drivers of environmental change

The state of ongoing strife in South Sudan is the major impediment to good governance that would ensure the productive use of its natural resources and the protection of its environmental assets. Indeed, the lack of strong, effective institutions for peacefully managing competing claims to local power and control, and ownership of livestock and natural resources is an important factor in the ongoing conflict. The proliferation of small arms, the politicisation of ethnicity, a legacy of weak property rights, the lack of economic diversification and over-reliance on oil are other important contributing drivers.

The influx of refugees, returnees and internally displaced people since 2005 has also been a significant cause of inappropriate land use and over-exploitation of natural resources. The increase in numbers has put more pressure on the already scarce environmental and financial resources in the country's towns and cities, especially through the cutting of wood for building purposes and fuel. The following section details some of the report's main conclusions and recommendations.

Key conclusions and recommendations:

- At the country's formation in 2011, formal governing institutions were created, but given the years of conflict and the breakdown of former structures, they commenced from a generally low foundation. The new government's capacity to formulate policy and implement programmes is still limited, but is developing and evolving. It should be further strengthened.
- The foundational document guiding South Sudan's future is the Draft "South Sudan Vision 2040: Towards Freedom, Equality, Justice, Peace and Prosperity for All". It is recommended that the government adopt and implement the Draft Vision 2040 as soon as possible. It should also strengthen environmental governance by increasing the capacity and financing for the Ministry of the Environment and Forestry, which would help to ensure the country's natural resources are both protected and used sustainably.
- South Sudan is signatory to the Montreal Protocol to the Vienna Convention on Substances that Deplete the Ozone Layer, the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol to the UNFCCC, the International Plant Protection Convention (IPPC), the Convention on Biological Diversity (CBD), and the UN Convention to Combat Desertification. The institutional frameworks to accomplish environmental and climate-change commitments, however, are still at the nascent stage due to the low priority given to them in the context of the ongoing situation of conflict, as well as the lack of technical capacity and financial resources. The Government of South Sudan would do well to prioritise institutional strengthening and financing.

The natural drivers of environmental change

The impacts of global climate change and natural hazards are conspiring with all these socioeconomic drivers to form a complex dynamic of causes contributing to environmental change in South Sudan. Already, the country's climate is characterised by extremes and it regularly experiences drought, torrential rains and seasonal flooding.

Key findings:

- Climate change is expected to increase the risk of insufficient access to safe water and improved sanitation and food insecurity, as well as the population's vulnerability to certain climate-related health issues, including increases in illness and outbreaks of pests and disease.
- Increased drought, floods and a more unpredictable climate, when combined with rapid population growth and the expansion of farming, is likely to see a rise in clashes over natural resources, reflecting how climate change can contribute to conflict.
- A flourishing agriculture sector, which depends on the viability of land and water resources, is crucial to long-term peace and development.
- Disaster risk reduction action plan and climate change adaptation measures need to be implemented to build a climate resilient society.

Some of the findings for each sector are given below:

Agriculture

- About 80 per cent of the population lives in rural areas where subsistence agriculture is the mainstay of people's livelihoods;
- The lack of access to land and land-tenure regulation is a limitation to agricultural production;
- There is a huge potential for expanding irrigation, improving yields through seed selection and provision, developing aquaculture and taking advantage of agroforestry opportunities.

Forests

- Fuelwood and charcoal account for over 80 per cent of all wood used in South Sudan, with an annual deforestation rate estimated at between 1.5 and 2 per cent. There are no reliable data on the extent of forests, however, since a detailed forest survey and inventory has never been carried out;
- The country has valuable timber resources, so sustainably managing its forest resources offer South Sudan the opportunity to provide jobs and income, and to maintain the ecological goods and services they provide; however, on-going conflicts prevent the forests from being developed and sustainably managed to provide goods and services for future generations.

Biodiversity

- The Sudd swamp is one of the world's largest tropical wetlands. It has been declared a wetland of international importance under the Ramsar Convention on Wetlands;
- South Sudan has 14 national parks or protected areas and is home to the world's second largest animal migration after the great Serengeti-Maasai Mara wildebeest migration; this epic migration of antelopes offers tremendous opportunity for the development of ecotourism;
- The country harbours an immense diversity of wildlife species, many of which face threats from human activities, including wildlife poaching and trafficking; deforestation; settlements, cropland and livestock expansion; road construction; mining and oil development; and climate change impacts;
- The Wildlife Conservation Society (WCS) and the South Sudan Wildlife Service reportedly estimated an elephant population of some 2,300 in the country prior to the civil war, which began in 1983, down from about 79,000 in the 1970s.

Water resources

- There is little information on the distribution and hydrology of underground waters, or about the rates of water extraction and the impacts of human activities, such as potential over-abstraction and pollution;
- South Sudan's Ministry of the Environment considers the construction of large hydroelectric dams and other related development schemes within the Nile Basin to be the most significant environmental threats to South Sudan's surface and subsurface water resources;
- Although the government is gradually instituting water management policies and regulations, the state of conflict, low population densities and widely scattered villages and towns present formidable challenges to providing water facilities, services and infrastructure in a cost-effective way.

The urban environment

- The most significant driver of urbanisation is the natural increase in population due to the high fertility rate. Another driver is the influx of refugees, Internationally Displaced Persons (IDPs), immigrants and returnees to urban settlements. For example, in early 2017, there were 260,868 refugees in South Sudan and the country was the site of Africa's largest refugee crisis;
- The collection, transportation and final disposal of both solid and liquid waste are inefficient or non-existent in most of South Sudan. As much as half of urban waste is burned resulting in the proliferation of vectors, flies, rodents, pathogens and foul odours, soil pollution, the destruction of wildlife habitat, and air pollution that results in respiratory illnesses among the population. Furthermore, the lack of proper sewage systems and water treatment means human waste contaminates the water people use for household purposes, leading to the risk of water-borne illnesses such as cholera;
- Irreversible impacts on the environment, including deforestation, water pollution and poor sanitation, are related to large concentrations of people and the creation of informal settlements in urban centres. Also, large areas in most towns and municipalities have been gazetted for predominantly residential purposes with little or no space protected as parks and public recreational spaces;
- To address the challenges of rapid urban growth in Juba City and its environmental impacts, the Municipal Government prepared a Juba City Sanitation Reform and Investment Plan, which lays out an integrated strategic approach for dealing with sanitation issues. Implementation of this plan will require substantial investments to strengthen the human and operational capacities of government ministries and municipal-level departments.

Energy

- Most of South Sudan's energy is produced from oil, and its oil-dependence has been increasing. Most of the country's needed oil products are imported, however, because as yet there are no working refineries and current reserves are projected to last only until 2035;
- The potential for renewable energy is huge, including biomass resources (forests, animal wastes, and agricultural residues), hydro, wind and solar energy;
- The use of woodfuel and charcoal is causing deforestation and polluting emissions that are responsible for respiratory diseases.

Petroleum, mining and industry

- With the exception of oil, the mining and industrial sectors have yet to be developed;
- Some of the impacts of oil production include loss of grazing land, deforestation, loss of traditional livelihood opportunities for some local tribes (Dinka, Nuer and Shilluk), and soil and water contamination of critical ecosystems, such as wetlands;
- Pollutants from the oil extractive industry are likely to have led to emerging health problems, including rising rates of female infertility, increases in the number of miscarriages, birth defects, and eye and skin problems in and around oil producing areas;
- The limitations to industrial development include the lack of geological exploration in non-hydrocarbon minerals; the dearth of investments; the shortage of trained human resources; the lack of basic infrastructure; power shortages; and the state of conflict and insecurity.

Recommendations for peace building through natural resources

South Sudan's natural resources—its land, water, grasslands, forests and mineral deposits—are critical to the country's prospects for a peaceful and prosperous future. The majority of South Sudan's people rely on these resources for their daily survival. The country needs to harness these assets to create jobs, generate revenue to fund basic government services and lift people out of poverty. The effective management of South Sudan's natural resources could greatly improve the country's prospects for peace and stability. Essential elements for an effective natural resource management strategy include:

- Improve resource governance and sustainability;
- Provide better accountability;
- Involve more community participation; and
- Provide stronger mechanisms for dispute resolution, reduced competition for resources, and improved transboundary resource management.

Land – It is imperative to resolve land tenure issues and successfully manage land resources.

- Prepare for and manage the growing demand for land. Rapid population growth, returning refugees, and environmental degradation are simultaneously constraining the amount of productive land available and increasing competition over land both in rural areas (for livestock and agriculture) and in urban centres (for building);
- Halt land grabbing: Weak and inconsistent land management, endemic corruption and insecurity have enabled powerful elites opportunities to make land grabs, which undermine the rule of law and foster resentment among local people;
- Establish the structures to resolve land disputes: Develop more effective mechanisms to resolve land disputes, which are inhibiting development and undermining healthy community relations;
- Launch a major initiative to secure the land rights of people.

Forests – Woodlands are a source of fuel and timber, the exploitation of which can lead to deforestation and land degradation.

- Reduce the rate of deforestation for firewood by planting woodlots and involving communities more closely in managing their local forests;
- Combat the illegal trade in high-value timber by raising awareness of the impacts of the trade;
- Establish a certification scheme that provides a market for sustainably produced, conflict-free timber;
- Provide alternative sources of domestic energy.

Grassland – There are nearly 12 million cattle in South Sudan. Yet the country faces famine and continues to import most of its meat from neighbouring countries, losing hundreds of millions of dollars every year without exports in return. Livestock are an important source of rural livelihoods and play important roles in defining social status. Cows are considered "walking wealth", especially among herding communities. A large cattle herd increases an individual's importance in the community. Because of this, the nation's huge livestock wealth has not been utilised or introduced into the country's economic development. Should South Sudan move to develop the livestock industry, and to avoid possible conflicts, it should:

- Create a rangeland policy;
- Establish formal grazing rights;
- Have well-defined property rights that are enforced and transferable;
- Promote responsible rangeland management and enhance understanding of the importance of the survival of pastoralism as a livelihood among non-pastoral groups;
- Negotiate and build peace among the users of communal grazing lands.

In many parts of the country, cattle are the only path to marriage. The bride price is typically 20 to 40 animals, each worth up to $500. A girl who is perceived as beautiful, fertile and of high social rank can fetch as many as 200 cattle. This is a significant incentive for young men to steal livestock. Cattle theft is a common occurrence and stolen animals are a source of meat, milk and dowry. These thefts exacerbate existing conflicts. According to some estimates, more than 5,000 civilians have been killed in cattle raids since South Sudan gained independence in 2011.

Extractives – South Sudan contains rich underground resources including valuable oil reserves.

- Make the country's mineral resources a strategic priority. This is a significant prospect for the country to become financially self-sufficient.
- Develop an extractives sector that does not create or exacerbate conflict;
- Minimise the negative social and environmental impacts of extraction operations;
- Strengthen transparency and accountability in the mining sector to improve governance and tackle corruption;
- Provide responsible security around active sites.

Water – Water management systems have to tackle inter-related challenges and prepare for and manage the increased demand for water.

- Mitigate the risk of climate-related disasters;
- Build and/or rebuild water infrastructure without exacerbating regional tensions;
- Reduce competition over scarce water resources through more efficient irrigation systems, drought resistant crops and public awareness campaigns;
- Increase the supply of water through water harvesting and infrastructure investments;
- Improve water governance by addressing the inequitable access to water for marginalised groups (including women), reducing corruption in the sector, supporting the community management of water and building capacity to resolve disputes;
- Prepare for the impact of climate and other human-driven change that will impact South Sudan's water security;
- Improve transboundary water management.

Wealth-sharing – Wealth-sharing arrangements among warring parties could be part of the peace building process. There are a number of ways such arrangements could be reached, for example:

- Revenue from natural resources is shared between the Central Government and sub-national Governments based on amicably agreed-upon formula;
- Direct payments to citizens, which is rather difficult to implement;
- A mechanism for income sharing is devised in line with tax based compensation, i.e. Subnational Governments receive the amount of revenue they would otherwise have received as income from natural resources.

Outlook and recommendations for achieving the SDGs

South Sudan's natural resources — its land, water, grasslands, forests and mineral deposits — are critical. The Sustainable Development Goals (SDGs) are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The prevailing conflict and violence has an undeniable impact on the environment, both directly and indirectly. The body of this report articulates some of the actions needed to achieve the following environment-related Sustainable Development Goals (SDGs 2030):

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable, and modern energy for all

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts* (*Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.)

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation, and halt biodiversity loss

In order to achieve the SDGs by 2030, appropriate policies and actions should be urgently undertaken to address the following:

- Maintain peace and security;
- Manage internal migration of people;
- Develop an industrial base to create income-generating activities and employment;
- Attract investments for infrastructure financing and tourism;
- Strengthen institutional capacity to manage natural resources;
- Develop policy and legislative frameworks for the sustainable development, management and conservation of natural resources;
- Establish effective enforcement mechanisms for protecting wetlands, forests and wildlife;
- Enhance the capacity to conserve and sustainably use natural resources for commercial and domestic purposes and to control their illegal use;
- Build the capacity of environmental institutions by providing resources, training and tools;
- Adapt to the impacts of climate change; and
- Negotiate transboundary issues such as Nile River water sharing.

The following are some specific recommendations for achieving the SDGs by 2030:

- Finalise, approve and implement Draft Vision 2040;
- Finalise and approve environmental policies in South Sudan;
- Create a proper coordination and governance structure for implementing the SDGs;
- Institutionalise the environmental assessment processes, and develop measuring and monitoring systems;
- Take urgent action towards addressing land tenure issues. Land tenure security has been recognised as highly relevant to achieving the SDGs in ending poverty and hunger. Indicator 1.4.2 aims to measure progress on secure tenure rights for all by measuring the "Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure";
- Strengthen environmental awareness and education;
- Mainstream gender in environment and development activities;
- International organisations should provide support on all the above focusing on:
  - Technical support in institution building; and
  - Mobilising financial resources from international sources.

Conclusion

The Republic of South Sudan's natural environment provides abundant environmental goods and services that offer multiple opportunities for economic development and improved livelihoods; it is a fragile endowment, however, that must be managed sustainably to support the livelihoods of present and future generations. Peace, however, is the overarching goal for South Sudan, since:

"There can be no sustainable development without peace and no peace without sustainable development"

(United Nations General Assembly, 2015).

Introduction to the report

Background

The state of the environment in a given area depends on and is influenced by a number of factors. First, existing geological, ecological and climatic features are the foundational environmental characteristics of a place. Environmental change occurs when natural forces, such as tectonic activity and meteorological events, as well as human agency, alter or affect those conditions.

After years of civil war, South Sudan is facing urgent environmental and natural resource challenges including: deforestation, land degradation, loss of biodiversity and habitat, pollution of land and water resources, conflicts over diminishing resources such as forests, rangelands, water points for livestock, and poor solid waste and sanitation services in urban areas. However, the extent of these environmental challenges is not known, and there was an urgent need to assess the environmental situation and gather data and information on which to base the necessary interventions. Most of the required data and information are either absent, obsolete or not organised in a manner that can make them a basis for policy and decision-making.

The last detailed environmental assessment was carried out by UN Environment in 2007 in the form of a Sudan Post-Conflict Environmental Assessment (PCEA). An Environmental Impact,Risk and Opportunity (EIRO) study conducted by UNDP in early 2011 was mainly based on a desk review of previous studies, including the PCEA. The PCEA covered all of pre-partition Sudan and is now considered out of date for South Sudan as the situation has been changing fast. Following the Comprehensive Peace Agreement (CPA) in 2005 and independence in July 2011, and given the pace of environmental change in South Sudan, the Ministry of the Environment and Forestry (MoEF) of the Republic of South Sudan requested that UN Environment facilitate a study on the state of the environment in the country. The aim was to identify and prioritise key environmental challenges for South Sudan and develop actions to address these challenges. The report will help the Government of South Sudan to make informed decisions about its environmental resources and to maintain a sustainable environment in the most effective way possible.

Scope of the report

To set the context and provide background, a brief introduction to South Sudan, its environmental features and characteristics, followed by a summary of the major driving forces of environmental change in the country, have been provided.

Thematic chapters describe the major pressures on the environment in South Sudan and assessment of their impacts on ecosystem goods and services, and human well-being. Human activity exerts pressures on these ecosystem goods and services. Examples include farming, grazing, fishing, timber and non-timber harvesting, mining, as well as constructing roads, settlements, energy and other infrastructure. In turn, these pressures usually have detrimental impacts on land, water, air and biodiversity, ranging from the loss and degradation of land and water resources, to air and water pollution.

These chapters provide data on the status of the country's environmental assets, showing their present distribution, and noting and analysing the trends in their quantity and quality over time. They make a major contribution to building a baseline of information about the state of South Sudan's environment against which to measure future change. The information they contain provides the foundational environmental knowledge upon which to build, as the country increasingly develops the infrastructure and capacity to monitor and measure the state of its natural resources.

Chapter 11 provides the outlook and recommendations for South Sudan to address its environmental challenges and achieve the Sustainable Development Goals.

The production process

UN Environment, in collaboration with the Ministry of Environment and Forestry, selected the Environmental Pulse Institute (EPI), USA, to provide technical assistance in developing the State of Environment and Outlook report (SEOR) for South Sudan. UN Environment and MoEF supported EPI in organising an Inception Workshop to launch the SEOR process and discuss the Table of Contents, as well as Validation Workshops to peer review the draft chapters.

Field visits were an integral part of the development of the South Sudan State of Environment and Outlook report 2017. The basic objective was to listen to local officials and residents to elicit their perspective on the environmental problems they were facing, obtain a real understanding of the nature of people's needs in an area and glean their ideas for potential solutions. In addition to face-to-face interviews, a simple questionnaire approach was used to stimulate feedback from the people.

Methodology

The evidence in this report was gathered through a number of rigorous methods, including the following:

- An extensive literature review of government sources, reports by international organisations and peer-reviewed scientific papers;
- Stakeholder consultations in Juba at an Inception Workshop to identify data sources with officials and other stakeholders and to launch the work;
- Field work to collect "evidence" in specific places experiencing noticeable environmental change; and
- A Validation Workshop held in Juba to solicit comments on draft chapters and validate the first draft.

The approach to preparing and presenting the data and information in the report is based on the following:

- The use of the Driving Forces-Pressure-State-Impact-Response (DPSIR) methodology as the organisational and analytical framework;
- The compilation, analysis and visualisation of statistical and geo-spatial data, including the presentation of visually compelling ways to present the data: satellite images, maps, graphs and charts, boxes with case studies and ground photos.

Cattle Herders in Rumbek.
Photo credit: JennaCB123 [GFDL/ GNU.ORG/ CC BY-SA 3.0

CHAPTER 1
HISTORICAL, GEOGRAPHICAL AND SOCIOECONOMIC CONTEXT

CHAPTER 1
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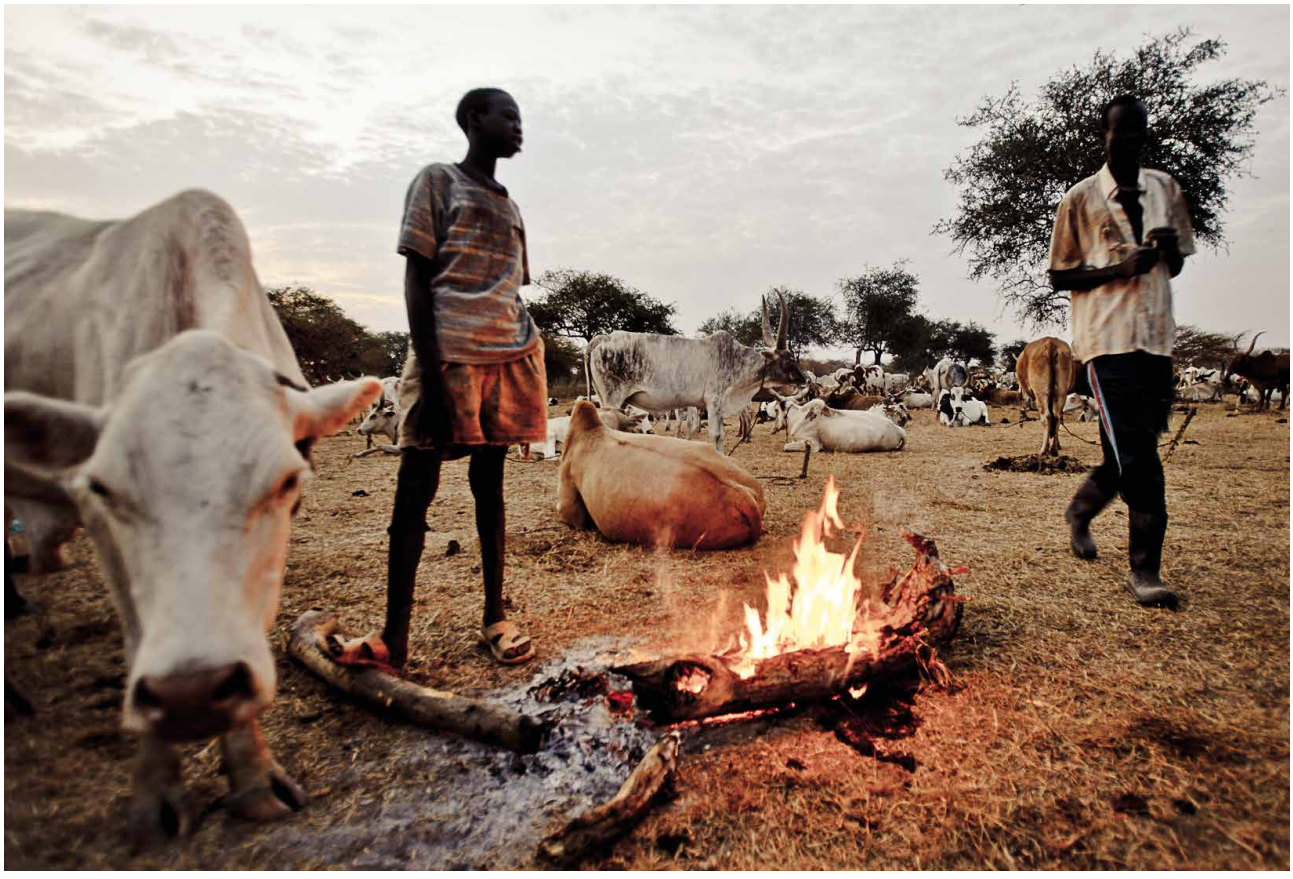
1.1 Introduction to South Sudan

South Sudan is a landlocked country that falls almost entirely (96 per cent) within the Nile River Basin in East-Central Africa (NBI, 2016). It is bordered in the north by Sudan, by Ethiopia and Kenya in the east, by Uganda and the Democratic Republic of the Congo (DRC) in the south, and in the west by the Central African Republic (Figure 1). South Sudan lies within the tropical zone between latitudes 3.5° and 12° North and longitudes 24° to 36° East. It occupies an area of 658,842 km^2 (RSS, 2012). The country is covered by extensive grasslands, wetlands and tropical forests. Its natural assets include significant agricultural, mineral, water, wildlife, timber and energy resources.

South Sudan is inhabited by several different ethnic groups, the largest of which is the Dinka, a traditionally pastoralist people, followed then by the Nuer. Other groups include the Zande, the Bari, the Shilluk, and the Anywa (Anwak). In total there are 64 ethnic groups in South Sudan. There is also a small Arab population in South Sudan (Encyclopaedia Britannica, 2016).

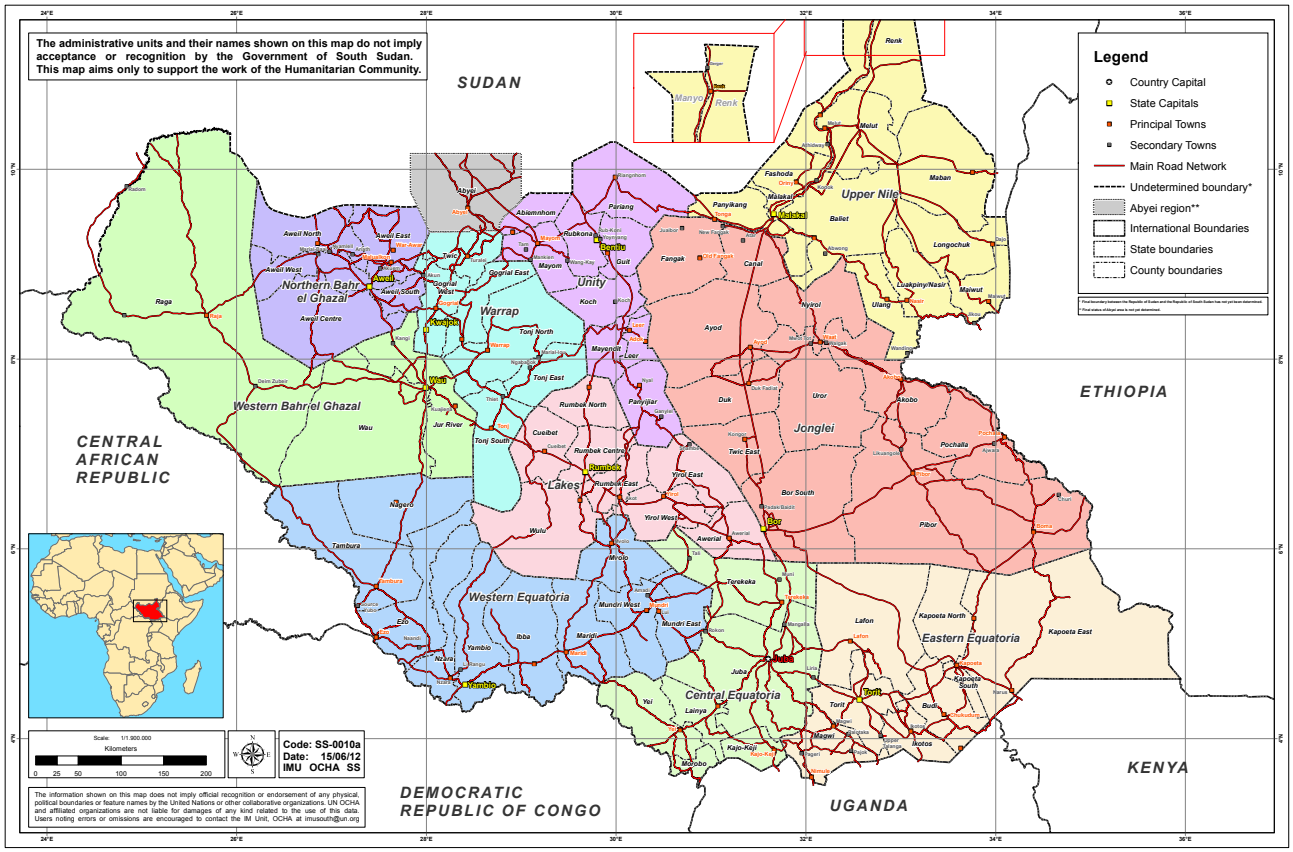
With less than 13 people per square kilometre, population density in the country is one of the lowest in sub-Saharan Africa (BRACED, 2016). Livelihoods in the northern dry areas are dominated by seasonal agriculture, pastoralism, fishing and hunting. Livelihood opportunities vary in the low woodland savannahs in the country's centre (MOE, 2015).

The country is divided into three regions (former historic provinces): Bahr el Ghazal in the northwest, Equatoria in the south and Greater Upper Nile in the northeast. The country initially comprised of ten states but this has now increased to thirty-two.



Dinka cattle herdsmen in Abyei. *Photo credit: ENOUGH Project/Flickr.com/ CC BY-NC-ND 2.0*

FIGURE 1: SOUTH SUDAN ADMINISTRATIVE MAP - STATES AND COUNTIES OF SOUTH SUDAN



Source: (UN OCHA)

A brief history of South Sudan

The Republic of South Sudan achieved independence on 9 July 2011 following a six-year interim period after the Comprehensive Peace Agreement (CPA) signed in Nairobi in 2005 that ended two decades of civil war. Historically, between 1899 and 1955, South Sudan was part of Anglo-Egyptian Sudan, under joint British-Egyptian rule. Sudan gained independence in 1956 but was wracked by two civil wars. The first war was a secessionist movement in the south between 1955 and 1972, which ended in a measure of autonomy being granted for southern Sudan. The second civil war between the north and south erupted in 1983 when Sudanese President Nimeiri abolished that autonomy and transformed Sudan into a Muslim Arab state, prompting the formation of the Sudanese People's Liberation Army. A violent war ensued, in which southern villages were destroyed and survivors fled, including the so-called "Lost Boys", some 20,000 Sudanese children who walked to Ethiopia (Larson, 2011); (BBC, 2016).

In the late 1980s, Nimeiri was disposed, but the conflict worsened and in 1989, the military seized power in Sudan and southern rebel factions created the Sudanese People's Liberation Army-United coalition. Villages in the south continued to be raided and there was bitter fighting between some ethnic groups, especially the Dinka and Nuer (Larson, 2011); (BBC, 2016); (NG, 2014).

South Sudan gains its independence July 9, 2011.
Photo credit: Steve Evans/ Flickr.com/CC BY-SA 2.0.

There were numerous attempts to broker peace between warring factions in the region, by neighbouring countries and by the international community, but it wasn't until 2005 that the CPA was signed, providing a permanent ceasefire, autonomy for the south, a power-sharing government involving rebels in Khartoum, sharing of oil revenues and the promise of a south Sudanese referendum on independence to take place six years later (Larson, 2011); (BBC, 2016).

Peace remained fragile as numerous rebellions erupted, especially after the death of south Sudanese John Garang, the first vice-president of Sudan in August 2005, over the oil-rich border town of Abyei and leading up to the referendum on independence. In January 2011, the south Sudanese overwhelmingly voted in favour of full independence and on 9 July, the Republic of South Sudan celebrated its creation (Larson, 2011); (BBC, 2016). It was formally admitted into the United Nations General Assembly as the 193rd member state on 14 July 2011 and into the African Union as the 45th member state on 15 August 2011 (UNDAF, 2011).

Summing up progress during the CPA period, the United Nations Development Assistance Framework for the Republic of South Sudan (UNDAF) reported that the government's achievements had been impressive *"all the more so when the low baseline resulting from decades of marginalisation and war is taken into account. Essential executive, legislative and judicial institutions have been established at the central and state levels. More than two million people have returned to the south, including 330,000 south Sudanese refugees from neighbouring countries. The number of children in primary school has doubled and 6,000 kilometres of road have been opened, although not yet upgraded into all-weather routes."* (UNDAF, 2011, p. 5).

Celebration of the independence of South Sudan by the Tama tribe.
Photo credit: Al Jazeera/ Wikicommons/ CC BY-SA 2.0 i.

Nevertheless, since independence, both internal and external threats have continued to disrupt peace and security, and prevent the new country's development. Between December 2013 and an internationally-mediated peace deal in August 2015, the country suffered strife and insecurity over ethnic disputes; oil export fees; the border town of Abyei and other areas of conflict, including the Ilemi Triangle and Kafia Kingi. There was also a civil war prompted by accusations of treason by President Salva Kiir toward ex-Vice-President Reik Machar. Since August 2015, implementing the agreement and forming a transitional government has been a formidable challenge (UNOCHA, 2013); in July 2016, the peace deal broke down and fighting resumed (BRACED, 2016).

The conflict and the associated limitations facing governing institutions have resulted in severe food insecurity and worsening poverty, often closely linked to environmental factors related to the crisis (AfDB, 2016). In some areas, for example, local-level, inter-tribal conflict disrupted the traditional migration routes of pastoralists and the natural resources people needed to survive, badly affecting many livelihood activities. Today, less than 1 per cent of the population has access to electricity, more than 96 per cent use firewood or charcoal, only 59 per cent has access to improved sources of drinking water and about 80 per cent has no access to any toilet facility (BRACED, 2016); (MOE, 2015); (UN-OHRLLS, 2016).

Returnees from the north and their belongings at Malakal port.
Photo credit: BBC World Service/ Flickr.com/ CC BY-NC 2.0 (UNDAF, 2011, p.5)

1.2 Geographical context

Landforms and topography

The major geographical features of South Sudan are the White Nile, which flows north from Central Africa's uplands and dominates the centre of the country, and the vast Sudd swamp, one of the world's largest wetlands. The Sudd swamp is fed by the White Nile and covers over 100,000 km^2, more than 15 per cent of the country's area. Rising out of the northern and central plains are the southern highlands along the border with Uganda and Kenya. The Ethiopian highlands border the country to the east, and the Congo River basin highlands are on the southern and western margins (Fernando & Garvey, 2013).

Figure 2 maps the country's topography. The highest point is Mount Kinyeti, at 3,187 m, in the Imatong Mountains (CIA, 2016).

FIGURE 2: **TOPOGRAPHY OF SOUTH SUDAN.**

Data Source: USGS SRTM

The climate

The climate of South Sudan is characteristically hot and dry, with seasonal rains brought on by the annual migration of the Inter-Tropical Convergence Zone. Temperatures range from 25 to 40°C. The growing season is generally between 100 to 250 days, depending on the agro-ecological zone (MOE, 2015). Rain typically falls unevenly across the country; the northeast is drier and precipitation increases towards the southwest (Figure 3).

FIGURE 3: **RAINFALL DISTRIBUTION, 2014.**

Source: (BRACED, 2016)

The Sudd swamp, one of the world's largest tropical wetlands. *Photo credit: UN Environment South Sudan.*

There is a wetter green belt along the southern border that includes western, central and eastern Equatoria, which has bimodal rainfall regimes from April to June and from August to October, enabling two or three harvests a year (BRACED, 2016). Annual rainfall in the green belt ranges from 800 mm to 2,500 mm (MOE, 2015).

Rain in the rest of the country occurs between April and October. It is often heavy and continual, leading to beneficial seasonal floods that improve soil fertility, grass and pasture growth, and create fishing ponds (BRACED, 2016). Rainfall in the arid zone can be as low as 300 mm per year (MOE, 2015).

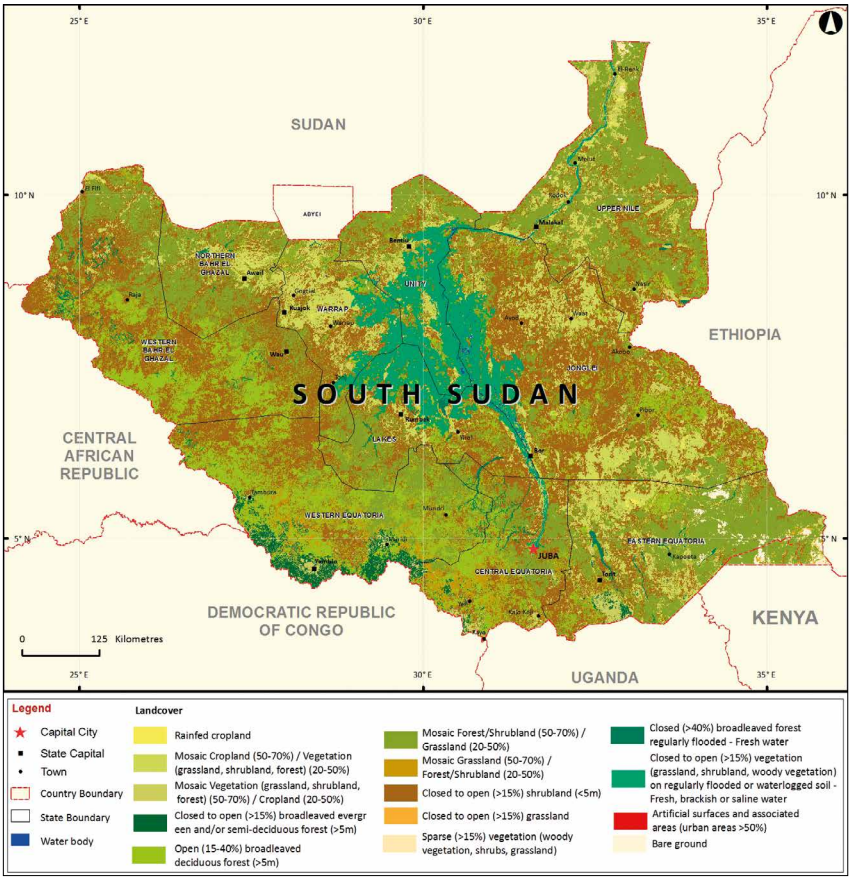
Children go fishing after rains in Jamam Refugee camp in South Sudan.
Photo credit: Alun McDonald/ Flickr.com/ CC BY-NC-ND 2.0

Land cover

Most of the country is covered with natural and semi-natural vegetation with variable tree density. Vegetation cover is mostly high in the southwest, with thick tropical forests in the Greater Equatoria region, and low in the southeast and north, where semi-arid savannah dominates. Grasslands, aquatic vegetation and open water occupy the wetter regions. A large part of South Sudan is covered by the Sudd swamp, a conglomeration of smaller wetlands (Fernando & Garvey, 2013); (RSS, 2016b).

Figure 4 shows the distribution of the basic land-cover types (cropland, scrubland, grassland, forests, wetlands and lakes) and Table 1 provides information on the vegetation and soil types associated with them.

FIGURE 4: **LAND COVER OF SOUTH SUDAN.**



Source: (ESA, 2009)

TABLE 1: **BIOPHYSICAL PARAMETERS OF PHYSIOGRAPHIC/CLIMATIC REGIONS**

Physiographic/climatic region	Average length of growing period (LGP) (days)	Elevation (m)	Dominant soil type	Vegetation
Flood plain	121	415 (374-500)	Chromic Vertisols	Deciduous shrubland/ sparse trees
Ironstone	178	581 (432-999)	Plinthic Ferralsols	Deciduous woodland
Green Belt	214	723 (531-1,000)	Plinthic Ferralsols	Mosaic Forest/ Savannah
Hyper-arid	0	536 (366-1,000)	Chromic Vertisols	Croplands (>50%)
Arid	43	552 (383-1,000)	Chromic Vertisols	Croplands (>50%)
High altitude areas	146	1,293 (1,001-3,055)	Eutric Nitosols	Mosaic Forest/Savannah
Colluvial	131	448 (404-511)	Dystric Regosols	Deciduous shrubland/ sparse trees
North western plateau	133	614 (483-1,000)	Dystric Regosols	Deciduous woodland
Lower hills and mountain slopes	143	661 (501-1,000)	Ferric Luvisols	Deciduous shrubland/ sparse trees

Source: (Odero, n.d.)

1.3 Governance

Governance and peace

The state of ongoing strife in South Sudan is a major impediment to good governance. According to the Global Peace Index, in 2016, South Sudan ranked last (162nd) among 162 countries. The Index is calculated by the Institute for Economics and Peace and measured by 23 qualitative and quantitative indicators under three categories: the level of safety and security in society, domestic and international conflict and militarisation (IEP, 2016).

According to the Food and Agriculture Organization of the United Nations (FAO) Resilience Strategy for South Sudan, the important drivers of violent conflict that have exacerbated existing tensions are the lack of strong, effective institutions for peacefully managing disputes or competing claims to local power and control and ownership of livestock and natural resources, "the proliferation of small arms, the politicisation of ethnicity, a legacy of weak property rights, lack of economic diversification and over-reliance on oil" (FAO, 2016).

Levels of governance

At the country's formation in 2011, formal governing institutions were created, but given the years of conflict and the breakdown of former structures, they commenced from a generally low foundation. The new government's capacity to formulate policy and implement programs is still limited, but is developing and evolving. South Sudan has five administrative levels: national, state, county, payam and boma (World Bank, 2014). There are ministries at both national and state levels; lower-level governance is enacted through departments or units for the various sectors (Encyclopaedia Brittanica, 2016).

The transitional constitution of South Sudan also recognises the highly decentralised traditional governance institutions as practised by different ethnic groups. The Dinka, Bongo and Luo people consider traditional leaders to be more legitimate than local-level government officials. Customary law and authorities are important in settling disputes, mobilising the community in collective actions, enforcing regulations in the use and protection of common natural resources and to some degree in ensuring the health and welfare of all community members. They are, however, patriarchal systems that neglect to provide opportunities for women to have meaningful participation in community meetings, and they favour men in customs regarding property, inheritance and material, to the detriment of women (Murray, 2016).

Vision 2040

The foundational document guiding the future of South Sudan is the draft "South Sudan Vision 2040: Towards Freedom, Equality, Justice, Peace and Prosperity for All". The Vision has seven management pillars, as follows:

- Educated and Informed Nation
- Prosperous, Productive and Innovative Nation
- Free, Just and Peaceful Nation
- Democratic and Accountable Nation
- Safe and Secure Nation
- United and Proud Nation
- Compassionate and Tolerant Nation (RSS, 2016b).

The overarching goals are to create a vibrant, competitive and diversified economy driven by agriculture, industry, mining, tourism, and services that attract investors. The Vision foresees the government initiating and investing in agriculture to achieve food security; advancing the role of women; and promoting partnerships between local and foreign investors, which invest in development that substantially increases resource ownership and management by citizens (RSS, 2016b).

Environmental governance

Vision 2040 also promises the government will adopt appropriate measures to limit pollution that may result from rapid industrialisation and to foster sustainable environmental management (RSS, 2016b). In addressing international goals to mitigate greenhouse gas emissions and in recognition of the significance of agriculture and livestock as the backbone of the population's livelihoods, the government of South Sudan has committed to promoting sustainable, climate-smart agriculture and livestock production and management. It aspires to prioritise climate resilience in the agricultural sector (crop production, livestock, and fisheries) by building on traditional knowledge and supporting community-based adaptation strategies (RSS, 2015).

Institutions for environmental governance

The institutional frameworks to accomplish environmental, natural disaster reduction and climate-change commitments are still at the nascent stage in South Sudan due to the low priority given them in the context of the ongoing situation of conflict as well as the lack of technical capacity and financial resources (USAID, 2016). Some of the relevant institutional frameworks already in place are the Ministry of Humanitarian Affairs and Disaster Management; South Sudan Relief and Rehabilitation Commission; Ministry of Environment and Forestry; South Sudan Directorate of Me-

trological Services; Ministry of Agriculture and Food Security, Ministry of Livestock and Fisheries; Ministry of Energy and Dams; Ministry of Irrigations and Water Resources; Ministry of Finance, Commerce and Economic Planning; Ministry of Land, Housing and Physical Planning; Ministry of Petroleum, Mining and Industry; Ministry of Foreign Affairs and International Cooperation; and the Ministry of Wildlife Conservation and Tourism (Tiitmamer, 2015).

Environmental policies and regulations

The National Environmental Policy governs natural resources. It advocates the development of a national climate change adaptation and mitigation policy and associated strategy. Although these have yet to be formally developed, adaptation strategies and plans are part of South Sudan's development plans and include strategies related to agriculture and forestry, livestock, health, water and disaster risk management (USAID, 2016).

Other policies that address climate change adaptation include the National Policy on Food Security, which advocates building adaptive capacity by identifying drought- and flood-resistant seed varieties, and the 2015 draft Disaster Risk Management Policy, which proposes strategies to adapt to potential flooding, such as building dykes, but has yet to incorporate those that build resilience to droughts (USAID, 2016).

Importantly, the holders of traditional knowledge play a role in upholding cultural norms related to protecting and equitably using environmental resources. Such regulations include, for example, the responsibility of fishers to return small fish to the water and rules about the use of forest fires and protecting certain wildlife and tree species (USAID, 2016).

Multilateral Environmental Agreements (MEAs)

The Ministry of Foreign Affairs and International Cooperation is in charge of international environmental conventions and treaties (UNEP 2016). South Sudan is signatory to the Montreal Protocol to the Vienna Convention on Substances that Deplete the Ozone Layer; the United Nations Framework Convention on Climate Change (UNFCCC); the Kyoto Protocol; the Convention on Biological Diversity (CBD); the UN Convention to Combat Desertification (UNCCD) and Ramsar Convention (John, 2015).

The country had begun working on a number of commitments to international environmental agreements prior to the resumption of conflict in 2013, including its First National Communication to the UNFCCC, a National Adaptation Programme of Action, the National Adaptation Plan, and the National Biodiversity Strategy and Action Plan (UNEP, 2016). In 2015, South Sudan submitted its Intended Nationally Determined Contributions (INDCs) to the UNFCCC and its Fifth National Report to the Convention on Biological Diversity.

1.4 The economy

Although South Sudan has abundant natural resources including minerals, precious metals, fertile land, hardwood timber, Gum Arabic and honey, amongst others, apart from oil, they are largely unexploited (FAO, 2016). Oil is the major income-earner, generating 98 per cent of government revenues (Table 2), while the local economy is fundamentally subsistence in nature (BRACED, 2016); (World Bank, 2016c).

Produced water ponds along Paloch Oil Field. *Credit: Department of Health Safety and Environment (HSE), South Sudan Petroleum Authority, Ministry of Petroleum*

TABLE 2. KEY ECONOMIC DATA FOR SOUTH SUDAN

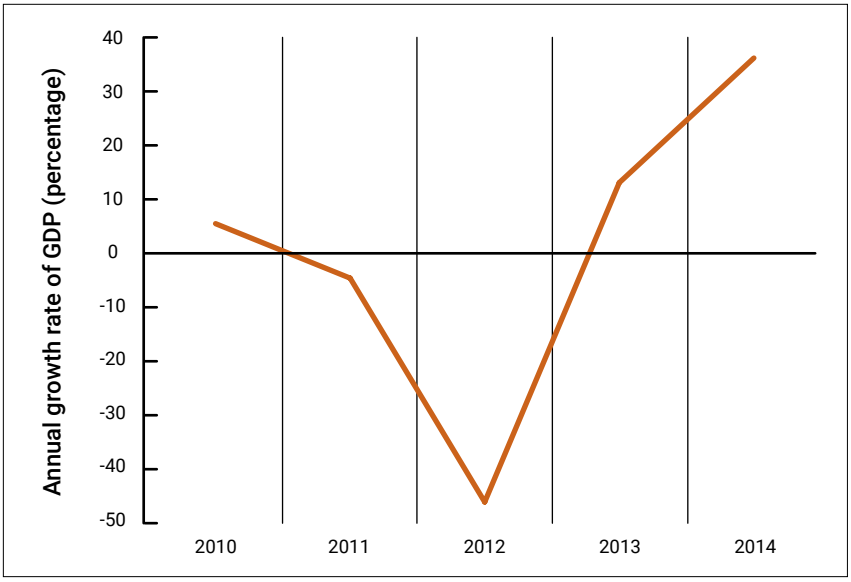
Key Economic Data	Unit	Value
GNI (Gross National Income) per capita (2013)	USD	950
Growth in GNI per capita 2014	%	-19
Ease of doing business (2015)	Rank	187
Government revenue from oil sector (2013-2014)	%	98
Government expense (% of GDP)(2014)	%	44
Tax revenue (excluding grants, % of GDP) (2013)	%	3.7
Net official development assistance (% of GNI) (2014)	%	19

Source: (DANIDA, 2016)

As a result of decades of war, the country's economy is extremely fragile. Along with variable oil prices and declining production, the conflict has caused the GDP growth rate to fluctuate over the past few years (Figure 6). In 2014, GDP rose by 15.9 per cent, but in 2015, it declined by an estimated 5.3 per cent (AfDB, 2016). In 2014, per capita Gross Domestic Product (GDP) was only $1,111 (World Bank, 2016c).

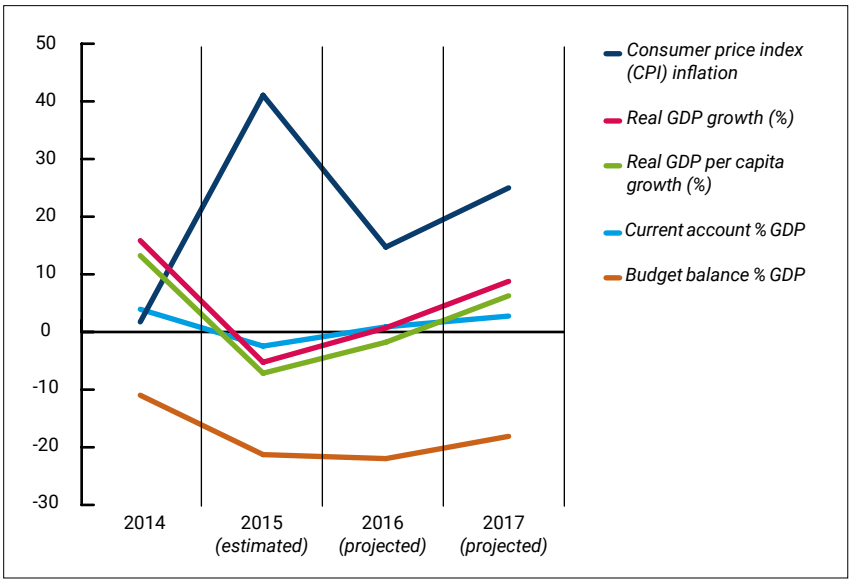
Most South Sudanese derive their livelihoods from subsistence agriculture and pastoralism, which account for around 15 per cent of GDP; about 78 per cent of households depend on crop farming or animal husbandry as their primary source of income. Of the working population, 53 per cent are still traditionally unpaid family workers and only 12 per cent are paid employees (RSS, 2016b); (World Bank, 2016a). Approximately 12 to 15 per cent of the population relies on fisheries as their primary source of livelihood (MOE, 2015).

FIGURE 5: FLUCTUATIONS IN ECONOMIC GROWTH



Source: (UN-OHRLLS, 2016)

FIGURE 6: MACROECONOMIC INDICATORS



Source: (AfDB, 2016)

Oil dependence

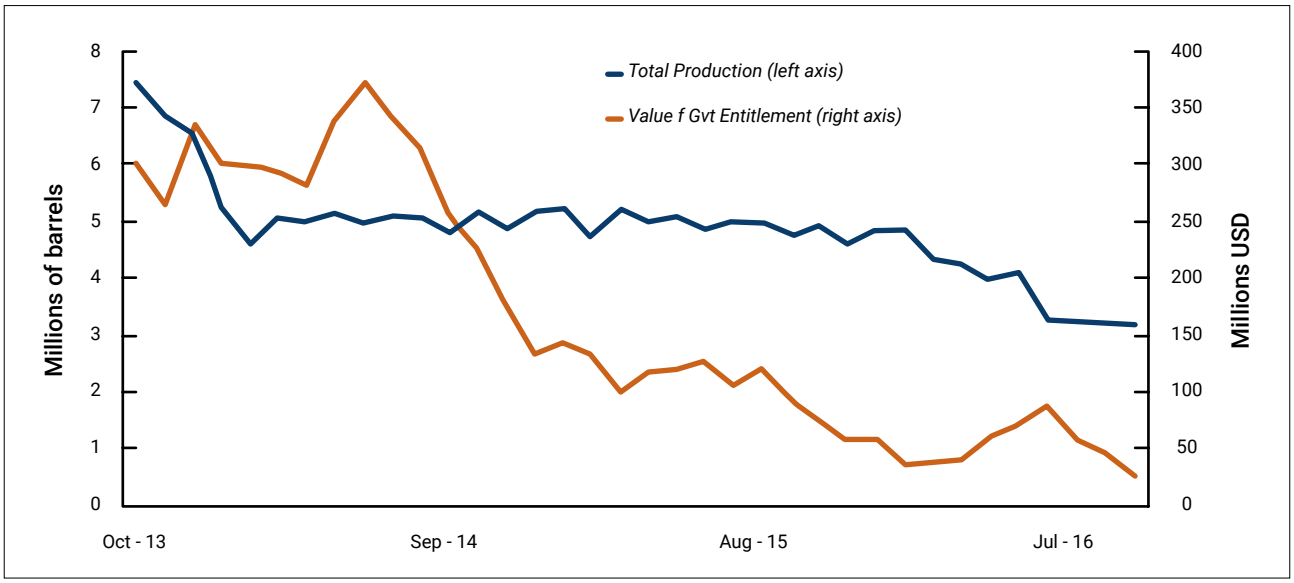
South Sudan is the world's most oil-dependent country; oil accounts for almost all exports and around 60 per cent of its GDP (AfDB, 2016). Other exports are timber, metals (gold and silver) and foodstuffs. The vast majority of products sold in South Sudan are imported (MOE, 2015).

A series of oil shocks between 2012 and 2015 led to a sharp fall in oil production and exports (MOF, 2016) (Figure 7). Oil exports peaked at 350,000 barrels per day before independence in 2011, fell to 165,000 barrels per day in 2014 and continued to decline to about 120,000 barrels per day in 2016 (World Bank, 2016c). Estimates of current reserves predict that oil production will steadily decline until they become negligible by 2035 (World Bank, 2016c). International oil prices also collapsed between 2014 and 2015. Both these factors lead to a severe decline in government revenues (AfDB, 2016). This was followed by rapid inflation and the depreciation of the exchange rate as the government also borrowed from the Bank of South Sudan (MOF, 2016). Annual inflation increased by 730 per cent from August 2015 to August 2016, indicating a state of hyperinflation (World Bank, 2016a).

The Ministry of Finance and Planning estimates that since the independence of South Sudan, the per capita Gross National Income (GNI) in US dollars has fallen by around 70 per cent (MOF, 2016). The Central Bank has no reserves and the limited revenues are spent on defence and security loans (World Bank, 2016c).

Oil pipeline on the road from Bentiu to Yida. *Photo credit: Shannon Orcutt/ Flickr.com/CC BY-NC-ND 2.0*

FIGURE 7: **TREND IN OIL PRODUCTION AND REVENUES, 2013-2016**



Source: (MOF, 2016)

Conflict, the economy and the environment

Since most people in South Sudan depend on livestock and crops for survival, a flourishing agriculture sector is crucial to long-term peace and development. Although 95 per cent of the territory of South Sudan is suitable for agriculture, only 4.5 per cent of its potential arable land is cultivated (FAO, 2016).

War-related destruction and insecurity, population displacements, poor infrastructure and the lack of investment in agriculture have worsened the productive capacity of South Sudan (BRACED, 2016). The crisis has constrained the mobility of pastoralists, reduced the amount and viability of land that farmers can cultivate and disrupted market access, resulting in livestock mortality and reduced harvests (FAO, 2016). One of the results of disruptions in pasture and crop production has been a rise in the importance of small-scale fishing: over the past several years, its contribution to household livelihoods increased from 6.8 per cent to 10.2 per cent, due in part to the displacement of highly vulnerable populations toward water sources, such as rivers and swamps (FAO, 2016).

South Sudan once was a net exporter of food but is now a net importer. A large proportion of the population depends on purchased food and is vulnerable to market related shocks, especially those living near the Sudanese border. In July 2016, inflation of food prices reached a record high of 661 per cent. Across the country, there are high levels of food insecurity and about 51 per cent of the population currently lives below the poverty line (BRACED, 2016). The destruction, degradation and abandonment of pasture and croplands, and increased reliance on fisheries illustrate the impact of war and economic fragility on the country's environment.

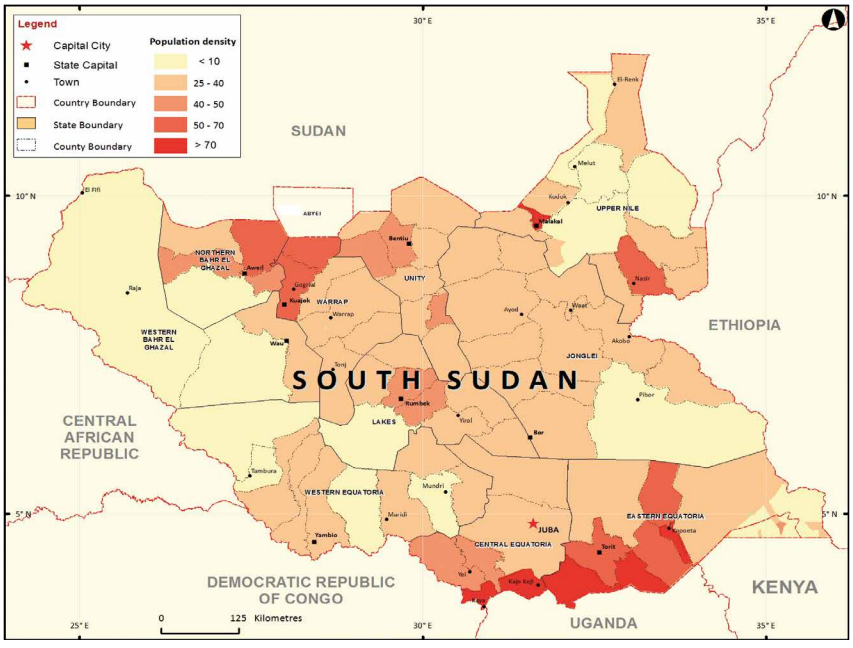
Two sisters in Kapoeta are selling greens.
Photo credit: Arshad Khan, UN Environment

1.5 Demographics

In mid-2017, the population of South Sudan was estimated at 13,091,132 based on the latest United Nations estimates (Worldometers, 2017). Jonglei is the most populous area, with 16 per cent of the total population, and Western Bahr el Ghazal is the least populous area with only 4 per cent of the total. The highest population densities are along the Nile River and their tributaries (Figure 8).

The majority of the population of South Sudan is young and lives in rural areas. About two-thirds of the population is under the age of 30 (World Bank, 2016c) and more than three quarters, or 81 per cent of people live in rural areas (RSS, 2010). In northern Bahr el Ghazal,

FIGURE 8: POPULATION DISTRIBUTION IN SOUTH SUDAN

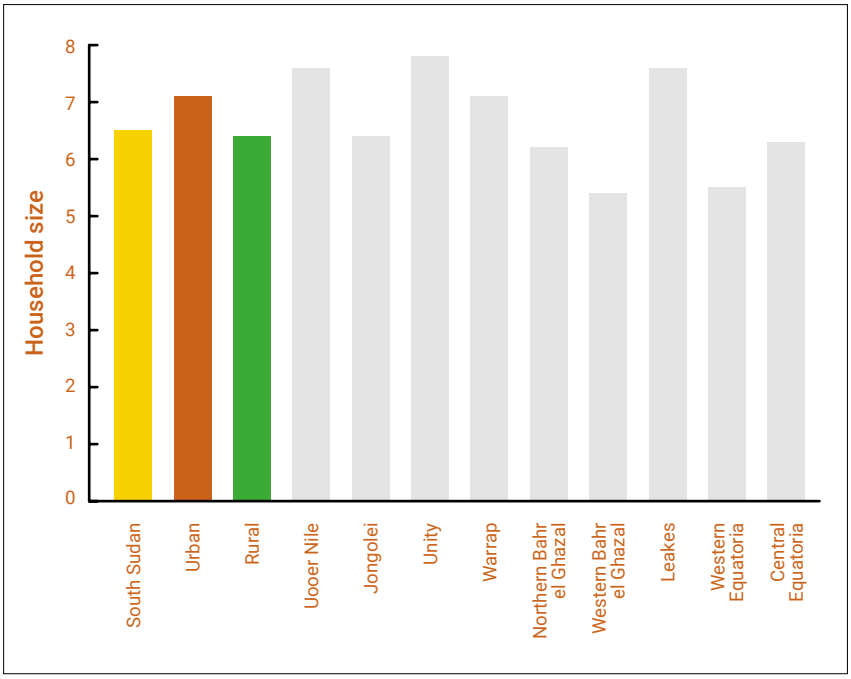


Map created by EPI with data from CIESIN, Columbia University, USA.

92 per cent of the population is rural while in Western Bahr el Ghazal, the proportion is 57 per cent (MOE, 2015). The main towns are Juba, the capital, Wau and Malakal.

In 2015, the average annual population growth was 3.53 per cent. The infant mortality rate is 105 (per 1,000 live births) and the maternal mortality rate is 2,054 (per 100,000 live births) (World Bank, 2016c). Households are large, with an average of 6.5 people living under one roof (NBS, 2012) (Figure 9); according to the country's 2010 Households Survey, in one out of ten households, there were more than ten members living together (RSS, 2010).

FIGURE 9: AVERAGE HOUSEHOLD SIZE, 2009



Source: (NBS, 2012)

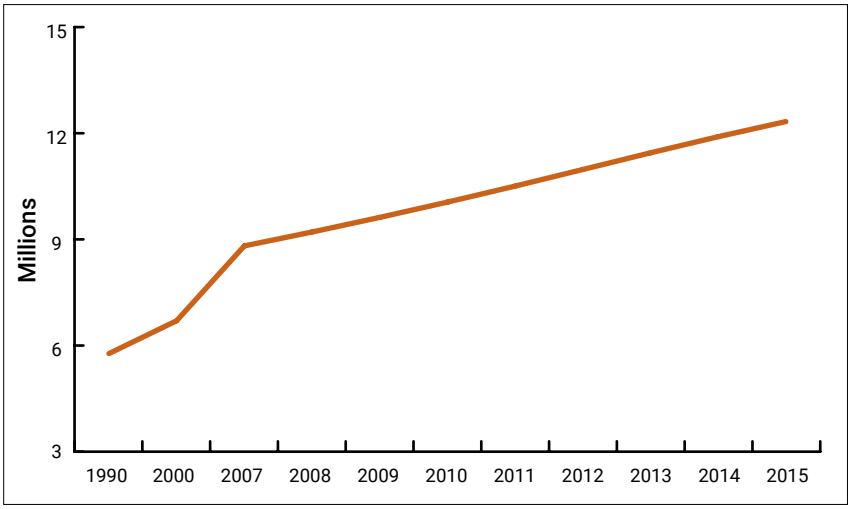
Population growth

After the signing of the 2005 CPA, a large number of returnees from neighbouring countries swelled population numbers in the South. With the emergence of the new country in 2011, there was a new influx of returnees and refugees, primarily from the North. It is estimated that between November 2010 and April 2011, 290,000 people returned to the newly forming country (Fernando & Garvey, 2013). The population of South Sudan grew from 8.26 million in 2008 to over 12.3 million by 2015 (CountryEconomy, 2015b) (Figure 10). At the same time, over 1.6 million people were displaced internally and over 616,000 people fled to neighbouring states (AfDB, 2016).

Buses bring southern Sudanese back to home regions. *Photo credit: ENOUGH Project/Flickr.com/ CC BY-NC-ND 2.0*

Most returnees and internally displaced people since 2005 went to live in urban areas and ended up in informal settlements, living in generally crowded and unsanitary conditions. This increase in numbers has put more pressure on the already scarce environmental and financial resource bases in the country's towns and cities due to improper land use and the over-exploitation of natural resources, especially through the cutting of wood for building purposes and fuel. Women and girls tend to suffer more from environmental degradation since it forces them to spend more time and energy fetching water and firewood (MOE, 2014).

FIGURE 10: POPULATION GROWTH IN SOUTH SUDAN, 1990-2015



Source: (World Bank, 2016b)

All South Sudan's states have been affected directly or indirectly by displacement during the current crisis. The recurring nature of the main displacement triggers, including sporadic outbreaks of conflict and acute food insecurity, means that many people have been displaced multiple times, particularly in Unity and more recently in the Equatorias. As of November 2016, around 212,000 Internally Displaced People (IDP) were sheltered in several locations including Bor, Juba, Maban, Malakal, and Wau. The sites are overcrowded. Access to safe water and sanitation facilities is inadequate, exposing populations to waterborne and communicable diseases. In addition, as illustrated by the images below, expansion of the IDP camps has also led to the degradation of the surrounding areas (IDMC, 2017). Generally, green colour represents vegetation, brown represents human settlements or fields, and dark blue represents water.

BOR INTERNALLY DISPLACED PEOPLE (IDP) CAMP, 2005

Bor Internally Displaced People (IDP) Camp, 2005
Data Source: DigitalGlobe

Bor Internally Displaced People (IDP) Camp, 2016
Data Source: CNES/Astrium

The above images show the population expansion of the Bor area due to displaced people between 2005 and 2016. Green colour generally represents vegetation, brown generally represents human settlements or fields and dark blue generally represents water.

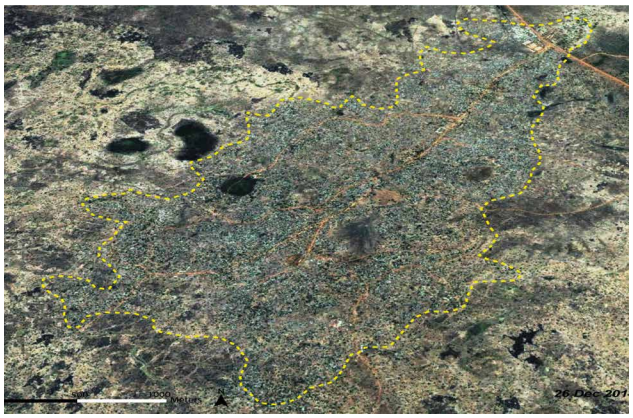
JUBA INTERNALLY DISPLACED PEOPLE (IDP) CAMP / PROCTECTION OF CIVILIANS (POC) AREA

Internally Displaced People (IDP) Camp near in UNMISS Tonging Compound, Juba. *Data Source: DigitalGlobe*

Internally Displaced People (IDP) Camp near Juba International Airport 2016. *Data Source: DigitalGlobe*

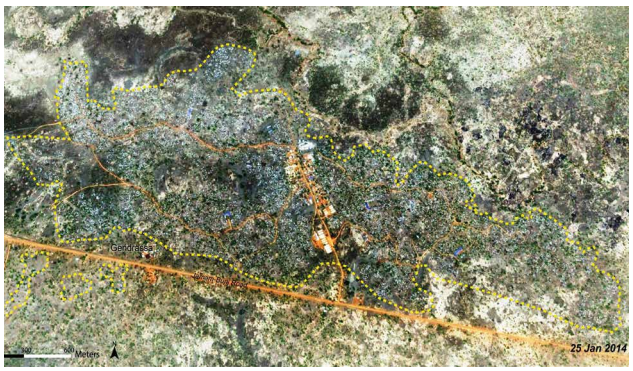
The above images illustrate the changes in just a two-year period around the Juba International Airport. Generally, the green colour represents vegetation, brown represents human settlements or fields and dark blue represents water.

MABAN REFUGEES CAMP

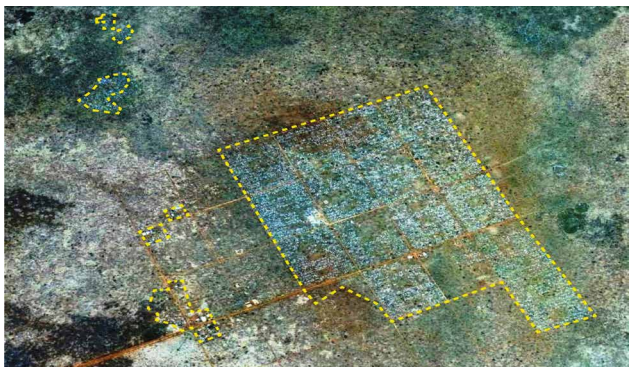


Batil Refugee Camp area in Maban County, 2014
Data Source: DigitalGlobe

Doro Refugee Camp in Maban County, 2014
Data Source: DigitalGlobe



Gendrassa Refugee Camp in Maban County, 2014
Data Source: DigitalGlobe



Kaya Refugee Camp in Maban County, 2014
Data Source: DigitalGlobe

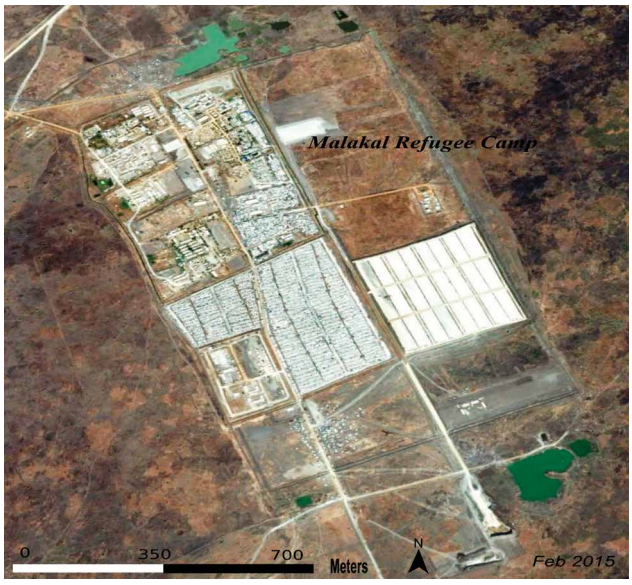
Maban, South Sudan, is home to four refugee camps, including Doro Camp, accommodating refugees who have fled the war in neighbouring Blue Nile State. As above, the green colour generally represents vegetation, brown represents human settlements or fields and dark blue represents water.

The conflict between the Uduk tribe and the Maban host community started in June 2016 when three people were killed from both communities. Violence erupted again in November and more than 12 people from the host community were killed. Tensions between the Maban host community and Blue Nile refugees have persisted since 2012, soon after refugees started fleeing the 2011 Blue Nile conflict to South Sudan. But the 2016 incidents mark the first time the Uduk ethnic community has been involved. From 2012 to 2015, sporadic conflicts, largely between the Ingessana tribe and host community, took place in three refugee camps in Maban (Kaya, Gendrassa and Yousif Batil) whereupon at least 100 people were killed.

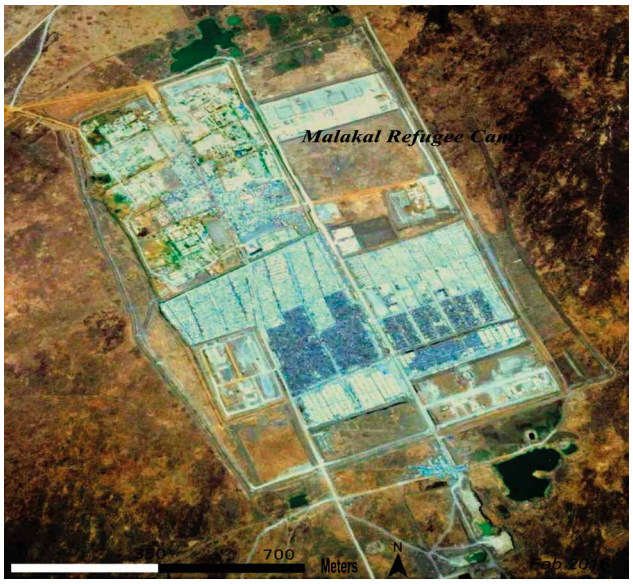
The root cause of the conflicts between the refugees and host community remains unclear. Several sources believe the conflicts largely stem over competition for limited resources. Many from the host community, for instance, resent the fact the refugees are receiving support from aid agencies while they do not receive consistent assistance despite the fact there are roughly 15,000 Maban locals internally displaced from the internal conflict of South Sudan, a local aid worker said.

MALAKAL IDP CAMP / POC AREA

Malakal POC Area , 2013
Data Source: DigitalGlobe



Malakal POC Area , 2015
Data Source: DigitalGlobe



Malakal POC Area 2016
Data Source: DigitalGlobe

Changes in the Malakal POC area 2013-2016. The images between 2015 and 2016 illustrate the destruction of the camp due to attacks by soldiers.

WAU INTERNALLY DISPLACED PEOPLE (IDP) CAMP

Wau Internally Displaced People (IDP) Camp, 2012
Data Source: DigitalGlobe

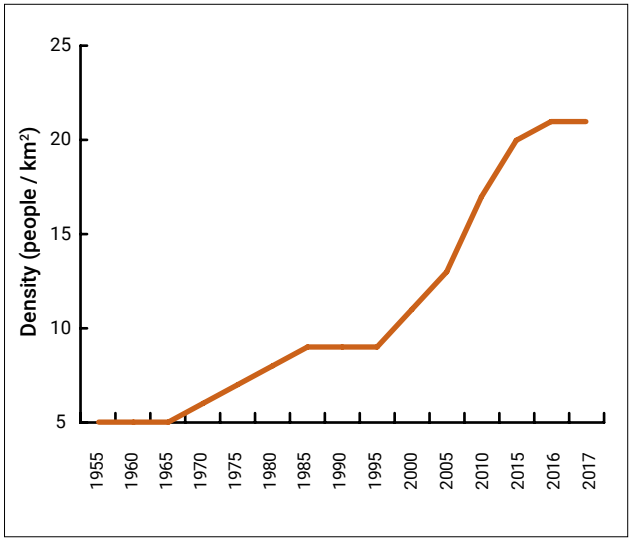
Wau Internally Displaced People (IDP) Camp / POC Area, 2016
Data Source: DigitalGlobe

The above figures illustrate the change in the Wau Internally Displaced People (IDP) camp between 2012 and 2016. Note the expansion north of the enclosed camp.

Population density

Population density is very low. In 2007, it was just 13 people per square kilometre, with 18 people for every square kilometre of cultivatable land, compared to 36 for sub-Saharan Africa (Fernando & Garvey, 2013). By 2017, the number had grown to 21 (Figure 11).

FIGURE 11: **TREND IN POPULATION DENSITY, 1991-2014**



Source: (World Bank, 2016b)

One of the settlements at Jie near Kapoeta
Photo credit: Arshad Khan, UN Environment

Poverty

The World Bank defines poverty as "pronounced deprivation in one or more dimensions of the welfare of an individual, such as limited access to health facilities, low human capital, inadequate housing infrastructure, malnutrition, lack of certain goods and services, inability to express political views or profess religious beliefs, etc." (World Bank, 2011). It reports that the incidence of poverty in the country has worsened over the past several years, increasing from 44.7 per cent in 2011 to 65.9 per cent in 2015 (World Bank, 2016a).

In South Sudan, poverty has many dimensions, including low consumption levels, poor health and education outcomes and inadequate access to markets (RSS, 2016b). In 2014, the Human Development Index ranked South Sudan 169th out of 188 countries and territories in terms of its long-term progress in three basic dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living. Between 2010 and 2014, the Human Development Index value of South Sudan declined by an annual average of about 0.15 per cent (UNDP, 2015).

The Government of South Sudan defines the national poverty line as 73 South Sudanese Pounds (SSP) per person per month and reports that 50.6 per cent of the population lives below this threshold. Poverty in urban areas is considerably lower than in rural ones: 24.4 per cent of the population compared to 55.4 per cent, respectively (Table 3) (RSS, 2016b).

TABLE 3: SELECTED POVERTY INDICATORS FOR SOUTH SUDAN

Indicator	South Sudan	Lower Middle Income Countries
Incidence of poverty (% of population)		
National average	50.6	41.1
Urban average	24.4	
Rural average	55.4	

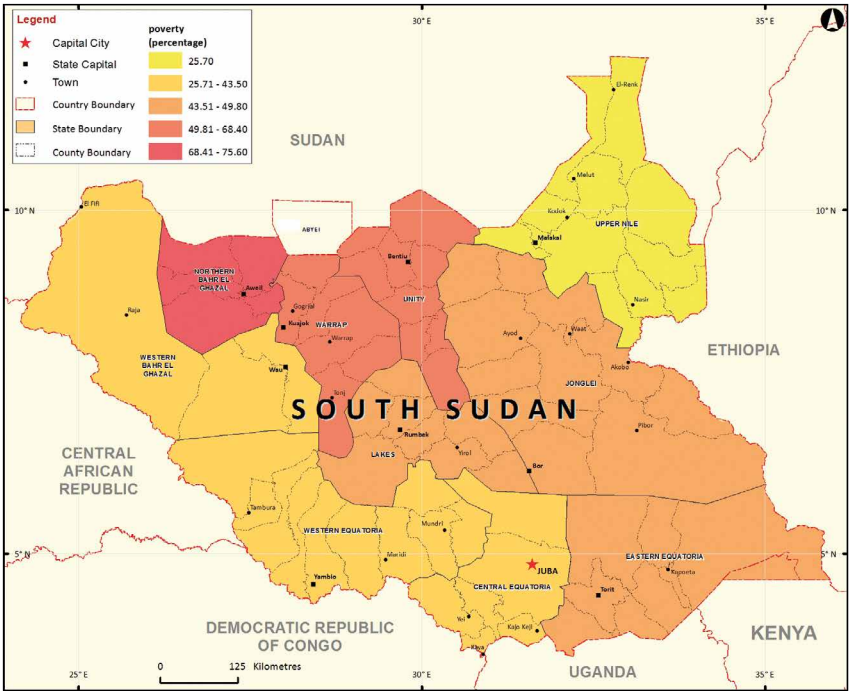
Source: (USAID, 2014)

Distribution of poverty

By region, poverty is highest in Northern Bahr el Ghazal (Figure 12). Fifty-nine per cent of female-headed households are poor compared to 48.1 per cent of those headed by males. Poverty levels decline significantly with higher levels of education; of households headed by an uneducated person, 55.4 per cent are below the poverty line compared to 26.4 per cent of those with some secondary education (RSS, 2016b).

In South Sudan, most people directly depend on being able to cultivate the land or graze their livestock on pastures, and collect water and fuel-wood from nearby sources. There are a variety of circumstances and events that can affect the environment, thereby disrupting livelihood activities and potentially

FIGURE 12: POVERTY BY STATE



Source: (RSS, 2016b)

worsening food scarcity or triggering a decline into poverty. They range from natural disasters, such as floods, droughts and fires, to livestock and crop diseases and pests, all of which can destroy or degrade the natural resources people need to survive. Droughts or floods affect over half the population of South Sudan and about 42 per cent are affected by crop diseases or pests (Table 4).

Conflict and insecurity in South Sudan are leading contributors to the disruption of livelihoods, including those related to the loss of environmental resources or their deterioration. The Famine Early Warning Systems Network expects food security, which is highly correlated to poverty, to deteriorate to extreme levels in 2017 in northern South Sudan because of reduced harvests, continued disruption of livelihood activities and persistent high staple food prices (FEWS Net, 2017). Indeed, as shown below, in early 2017, famine had become a national crisis.

TABLE 4: PROPORTION OF THE POPULATION AFFECTED BY VARIOUS EVENTS THAT CAN CONTRIBUTE TO WORSENING POVERTY

Type	Percentage of Population
Some shock	92
Drought / floods	56
Crop disease or pests	42
Livestock died or stolen	47
Severe illness or accident of household member	35
Death of household member	34
Fire	10
Robbery	11
Dwelling damaged	14
Severe water shortage	26
Other	4

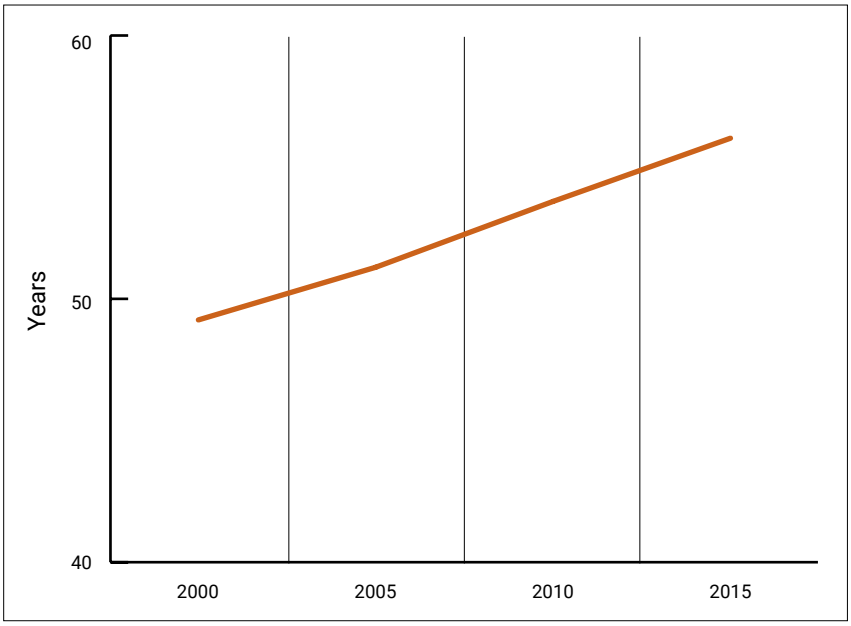
Source: (RSS, 2016b)

1.6 Health and public health

Although health indicators have been improving over the years, in 2014, life expectancy in South Sudan was still only 55 years (Figure 13).

Between 2005 and 2013, the under-five mortality rate declined from 140 to 99 deaths per 1,000 births. In 2013, the infant mortality rate was 64 deaths per 1,000 births, down from 87 in 2005 (Table 5) (USAID, 2014). Despite this progress, the infant mortality rate is the ninth highest in the world and the maternal mortality rate is the world's highest (UNESCO, 2013).

FIGURE 13: LIFE EXPECTANCY AT BIRTH (YEARS), 1960-2015



Source: (CountryEconomy, 2015a)

TABLE 5: KEY SOCIAL HEALTH DATA FOR SOUTH SUDAN, 2012-2014

Key Health-related Data	Unit	Value
Life expectancy (2014)	Years	55
Infant mortality (2013)	per/1,000 births	64
Under 5 mortality rate	per/1,000 births	99
Underweight children under 5 years old	%	34
Maternal mortality rate	per 100,000 live births	2,054
Access to clean drinking water (2012)	% with access	57
Access to health facilities	% without access	48
Number of doctors (2012)	Total	120
People between 15-49 years living with HIV (2013)	%	2.2

Source: (DANIDA, 2016); (USAID, 2014)

Malnutrition and food insecurity

Although the percentage of malnourished children under five (measured by weight) dropped from 32.5 in 2008 to 27.6 in 2014 (UN-OHRLLS, 2016), in 2017, as conflict continued to ravage the country, acute malnutrition had become a major, unprecedented public health emergency. The country faces the worst famine since fighting erupted more than three years ago (FAO, 2017b), with one in three children acutely malnourished in the southern part of Unity State in early 2017 (IPC, 2017b).

The agriculture sector has been a victim of chronic insecurity, poor infrastructure and lack of investment to such an extent that South Sudan is now a net importer of food, importing 50 per cent of its needs from Kenya and Uganda. The annual cost of total food imports is estimated at between US$200 and $300 million (AfDB, 2013). Food shortages are common and although the country aims to attract investors to develop industrial farming, the security situation is a barrier.

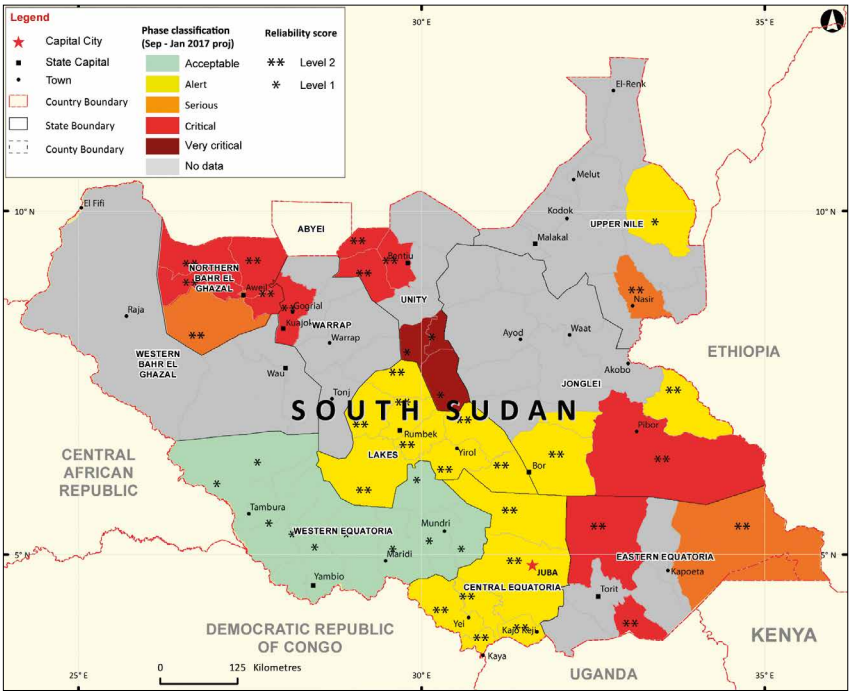
People lined up to get food in Bentiu. *Photo credit: Benno Muchler/VOA/Wikimedia Commons*

The Integrated Food Security Phase Classification, a set of international standardised tools to classify the severity and magnitude of food insecurity, estimated that from February to April 2017, 4.9 million people, representing about 42 per cent of the population, would be severely food insecure. It projected that by the height of the 2017 lean season in July, severe food insecurity would increase to 5.5 million people, or 47 per cent of the national population (IPC, 2017a). The most affected areas are the Unity, Jonglei and Upper Nile States (IPC, 2017a).

In early 2017, widespread insecurity, displacement, lack of access to services, low sanitation provision, the utter lack of hygiene practices and the ongoing economic crisis underpinned the high levels of acute malnutrition. In the Greater Equatoria region, especially in Greater Central Equatoria, the disruption of the 2016 agricultural season exacerbated these factors contributing to an atypical situation of worsening nutrition in the post-harvest season. A state of Global Acute Malnutrition existed in 15 per cent of counties for which there were data while others experienced levels over 30 per cent (IPC, 2017b). The United Nations declared a famine in part of the country, a declaration that is unusual despite the regular occurrence of food shortages in South Sudan. The criteria for the technical definition of a state of famine are that one in five households in a given area face extreme food shortages, 30 per cent of the population is malnourished, and the death rate exceeds 2 people per 10,000 per day (NASA, 2017).

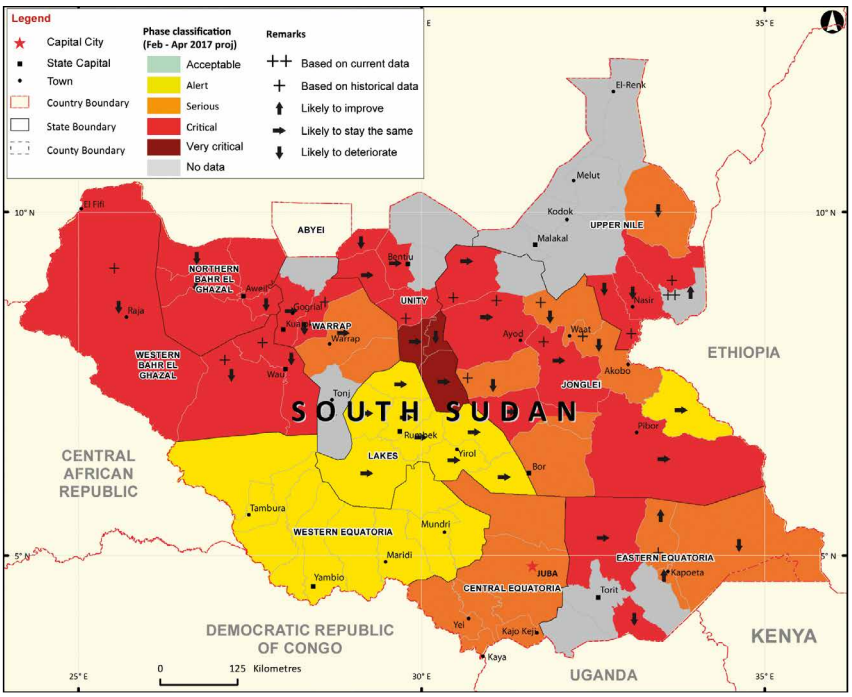
Figures 14 and 15 compare projections of acute malnutrition between September 2016 to January 2017 and February to April 2017, showing the increase in numbers of people in a malnutrition crisis.

FIGURE 14: THE DISTRIBUTION OF ACUTE MALNUTRITION, SEPTEMBER 2016-JANUARY 2017



Source: (IPC, 2017b)

FIGURE 15: THE DISTRIBUTION OF ACUTE MALNUTRITION, FEBRUARY-APRIL 2017



Source: (IPC, 2017b)

South Sudan would benefit from implementing the Framework for Action for Food Security and Nutrition in Protracted Crises (CFS-FFA) on how to mitigate the threat to food security and nutrition during protracted crises (FAO, 2017a). Some of these principles are listed in Box 1.

BOX 1: RELEVANT FRAMEWORK FOR ACTION FOR FOOD SECURITY AND NUTRITION IN PROTRACTED CRISES PRINCIPLES

PRINCIPLE 1: Meet immediate humanitarian needs and build resilient livelihoods

PRINCIPLE 2: Focus on nutritional needs

PRINCIPLE 4: Protect those affected by or at risk from protracted crises

PRINCIPLE 5: Empower women and girls, promote gender equality and encourage gender sensitivity

PRINCIPLE 9: Contribute to peacebuilding through food security and nutrition

PRINCIPLE 10: Manage natural resources sustainably and reduce disaster risks

Source: (FAO, 2017b)

Healthcare and disease

The most common illnesses in South Sudan are malaria, measles, tuberculosis, meningitis and cholera. There are also many endemic tropical diseases, including schistosomiasis (bilharzia), visceral leishmaniasis (kala-azar), dracunculiasis (Guinea worm disease) and African trypanosomiasis (sleeping sickness) (Encyclopaedia Britannica, 2016).

The incidence of HIV/AIDS among the population aged 15-49 is just below 3 per cent, which is lower than neighbouring countries. Knowledge of the disease is limited, however, and the rate of contraceptive use among women aged 15-49 is 4 per cent, the second-lowest in the world, making this disease a potential danger (UN-OHRLLS, 2016); (UNESCO, 2013).

There is a high and recurring incidence of gastrointestinal diseases, the result of drinking contaminated water, due to the lack of proper sanitation, sewage systems, waste-water treatment facilities and access to improved water sources (MOE, 2014).

Nationally, 58.7 per cent of the population had access to improved sources of drinking water in 2014; the proportion in urban areas was 66.7 and in rural areas, it was 56.9 (UN-OHRLLS, 2016). For about 38 per cent of the population, the drinking water source is a 30-minute walk one way (World Bank, 2016c). Only 6.7 per cent of the country's total population has access to improved sanitation; in urban areas, the proportion is 16.4 per cent while in rural areas it is merely 4.5 per cent (UN-OHRLLS, 2016).

Dispensing medicines at Warrap State Hospital.
Photo credit: UN Photo

In South Sudan, 99 per cent of households use solid fuels for cooking, exposing women and children to the risk of respiratory disease from inhaling small particulates from smoke. Pneumonia is the leading cause of death among children under the age of five years (RSS, 2010).

It is likely that climate change will increase the population's vulnerability to certain climate-related health issues, including increases in illness and outbreaks of pests and disease (BRACED, 2016). The Intergovernmental Panel on Climate Change expects that it will increase the risk of insufficient access to safe water and improved sanitation, food insecurity and limited access to health care and education (IPCC, 2014b).

Less than 40 per cent of the population has access to any form of modern healthcare (UNESCO, 2013) and only 17 per cent of children are fully immunised (World Bank, 2016c). For over a third of the population, the closest healthcare facility is a 30 to 60-minute walk away (NBS, 2012).

Scene from the water collection point.
Photo credit: UNDP South Sudan/Brian Sokol

1.7 Education

Literacy

The level of education in South Sudan is low. About 27 per cent of the population over the age of 15 is literate. The literacy rate among men is much higher than it is for women: 40 per cent versus 16 per cent (World Bank, 2016c); (Table 6). Literacy rates also vary by age bracket, income, location and level of urbanisation. According to the 2010 Household Survey, 16 per cent of women between the ages of 15 and 19 are literate compared to 11 per cent of those aged 20-24 (RSS, 2010). During the war, educational opportunities were reduced and as a result, many children and youth did not acquire basic literacy, numeracy or life skills, and lack these skills today (MGEI, 2012). Women in Central Equatoria and those in higher-income households are relatively more educated than those elsewhere in the country. Warrap and Unity have the lowest female literacy rates in South Sudan (RSS, 2010).

A scene from the classroom.
Photo credit: Sustainable sanitation via Foter.com / CCBY

School attendance

Primary school attendance is very poor all over the country even though urban and higher-income families have better attendance rates (RSS, 2010). More than half of the country's primary and lower secondary school-age children, up to age 15, do not attend school, ranking South Sudan as the country with the highest proportion of children out of school in the world (UNICEF, 2016); (Walters, 2016). Only 1.8 per cent of girls are enrolled at the secondary level and just 56.6 per cent of the country's teachers are trained to teach secondary level classes (MGEI, 2012). Between 2011 and 2014, the pupil-teacher ratio in primary education was 50 to 1 (UN-OHRLLS, 2016).

Educational opportunities are likely to remain extremely restricted since many schools have been closed due to the ongoing conflict. For example, between December 2013 and August 2015, more than 800 schools closed, and although more than 6,000 schools are still functioning, they all lack resources (Walters, 2016).

TABLE 6: KEY EDUCATION DATA FOR SOUTH SUDAN

Indicator	Unit	Value
Adult literacy rate (2013)	% of population	27
Female literacy rate (2010)	% of women who are literate	16
Male literacy rate (2010)	% of men who are literate	40
Primary education (Gross primary school attendance) (2014)	%	41
Girls in primary education (attendance of girls of school of age) (2011)	%	34

Source: (DANIDA, 2016); (RSS, 2010)

Indigenous knowledge

In terms of environmental knowledge, conflict and disruption has no doubt generally eroded traditional, local indigenous knowledge that has historically guided pastoralists and agro-pastoralists in protecting and sustainably using the natural resources that underpin their livelihoods. Indigenous knowledge is non-formal education that is handed down from generation to generation, and refers to "all accumulated experiences that people have transformed into means of production and management of their surrounding environments" (PSAP, 2013). Furthermore, climate change will likely disturb weather patterns that traditionally inform the pastoral calendar, thus challenging pastoralists and agro-pastoralists in their decisions, since their livelihoods are intimately connected with the seasonal weather conditions in which they raise their livestock (PSAP, 2013). In addition to forgotten local knowledge, other cultural attitudes and norms that act as socio-economic drivers of environmental change include practices in agro-pastoralism, shortcomings in the land tenure system and traditional farming practices such as shifting cultivation, and slash and burn.

Vocational education

In addition to indigenous knowledge, formal vocational education for farmers and herders is a valuable form of learning in a society dominated by subsistence agriculture (Box 2).

BOX 2: SUPPORT AND EDUCATION FOR FARMERS

The Food and Agriculture Organization of the United Nations (FAO) hosts Farmer Field Schools (FFS), which promote sustainable management practices, including training in modern farming techniques, water conservation, marketing opportunities and pest and disease control. Rural Extension agents from FAO set up and guide farmer groups where the knowledge of all participants is respected, shared, discussed and analysed by the group. Since 2008, FAO has established more than 500 such schools around the country, thus helping South Sudanese farmers to generate both food and livelihoods (FAO, 2013).

In March 2016, an international group for technical cooperation with developing countries set up a multi-purpose agricultural farmers' vocational training centre (ACAV Adoroba) in Morobo county of the Yei River state of South Sudan. The facility's goal is to support more than 200 farmer cooperative groups in the area to improve crop production, further their formal education, their health and environmental management skills, and provide better sanitation (ST, 2016). One of the challenges in South Sudan is the balance between farming and traditional pastoralism. Some experts fear that policies that favour the expansion of agriculture at the expense of pastureland may lead to the collapse of pastoral life and the loss of important indigenous knowledge (PSAP, 2013).

FAO Community Farming project. *Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0*

1.8 Technology

The long years of conflict have also affected technological advancement in South Sudan, which lags behind other African countries in the adoption of modern technologies. In 2010, the number of Internet users per 100 people was only 7, a proportion that rose to about 16 by 2014. Over the same period, the number of mobile cell phone subscriptions rose from 14.4 to 24.5 per 100 people (UN-OHRLLS, 2016). By comparison, in 2014, 74 out of 100 people in Kenya were subscribed to cell phone service (World Bank, 2016d). Even ownership of low-tech equipment is extremely low in South Sudan; for example, only an average of 5 per cent of the population lives in a household with a television (Table 7).

TABLE 7: **PROPORTION OF THE POPULATION LIVING IN HOUSEHOLDS OWNING SELECTED TECHNOLOGIES (PERCENTAGE), 2009**

Locale	Television/ satellite dish	Radio/ transistor	Phone	Computer	Refrigerator	Fan	Air cooler/ conditioner
South Sudan	5	28	19	1	1	2	1
Urban	24	59	65	4	7	9	3
Rural	1	22	10	0	0	0	0

Source: (NBS, 2012)

1.9 Conclusion

South Sudan is endowed with abundant environmental assets. The country falls almost entirely within the Nile River Basin and is covered by extensive grasslands, potentially productive croplands, vast wetlands and tropical forests. Its natural assets include significant agricultural, mineral, timber and energy resources. The climate is mostly hot and dry, with seasonal rains that allow for two or three harvests a year in the county's green belt. Apart from oil, however, its natural resources are largely unexploited and only 4.5 per cent of its potential arable land is cultivated.

The state of ongoing strife in South Sudan is a major impediment to good governance that would ensure the productive use of its natural resources and the protection of its environmental assets. Indeed, the lack of strong, effective institutions for peacefully managing disputes or competing claims to local power and control and ownership of livestock and natural resources is an important factor in the ongoing conflict. As succinctly expressed by FAO, "the proliferation of small arms, the politicisation of ethnicity, a legacy of weak property rights, lack of economic diversification and over-reliance on oil" are other important contributing drivers.

Environmental degradation is both a result of, and a contributing factor to the protracted conflict and insecurity in South Sudan. For example, decades of war have made the country's economy extremely fragile, leading to a state of hyperinflation. Thus, a large proportion of the population depends on purchased food and is vulnerable to market-related shocks. When fighting resumed in July 2016, local- level, inter-tribal conflict disrupted the traditional migration routes of pastoralists. This often forced them to compete with established farming communities, leading to livestock mortality, declines in the amount and viability of land those farmers can cultivate and reduced harvests. Along with disrupted market access, the loss of natural resources that people need to survive has badly affected many livelihood activities. The influx of returnees and internally displaced people since 2005 has also been an important driver of inappropriate land use and over-exploitation of natural resources. The increase in numbers has put more pressure on the already scarce environmental and financial resources in the country's towns and cities, especially through the cutting of wood for building purposes and fuel. Thus, conflict, poverty and environmental degradation are significant factors in the crisis of severe food insecurity and famine affecting the country at the time of writing.

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Dry landscape of Bahr el Ghazal.
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CHAPTER 2
CLIMATE CHANGE: IMPACTS, ADAPTATION AND MITIGATION

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2.1 Climate change in South Sudan

In 2014, the Intergovernmental Panel on Climate Change reported that anthropogenic greenhouse gas emissions were the highest in history and that the impacts on human and natural systems are widespread the world over (IPCC, 2014b). It reported a warming trend across the African continent over the last 50 to 100 years. The Famine Early Warning Systems Network also found an increase in seasonal mean temperatures in many areas of Ethiopia, Kenya, South Sudan and Uganda over the last 50 years. The Intergovernmental Panel on Climate Change scenarios predict that the mean annual temperature rise over Africa is likely to exceed 2°C by the end of this century (IPCC, 2014a).

The Intergovernmental Panel on Climate Change warned that continued greenhouse gas emissions would increase the likelihood of severe, pervasive and irreversible impacts on people and ecosystems. Substantially reducing emissions in a sustained way (mitigation) and acting to adapt to climatic changes are the only ways to limit the risks (IPCC, 2014b).

Although South Sudan contributes very little to global greenhouse gas emissions, it is highly vulnerable to the impacts of rising temperatures and increased rainfall variability due to climate change, since pastoralists and farmers rely heavily on seasonal rains. Indeed, according to the 2017 Climate Change Vulnerability Index, South Sudan ranks among the five countries in the world most vulnerable to the impacts of climate change. The others are the Democratic Republic of the Congo, the Central African Republic, Haiti and Liberia (Reliefweb, 2017). Climate change is thus a significant driver of environmental change in South Sudan.

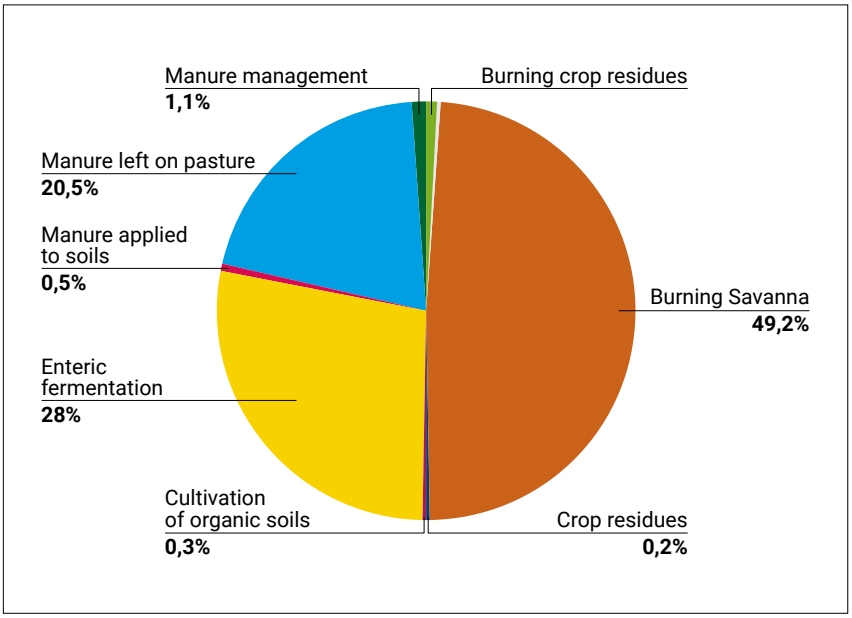
A woman wades through contaminated flood water in Bentiu South Sudan 2014. *Photo credit: BRACED Consortium, South Sudan.*

Greenhouse gas emissions

The state of conflict, insecurity, limited capacity and lack of financial resources in South Sudan have made collecting data on greenhouse gas emissions challenging. Given the low level of industrial development, however, they are likely to be relatively small, with most emissions derived from land use, land-use change and forestry, as well as the agriculture sector (Figure 1) (RSS, 2015).

Diesel generators for energy and the transportation sector also contribute to overall emissions. The United Nations Food and Agriculture Organization estimates that in 2013, South Sudan emitted 1,448 kilotonnes of CO_2 and per capita emissions were 0.1 metric tonnes (FAO, 2016).

FIGURE 1: EMISSIONS BY AGRICULTURAL ACTIVITY, CO_2 EQUIVALENT, 1990-2014

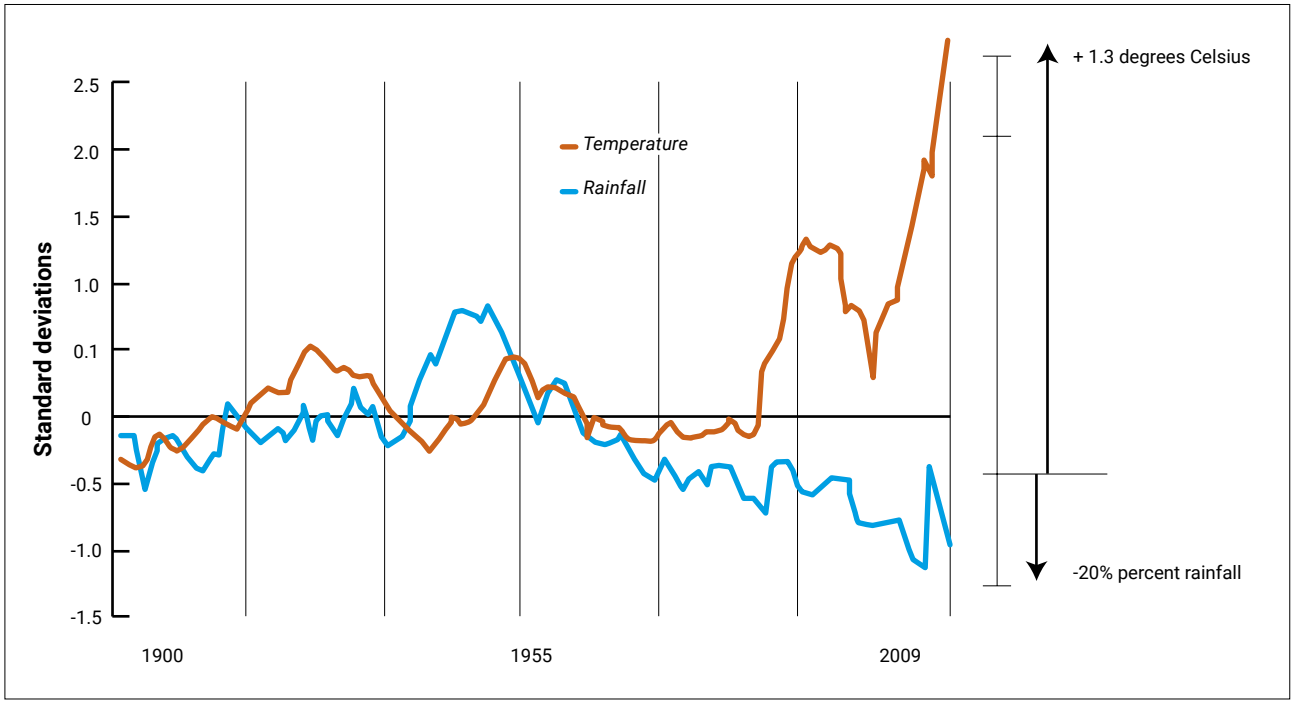


Source: (FAO, 2016)

Trends in temperature and rainfall

The meteorological service of South Sudan suffers from inadequate weather and climate forecasting equipment (BRACED, 2016). Available data show that temperatures in South Sudan are rising and the weather is becoming drier (Figure 2); (Richardson, 2011); (USAID, 2016). It is likely that these changes are related to global climate change.

FIGURE 2. TREND IN TEMPERATURE AND RAINFALL, 1900-2009



Source: (Richardson, 2011)

Since the mid-1970s, average temperatures have increased by 1°C, while some regions have experienced temperature rises of up to 0.4°C per decade (BRACED, 2016). It is projected that average temperatures in South Sudan will rise by 1°C by 2060, with lower increases in the south (USAID, 2016). Table 1 presents an overview of the climatic changes that have already occurred in South Sudan (left-hand column) and the predicted changes in those parameters in the future (right-hand column).

TABLE 1. CLIMATE CHANGE TRENDS IN SOUTH SUDAN, PAST AND FUTURE

Historical change Historical climate trends include:	**Future change** Projected changes include:
In the 2000s, much of South Sudan was over 2 °C warmer on average 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 increases in the world.	By 2060, South Sudan will get warmer by about 1 °C over and above 2020 values.
Rains in South Sudan have declined by 10-20 per cent since the mid-1970s.	Average rainfall is expected to decline by 10-20 per cent for any observed warming of more than 1 °C.
A general trend of delayed and shortened rainy seasons over the years has been reported in many places.	Between 1960 and 1989, the area of 858,000 km^2 receiving more than 500 mm rainfall declined; if present rainfall trends coxntinue, by 2025, it is expected to reduce to 249,000 km^2 (30 per cent of the area).

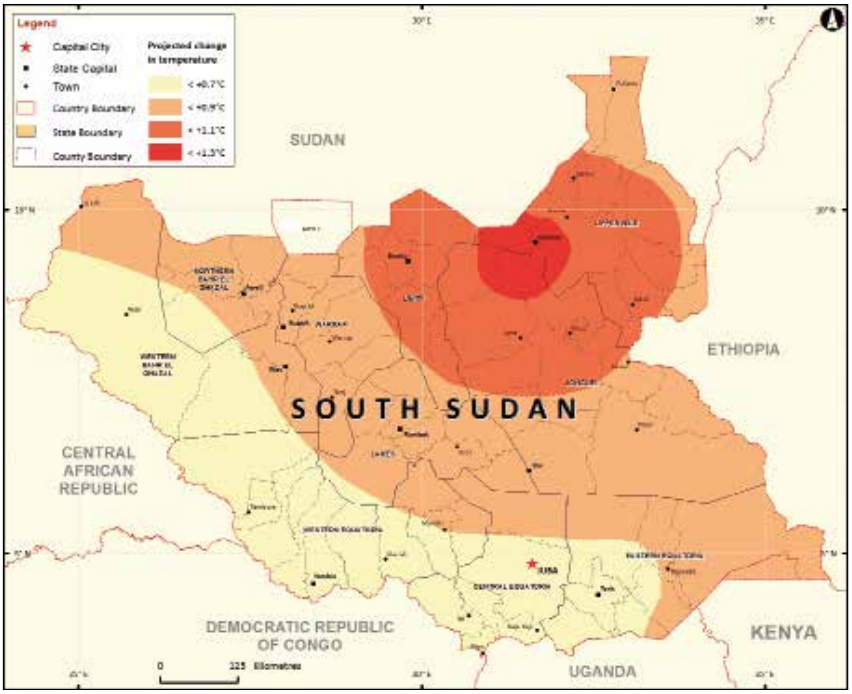
Source (USAID, 2016)

Figure 3 is the result of adding temperature increases already observed in South Sudan with predicted increases through 2039. Most of the area shown will experience an increase of between 0.5 °C and 1.3 °C from 1960 to 2039 (UNEP, 2011).

Warming trends lead to decreased evapotranspiration and declining precipitation. Since the mid-1970s, South Sudan has experienced a decline of between 10 to 20 per cent in average precipitation as well as increased variability in the amount and timing of rainfall from year to year (USAID, 2016). There is also some evidence that the onset of rain now occurs one month later (BRACED, 2016).

Figure 4 is a map constructed by-combining observed reductions in rainfall since 1960 with predicted reductions between 2010 and 2039. Some areas of South Sudan would see reductions of over 150 mm in rainfall between June and September. Most of this change (63 per cent) already occurred between 1960 and 2009 (UNEP, 2011).

FIGURE 3. PROJECTED CHANGE IN TEMPERATURE FOR SOUTH SUDAN, 1960-2039



Source: (USAID, 2016)

Dried up river. *Photo credit: Arsenie Coseac/Flickr.com/ CC BY-ND 2.0*

Dry landscape of Bahr el Ghazal. *Photo credit: Nonviolent Peaceforce/Flickr.com/CC BY-NC-ND 2.0*

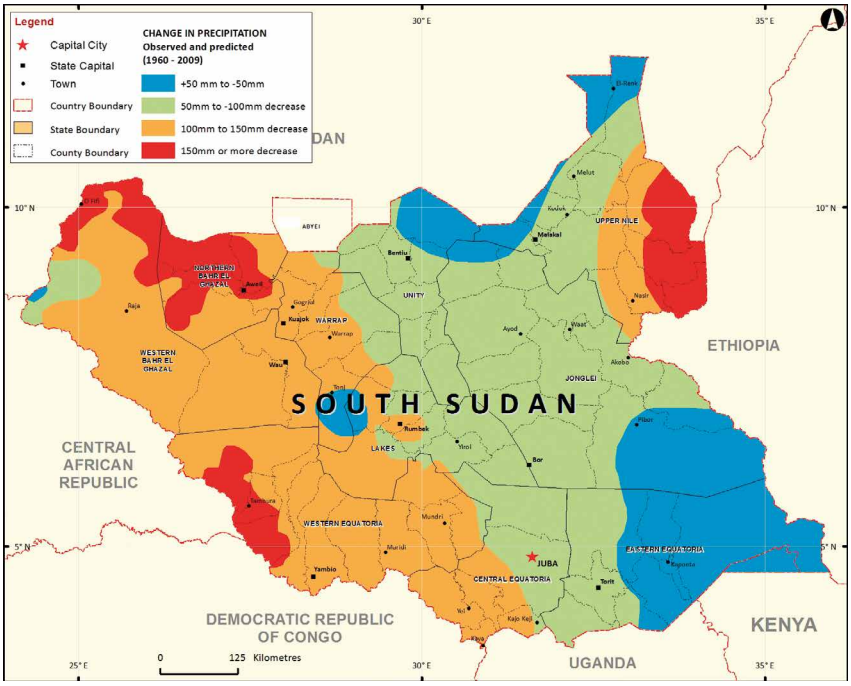
If the trend continues, by 2025 it is likely that the drying experienced in the north-eastern regions of the Upper Nile, Jonglei and Eastern Equatoria will extend across the country, potentially affecting Bahr el Ghazal, Tonj and Unity in the North and Central Equatoria in the South (BRACED, 2016). The Intergovernmental Panel on Climate Change regional models suggest that by the end of the 21st Century, most of Uganda, Kenya and South Sudan will experience drier weather in August and September (IPCC, 2014a).

Although human conflict triggered the worst food shortages in early 2017, as described earlier, drought has exacerbated the problem. After two consecutive wet seasons with poor rainfall in the Horn of Africa in 2016, forecasters predicted depressed rainfall in the 2017 March-May rainy season.

Figure 5 shows the extent of drought during a 12-week period ending on February 15, 2017. The brown areas experienced the highest degree of evaporative stress. The Evaporative Stress Index indicates how much water is evaporating from the land surface and the leaves of plants, and is an early sign that plants are stressed. The 2017 drought is linked to weak La Niña conditions in the Pacific in 2016, causing reduced rainfall in East Africa (amongst other effects), which was likely intensified by areas of unusually cool water in the western Indian Ocean and unusually warm water in the eastern part of the basin (NASA, 2017).

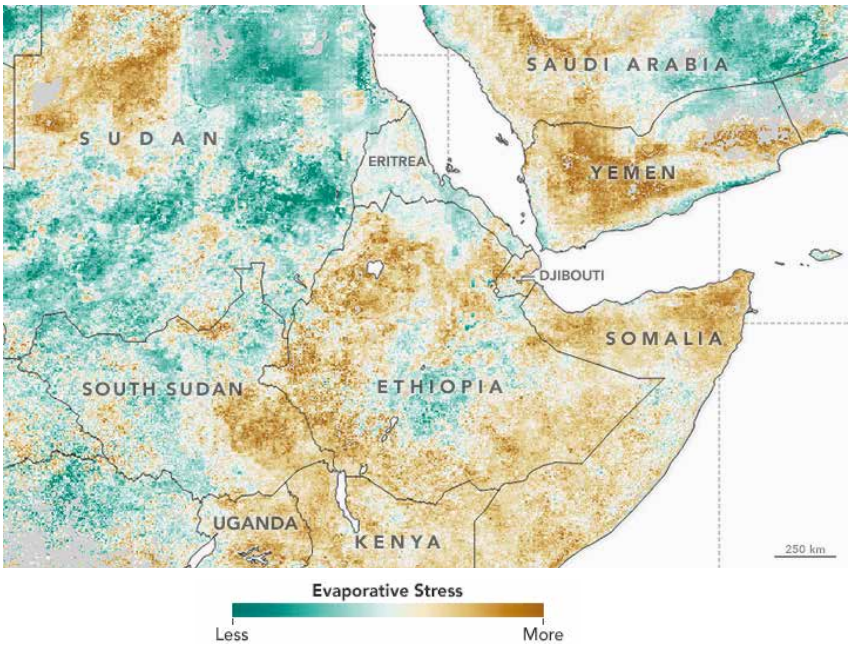
In addition to the scientific evidence of climatic change in South Sudan, agro-pastoralists and farmers have noticed the delayed onset of rains, prolonged dry spells at the beginning of the wet season and an increase in the intensity of rainfall events, resulting in more erratic and heavy flooding (Murray, 2016).

FIGURE 4. PROJECTED CHANGE IN PRECIPITATION FOR SOUTH SUDAN, 1960-2039



Source: (UNEP, 2011)

FIGURE 5: DROUGHT AREAS IN THE GREATER HORN OF AFRICA



Source: (NASA, 2017)

2.2 Impacts

The population of South Sudan is extremely vulnerable to the impacts of increased warming and unpredictable and reduced rainfall, given its fragile state and its extreme dependence on rain-fed subsistence agriculture. A warmer climate and drier weather have food security implications, reducing crop harvests and pasture availability and intensifying the impacts of droughts and floods. If the current climate change trend continues, rain-fed agriculture may become untenable.

Climate change will exacerbate the development challenges already stemming from decades of political instability, poverty and persistent food insecurity. Already, in 2007 and prior to the independence of South Sudan, the United Nations Environment Programme projected that expected changes in weather patterns would exacerbate existing household vulnerabilities and exceed current coping mechanisms, further limiting poor people's capacity to maintain sustainable livelihoods throughout the former Sudan. The projections were published in the *Sudan Post-Conflict Environmental Assessment*, which analysed livelihood activities in the major agro-ecological zones to understand climate change vulnerabilities and identify the most vulnerable areas in the country. It also assessed the climatic risks and impacts of climate change on key economic sectors that support these livelihoods.

Box 1 summarises the projected impacts on agriculture for the southern part of the former Sudan.

BOX 1. CLIMATE RISKS AND POTENTIAL IMPACTS IN THE AGRICULTURE SECTOR (CROP PRODUCTION, LIVESTOCK AND FISHERIES)

A · Increased temperatures and reduced rainfall could lead to loss of productive agricultural lands and decline in fish diversity and size.

B · Seasonal patterns in South Sudan have become erratic and rain-fed agricultural areas have decreased significantly in the northern and eastern parts of South Sudan as a result of climate change.

C · Reduced rainfall in combination with increasing temperatures could make reliance on rain-fed agriculture no longer feasible with significant impacts on food security.

D · Increased rainfall variability — onset and length of rainy season — have led to delayed planting and earlier harvest leading to a shortened growing season and reduced yields and/or crop failure.

E · Increased incidence of drought and flooding have led to loss of pasturelands and reduced access to water resources for livestock.

F · Climate change in general is likely to increase local conflicts over land use and resources between and amongst pastoralists and farmers.

G · Prolonged dry seasons can lead to reduced water quality in stagnating water ponds.

H · Multiple stressors faced by livestock will interact with climate change and variability to amplify the vulnerability of livestock-keeping communities; pest and disease pressure on livestock is expected to increase as a result of climate change.

I · 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 next years and exacerbate tensions and conflicts.

J · Rising temperatures and increased rainfall variability will reduce water quantity, which may lead to reduced crop production and food availability for humans, livestock, wildlife and fish.

K · 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 higher evaporation. It will also result in the water table dropping and reduction in wetland size.

L · A decline in water resources as a result of increased dry spells and low rainfall, will have the potential to increase conflicts over rights and access to water at a national and regional level.

Source: (UNEP, 2007)

Observed and likely impacts: recent findings

Numerous recent reports and analyses on the impacts of climate change in South Sudan support the 2007 findings. They agree on the likely impacts on pastoralism, farming and other livelihoods, as well as the effects of a changing climate on ecosystems and their services, summarised as follows:

1. The delay and shortening of rainy seasons that farmers depend on for crops and water for livestock;
2. Perennial rivers drying up due to higher evaporation, resulting in seasonal rivers;
3. As a result of increased river seasonality, the loss of fish species and reduced fish size;
4. Reduced water tables in boreholes;
5. Reduced water quality in stagnating ponds due to a prolonged dry season;
6. Reduced access to water for drinking and sanitation;
7. A southward shift in the Sahel, leading to declines in tree density and diversity of tree species, limited tree growth and increased incidence of wildfires;
8. Increased soil degradation due to wildfires as well as water erosion, with impacts on crops, wildlife and livestock;
9. Habitat degradation for livestock and wildlife due to vegetation degradation and desertification (in the north and south-east of South Sudan);
10. Reduced habitat and spawning areas for fish in rivers;
11. Reduction of wetlands, impacting food and fodder availability for livestock and wildlife;
12. Lower agricultural revenues per hectare due to unpredictable rains and soil degradation;
13. Competition for drinking water between people and livestock; and
14. Increased conflict over rights and access to water and natural resources.

Sources: (RSS, 2012); (USAID, 2016); (RSS; UNEP; GEF, 2016)

In 2014, the World Food Programme's (WFP) Vulnerability Analysis and Mapping department published an analysis of climate risk impacts on food security and livelihoods (WFP, 2014). It describes the negative consequences of long-term climate projections on food security and livelihoods in the 11 Livelihood Zones in South Sudan, as mapped by the Famine Early Warning Systems Network. This map is featured in this report's chapter on Agriculture (Chapter 4). Livelihood Zones are *"geographic areas in which households obtain their basic survival needs, notably food and cash income, in relatively similar ways"* (FEWS NET, 2013).

The WFP report provides a resilience profile of each of the zones. It concludes that the agro-ecological zones in central and northern regions of the country are the most vulnerable to the negative impacts of more intense rainfall, and it makes a number of recommendations to enhance resilience and adaptability to climate-change impacts, as described in the following section.

Dry season poses tough challenges for the cattle keepers. *Photo credit: BBC World Service/Flickr.com/ CC BY-NC 2.0*

2.3 Adaptation

The United Nations Framework Convention on Climate Change defines adaptation to climate change as *"adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change. Adaptation activities span five general components: observation; assessment of climate impacts and vulnerability; planning; implementation; and monitoring and evaluation of adaptation actions"* (UNFCCC, 2014b).

THE WFP REPORT (2014) RECOMMENDS THE FOLLOWING CLIMATE-CHANGE ADAPTATION MEASURES:

- Continue to invest in flood protection, improved drainage, construction of flood barriers, improved retention areas and prevention;
- Introduce a well-coordinated seed-distribution programme adapted to the realities of each affected area to provide resettled people with short-maturing seeds and rudimentary tools to help revive farming activities. Any introduction of flood-resistant crops should be carried out with extensive consultation of the community and follow-up by the relevant government agencies;
- Some pastoralist communities should be helped to re-stock high value animals, such as cattle, goats and sheep;
- There is need to build, improve and maintain flood defences, such as river channels, raised embankments, floodwalls and culverts to reduce flood risk;
- Develop and provide accurate flood forecasting and disseminate easier-to-understand warning alerts so that people may act on them; and
- The most effective flood prevention measure is land use planning (WFP, 2014).

Concern Worldwide's livelihoods team walk through Kiir Yum Kiir's sorghum crop in Aweil 2014. *Photo credit: Concern Worldwide*

The report also highlights the risks to agricultural markets from climate-change impacts. It recommends stabilising food markets during shocks through subsidies; improving road infrastructure to enhance access to markets; implementing early-warning systems to provide timely information about roads and routes that are unreachable due to climate-related disasters; and introducing other innovative mechanisms, such as insurance schemes, that can also help reduce some of the negative effects of climate change on food security (WFP, 2014).

Food security and climate resilience

Food assistance for assets (FFA) is one of the WFP's key initiatives aimed at addressing the most vulnerable people's immediate food needs while improving communities' long-term food security and resilience. By helping communities to enhance the use and management of their own resources, WFP is supporting a shift away from reliance on humanitarian assistance to achieve more sustainable food security. In South Sudan, WFP is supporting nearly 500,000 people through FFA activities.

Asset creation work is led by communities, based on their priority needs, to help households develop agricultural livelihoods, construct community infrastructure, manage natural resources and adapt to climate change. In all FFA projects, WFP supports communities to asses any potential environmental impacts of asset creation work – such as deforestation during clearing of crop-land – and to develop mitigation measures, such as developing tree seedling nurseries to help reforestation. Support through FFA is aiding vulnerable households to build and make better use of productive assets in a way that promotes community ownership, sustainability and stewardship of natural resources.

Households in the outskirts of Aweil, the capital of Northern Bahr el Ghazal State have experienced years of heavy flooding, which has persistently destroyed crops, and prevented access to health and other services. With support from WFP, the people around Aweil have joined together to build a 2 metre high dyke road to ensure they can pass through flooded areas, even during the heaviest rains.

Through community based planning supported by WFP, the dyke road was identified by community members as their biggest priority to address the challenge of annual flooding. With the new road, household farms are protected from widespread flooding, ensuring that farmers are able to plant and harvest crops to help meet household food needs. The road also ensures that the community is not cut off from basic services, such as schools and health centres, during the rainy season which typically lasts for five months of the year.

Throughout the construction, the participants were supported with training to learn the best way to construct the dyke road to ensure its longevity – such as implementing culverts to allow natural water flow, and use of local grasses to help stabilise the road and reduce erosion. In addition, the community-led nature of the project has helped to ensure local participation and ownership of the dyke road.

Thanks to the project, households around Aweil will have improved access to local markets, health facilities, and social services. The project has also promoted social cohesion since the dyke road passes through several communities, bringing the same protection and increased accessibility to services to all.

The dyke road near Aweil is one of many similar projects supported by WFP in South Sudan, which is helping households to manage and benefit from their natural environment. (Courtesy: WFP office in South Sudan) (Fominyen, 2015)

Government policies and plans

The Government of the Republic of South Sudan has already prioritised climate change and identified measures needed to address climate change impacts now and in the future; it is supporting climate change adaptation at different policy levels and at institutional and community levels (Karani & Owino, 2017). Table 2 provides the relevant climate-change provisions contained in some of the country's various policies, laws and plans related to the environment and Table 3 lists the most important institutions responsible for climate change adaptation in South Sudan.

At the national level, the most significant adaptation goals are set out in the National Adaptation Plan of Action (NAPA) for South Sudan. Under the United Nations Framework Convention on Climate Change, NAPAs provide "a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs to adapt to climate change – those for which further delay would increase vulnerability and/or costs at a later stage" (UNFCCC, 2014a). South Sudan's NAPA specifies five priority activities (referred to as Priority Adaptation Projects) for effective climate change adaptation across the five identified priority thematic areas, namely: i) Environment; ii) Water Resources; iii) Agriculture; iv) Disaster Risk Reduction; and v) Policy and Institutional Framework (RSS; UNEP; GEF, 2016).

TABLE 2. POLICIES, LAWS AND PLANS EXPLICITLY ADDRESSING CLIMATE CHANGE IN SOUTH SUDAN

Policies, laws and plans	Relevant climate change provisions
Draft Environmental Protection Policy 2013	Provides policy guidance on how to address climate change issues by developing a national strategy and climate change policy, and mechanisms for adaptation and mitigation. It encourages the formulation and enactment of laws that maintain and preserve ecological functions and the integrity of forests, that conserve biological diversity and, water and soil resources in fragile ecosystems and that promote passive and non-invasive forest management activities as alternative sources for income generation (livelihood improvement).
Draft Environmental Protection Bill 2013	Aims to protect the environment in South Sudan and to promote ecologically sustainable development that improves quality of life. It provides for the preparation of a National Environmental Action Plan and 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 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 meant to mitigate the adverse effects and impacts from climate change in the medium and long-term. These include the development of community adaptive capacity for climate change through the development of crops that can resist droughts and floods.
The Agriculture Sector Policy Framework for 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 on plant genetic resources.
Policy on Agriculture and Livestock 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.
Fisheries Policy 2012 - 2016	Aims at responding to climate change and natural disasters through research and development of strategies. Provides a framework to manage fisheries resources to maximise production and avoid overfishing and to prevent destruction of wetlands and promote their conservation.
Draft Policy on Wildlife Conservation and Protected Areas 2012	Recognises climate change as a global reality with serious implications for natural ecosystems and wildlife resources. The policy calls for designing coping strategies to address the impacts of climate change on habitats and populations of wildlife species.
Forest Policy 2014	Recognises the critical role played by forests in providing "critical environmental services, water catchment and in mitigating climate change." The forestry policy proposes the ratification of the UNFCCC so that the country can benefit from the Clean Development Mechanism (CDM). It also proposes establishing a designated national authority "to facilitate the flow of climate change benefits to South Sudan." The policy also emphasises the need for measures "so that South Sudan can access financing under REDD." (REDD refers to Reducing emissions from deforestation and forest degradation). It calls for delineation and gazettement of forests to attain a national forest cover of 20 per cent of land area.
The 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 draining to, or above, any water facility forming part of a water supply or any catchment, lake, reservoir, aquifer, wetland, spring, or any 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; manage floods and droughts, and mitigate water-related disasters and establish appropriate management structures, including mechanisms for inter-sectoral coordination and stakeholder participation.
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 right conflicts and conflicts over pastures and water points.
National Adaptation Plan of Action 2016	The NAPA lists priorities and guiding principles for adaptation projects to address the urgent and immediate climate change concerns in South Sudan

Source: (Tiitmamer, 2015)

TABLE 3. KEY INSTITUTIONS RESPONSIBLE FOR CLIMATE CHANGE ADAPTATION IN SOUTH SUDAN

Institution	Roles and responsibilities
Ministry of Environment and Forestry	Tasked with developing policy and regulatory frameworks on environment and forestry. The Directorate of Climate Change and Meteorology in the Ministry develops and implements programmes to address climate change issues and coordinates the implementation of South Sudan's obligations under the UNFCCC and the Convention on Biodiversity (CBD).
Ministry of Wildlife Conservation and Tourism	Manages protected areas (national parks and game reserves) and protects, conserves and manages wildlife resources in South Sudan through the Wildlife Service.
Ministry of Agriculture and Food Security	Its mandate is to develop and implement policies, objectives and strategies to develop South Sudan's agricultural sector to improve food security and contribute to economic growth and environmental sustainability, and to facilitate and encourage the equitable and sustainable development of improved livelihoods. It exercises its role through the Directorate of Research and Training and the Directorate of Agriculture and Extension services.
Agricultural research institutes	The key institutes established under the Ministry of Agriculture and Food Security are the Yei Agricultural Research Centre (YARC); Parataka Agricultural Research Centre (PARC); and Halina Agricultural Research Centre. They are involved in testing varieties of seeds, including seeds that can resist droughts.
Ministry of Finance and Planning	Allocates financial resources to government ministries and agencies, thus enabling them to respond to disasters such as floods and drought. It has an important role in climate change adaptation.
Ministry for Energy and Dams	Plans and provides power generation, transmission and distribution facilities to industrial and domestic consumers through the South Sudan Electricity Corporation (SSEC), the implementing body of the Ministry whose mandate is to execute the Ministry's policies, strategies and plans for availability, accessibility and affordability of electricity.
Ministry of Water Resources and Irrigation	Responsible for managing water resources and developing water policies, strategies and plans, such as the Irrigation Development Master Plan and the Water Resources Utilisation and Development Master Plan.
Ministry of Livestock and Fisheries	Charged with livestock and fishery policy development. The Directorate of Veterinary Services is responsible for preparing and enforcing laws governing livestock diseases control/eradication and the safety of food 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 fisheries, among other disciplines. Universities include Dr. John Gerang 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 developing fishery resources through training and research, while the forestry centre is involved in providing practical skills to manage forests in a sustainable manner.
Ministry of Humanitarian and Disaster Management (MHDM)	Responsible for policy decision-making on disaster risk reduction at the national level. Its mandate is to oversee all humanitarian work in South Sudan. It is composed of the Directorate of Administration and Finance; the Directorate of Planning, Coordination, Monitoring and Evaluation; and the Directorate of Disaster and Management.
South Sudan Relief and Rehabilitation Commission (SSRRC)	This is the operational arm of the MHDM, responsible for implementing policies made by the Ministry under the Directorate of Disaster Management at the national level and through SSRRC's representatives at the levels of states and counties. It is involved in establishing an early warning system at national and state levels.
Ministry of Foreign Affairs and International Cooperation	It is 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 the Republic of South Sudan.
South Sudan Directorate of Meteorological Service (SSMS)	The SSMS has re-established climate stations to deliver information on actual weather, forecast weather, seasonal outlook and climate.
South Sudan Seed Council	This council has been proposed to coordinate the implementation of the seed policy.
South Sudan Food Security Council	Has been proposed by the 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 policy on forestry to administer, regulate and supervise forestry activities in South Sudan.
Community based organisations (CBOs)	Under the National Environment Policy, CBOs are expected to play a pivotal role in advocacy on sustainable management of biodiversity and ecosystems through mobilising and sensitising local people and ensuring that the concerns of the underprivileged are integrated in to the national development plans.

Sources: (MOE, 2015); (Tiitmamer, 2015)

2.4 Mitigation

Along with adaptation, mitigation is one of the two fundamental methods for the international community to address climate change under the United Nations Framework Convention on Climate Change. Mitigation involves "human interventions to reduce the emissions of greenhouse gases by sources or enhance their removal from the atmosphere by "sinks". A "sink" refers to forests, vegetation or soils that can reabsorb CO_2" (UNFCCC, 2009).Thus, climate change mitigation refers to efforts to reduce or prevent greenhouse gas emissions. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient or changing management practices or consumer behaviour.

Given the present low level of greenhouse gas emissions in South Sudan, the country's aim is to proceed with economic development in a sustainable manner. In the report of its Intended Nationally Determined Contributions that South Sudan presented to the United Nations Framework Convention on Climate Change, the Government explains its intention to realise its abatement potential, as follows:

"South Sudan strives to be a newly industrialised, middle-income country by 2040. This development trajectory is expected to result in increased emissions from the energy sector. However, South Sudan intends to develop clean energy whenever possible, with deliberate efforts by the Government towards enhancing hydroelectric, geothermal, wind, solar and other clean energy development. Climate-change impacts continue to slow down the attainment of its national development goals. South Sudan will continue making investments with both domestic and international resources to adapt to climate change and realise its abatement potential" (RSS, 2015).

When operational, the Environment Policy Framework and Environmental Bill are expected to address the drivers of environmental degradationand contribute towards mitigating climate change. However, the country estimated that around US$50 billion would be required for mitigation and adaptation actions across sectors up to 2030 (RSS, 2015); (UNDP, 2017).

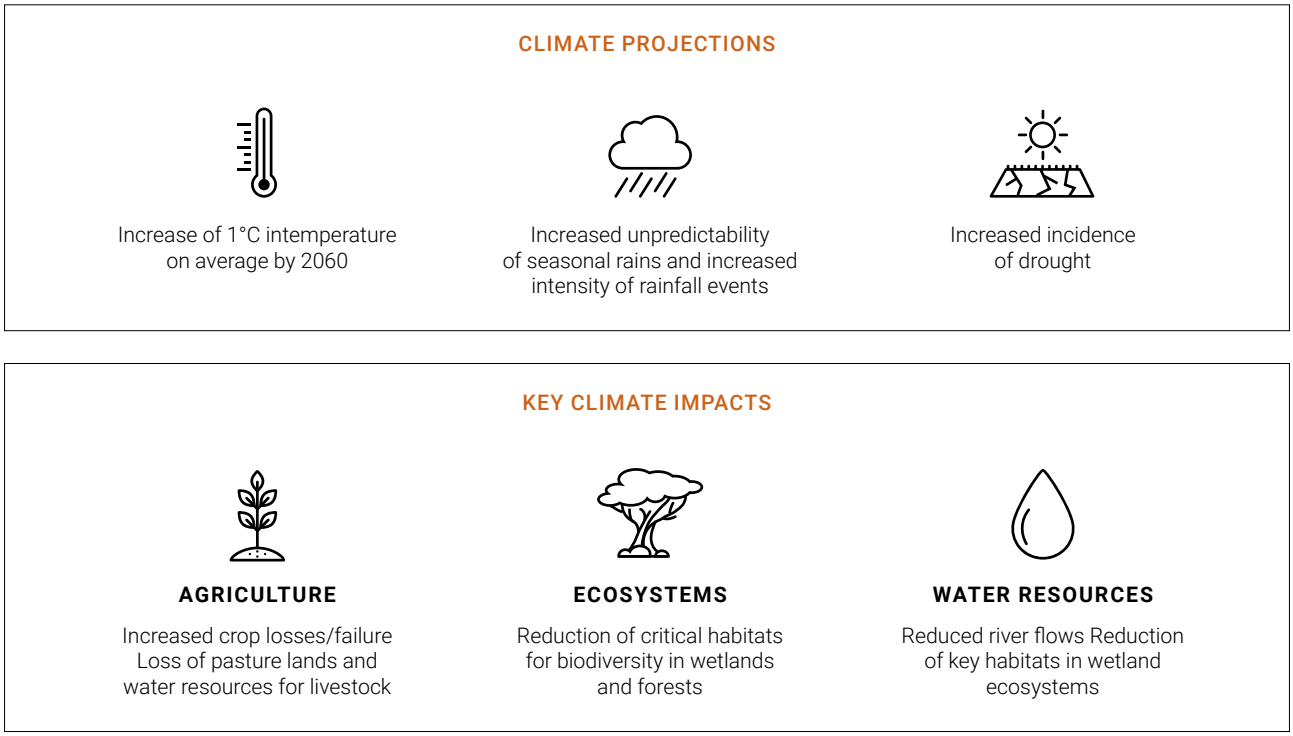
Solar panel at Abiriu Haffir. *Photo credit: Arshad Khan, UN Environment*

2.5 Conclusion

Thus, although South Sudan contributes very little to global greenhouse gas emissions and its development trajectory promises to focus on clean energy, it is highly vulnerable to the impacts of rising temperatures and increased rainfall variability due to climate change. Between the 1970s and the 2000s, the country's central and southern regions experienced one of the world's highest increases in temperatures (as much as 0.4°C per decade). By 2060, South Sudan overall will get warmer by about 1°C over and above 2020 values.

This warming trend has already affected the country's rainfall patterns. Since the mid-1970s, its average precipitation declined between 10 to 20 per cent and the variability in the amount and timing of rainfall from year to year also increased. Average rainfall is expected to decline by 10-20 per cent for any observed warming of more than 1°C.

FIGURE 6. **CLIMATE PROJECTIONS**



Source: (USAID, 2016)

These changes make South Sudan one of the five countries in the world most vulnerable to the impacts of climate change, which are likely to be devastating. Almost 80 per cent of households depend on crop farming or animal husbandry as their primary source of income, and these farmers and pastoralists rely heavily on seasonal rains, but if the current climate change trend continues, rain-fed agriculture may become unsustainable. In turn, loss of livelihoods will increase conflict over rights and access to water and natural resources. South Sudan needs to achieve political stability and legalise and implement its draft policies and plans so that it can act on its climate change adaptation and mitigation priorities.

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Poor road network: road between Thiet and Tonj.
Photo credit: Steffen Emrich/Flickr.com/CC BY-ND 2.0

CHAPTER 3
NATURAL HAZARDS AND DISASTER RISK REDUCTION

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3.1 Introduction

The United Nations Office for Disaster Risk Reduction defines a natural hazard as a natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage, adding that human activity that degrades the environment can exacerbate natural hazards by heightening their intensity, severity and frequency (ISDR, 2009).

Natural hazards can be categorised as geophysical: earthquakes, volcanos, landslides, avalanches, tsunamis; meteorological: storms, cyclones, hurricanes, typhoons, blizzards; hydrological: floods, storm surges; climatic: droughts, extreme temperatures, wildfires; and biological: epidemics, infestations (WVI, n.d.).

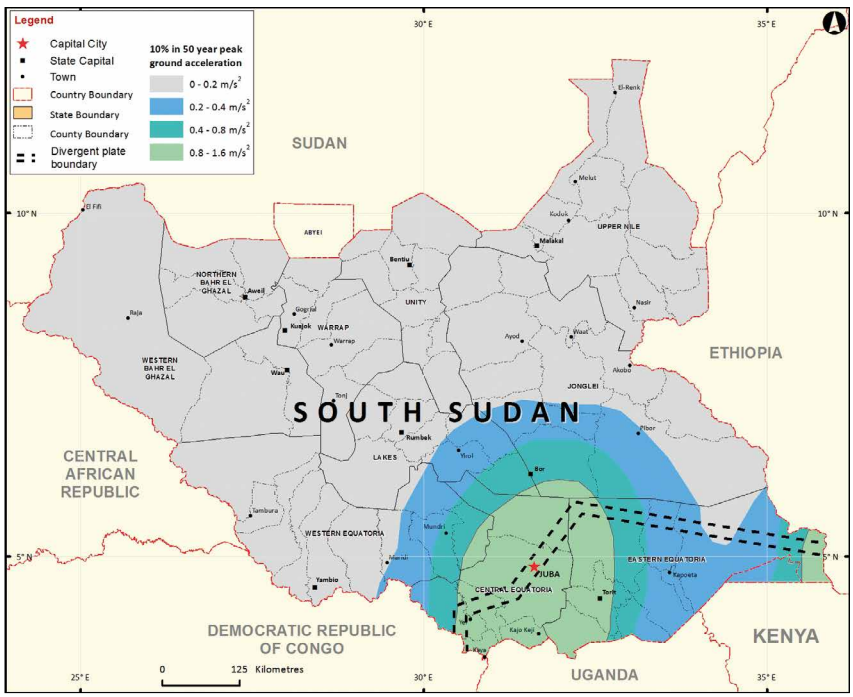
Flooded Aweil. *Photo credit: UN Photo/Tim McKulka*

Geological hazards

South Sudan is part of the East African Rift system, a 3,000-km long continental rift originating in the Cenozoic Era. It extends from the Afar triple junction, between the horn of Africa and the Middle East, to western Mozambique. Earthquakes and volcanic eruptions occur throughout the East African Rift system and are characterised by mainly shallow earthquakes due to the earth's crust rupturing and tearing apart, and volcano-tectonic earthquakes.

South Sudan is situated in the northern part of the western branch of the Afar triple junction, comprising the West Nile Region. Figure 1 shows the risk of seismic activity in South Sudan and Table 1 lists the most recent earthquakes that occurred in the country.

FIGURE 1. SEISMIC RISK



Source: (Hayes, et al., 2014)

TABLE 1. THE MOST RECENT EARTHQUAKES IN SOUTH SUDAN

Place	Date	Magnitude
130 km from Kapoeta, Eastern Equatoria	2014, February 11	4.4
72 km from Juba, Central Equatoria	2010, May 01	4.4
103 km from Kapoeta, Eastern Equatoria	2007, December 27	3.9
86 km from Juba, Central Equatoria	2006, March 09	4.4

Source: (Earthquake Track, 2017)

Hydro-meteorological and climatic hazards

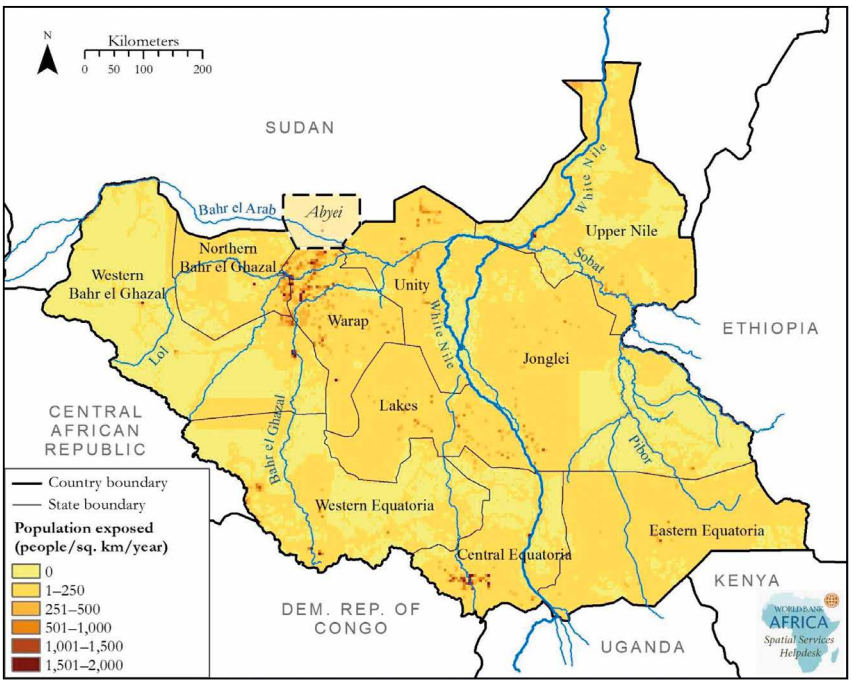
The climate of South Sudan is characterised by extremes and it regularly experiences drought, torrential rains and seasonal flooding (IMPACT, 2016). As previously mentioned, global climate change is exacerbating these natural hazards. Erratic rainfall has become more frequent, leading to unpredictable and more severe flooding. Seasonal patterns have been disrupted, and floods and droughts can now occur in the same season. The northern regions of the country, already subject to prolonged dry periods, were affected by a severe drought in 2011 (BRACED, 2016).

Droughts

Droughts are also regular events in South Sudan, but now the country is generally experiencing substantially warmer and drier weather. Warmer temperatures due to climate change decreases evapotranspiration, which can lead to more frequent droughts (USAID, 2011). Figure 2 shows the number of people exposed to drought every year in South Sudan.

In the dry season, shallow or otherwise accessible groundwater may provide crucial water reserves in-times of drought, enabling the growth of a dry season crop. The availability of groundwater reserves may also help to defend against or resolve the frequent conflicts that arise during the dry season between migrating herdsman and existing communities (Fernando & Garvey, 2013) (Box 2).

FIGURE 2: POPULATION ANNUALLY EXPOSED TO DROUGHT IN SOUTH SUDAN



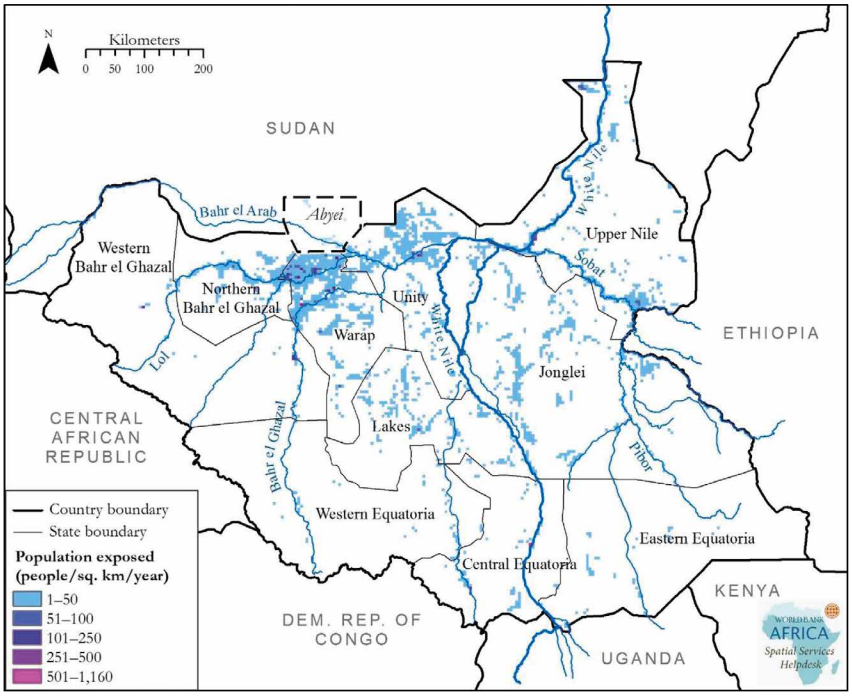
Source: (Fernando & Garvey, 2013)

Dry season livestock watering in Aweil. *Photo credit: BRACED Consortium, South Sudan.*

Floods

Flooding occurs naturally during every rainy season from May to October (Figure 3). Severe floods can destroy homes, schools, crops and livestock, and disrupt transportation and the provision of basic services, threatening the lives and livelihoods of local communities (SINA, 2016) (Box 1). Extensive seasonal flooding, which can cover between 10 km^2 and 30,000 km^2, occurs in the Sudd wetlands and along the rivers that flow into it. The floodwaters provide critical water and forage resources for livestock and they recharge groundwater reserves.

FIGURE 3: POPULATION ANNUALLY EXPOSED TO FLOODS IN SOUTH SUDAN



Source: (Fernando & Garvey, 2013)

BOX 1. FLOOD VULNERABILITY IN NORTHERN BAHR EL GHAZAL AND WARRAP

In 2016, the Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) consortium conducted an assessment of the vulnerability, adaptation, mitigation and resilience to climate change of the flood-prone river catchments of Northern Bahr el Ghazal and Warrap. Livelihood activities in the region are adapted to the seasons. In the dry season, people derive income from selling firewood, charcoal or grass; in the rainy season, they depend on agricultural labour; and during times of flooding, they sell fish and other wild foods. Seasonal floods and occasional droughts are normal events in the region. Traditionally, people had adopted seminomadic lifestyles as an adaptation to the destructive effects of floods. They also plant crops early and construct small dykes, raised tukuls (traditional housing) and elevated housing compounds as adaptation strategies. In the last few decades, however, the rains have come later, have been more intense and have broken riverbanks earlier.

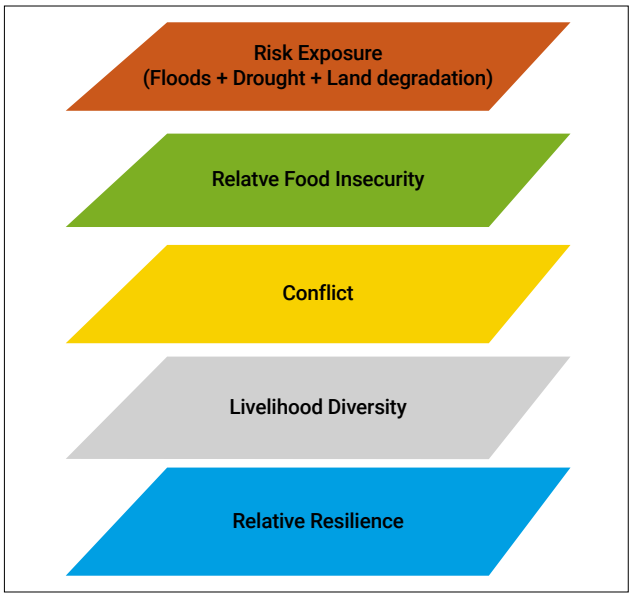
As a result, these coping mechanisms are insufficient. Some of the assessment's key findings include the following:

- A later and more intense rainy season leading to earlier floods and flash flooding;
- The most critical impact is that crops are damaged or destroyed before they are harvested;
- The extreme floods also damage or destroy housing, and disrupt access to healthcare and education;
- Often the excess flooding brings more fish to eat or sell, however, as well as more grass for cattle grazing and water for household and livestock use.

3.2 Impacts

Natural hazards such as floods and droughts are exacerbated by the impacts of the changing global climate as well as other drivers of environmental change, such as population growth and poverty, and by associated environmental stressors such as land degradation, wetland losses, livestock diseases and crop pests, amongst many others. Together, they have detrimental effects on livelihoods in South Sudan, which are so dependent on environmental assets and conditions. Figure 4 shows a way to visually portray the combined effect of multiple environmental stresses that exacerbate naturally occurring hazards such as floods and drought. It is taken from a World Food Program (WFP) assessment that developed resilience profiles for the livelihood zones of South Sudan using this conceptual framework.

FIGURE 4. WFP CONCEPTUAL FRAMEWORK USED TO DEVELOP A RESILIENCE PROFILE



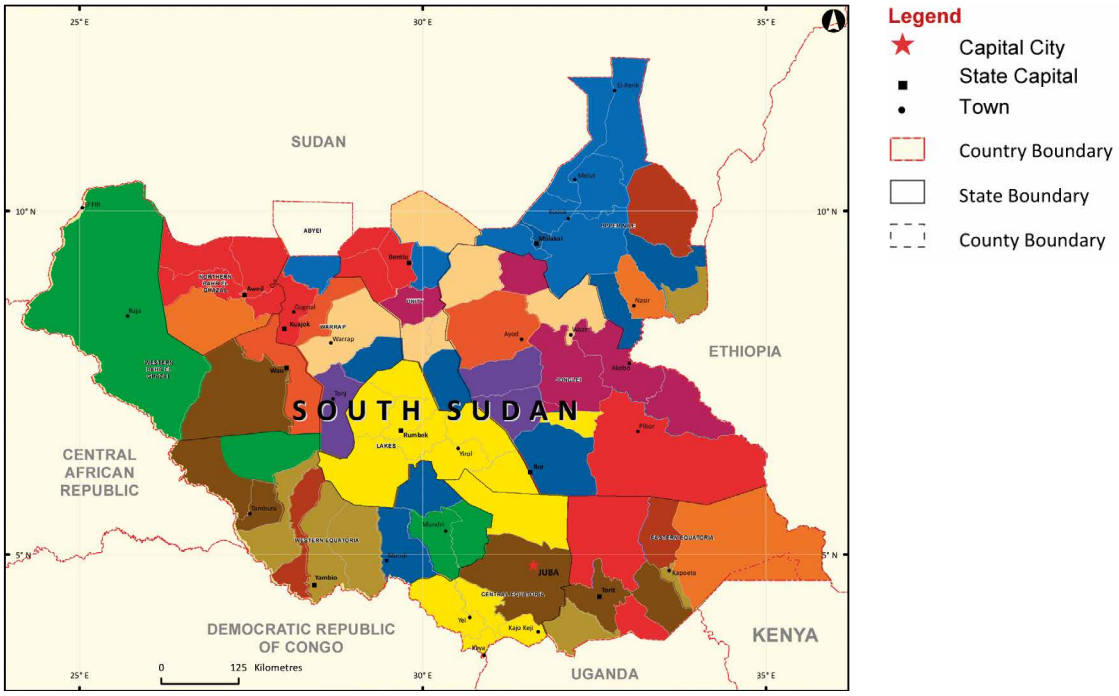
Source: (WFP, 2014)

Using spatial analysis and data on the intensity or level of population exposed to each of the natural hazards in the study (floods, drought and land degradation), the assessment produced a map of 10 category levels of exposure to the three hazards (Figure 5; (WFP, 2014)). Floods have the worst devastating impact compared to other hazards and are thus given more weight in the analysis.

The semi-arid area in livelihood zone SS05 on the map, where dry spells occur more frequently, is the zone that is most exposed to the three hazards. Zone SS08 is highly exposed to flooding and land degradation. The least exposed livelihood zones are SS04, SS02 and SS03, where households depend exclusively on crops and livestock, and the poorest live off wage labour. The rich agro-ecological zones in the country's western and southwestern parts have generally low exposure to floods, with low drought occurrences and medium land degradation (WFP, 2014).

After clashes in Jonglei where hundreds of cattle were stolen. *Photo credit: European Commission DG ECHO/Flickr.com/CC BY-SA 2.0*

FIGURE 5. CATEGORIES OF EXPOSURE TO FLOOD, DROUGHT AND LAND DEGRADATION



Source: (WFP, 2014)

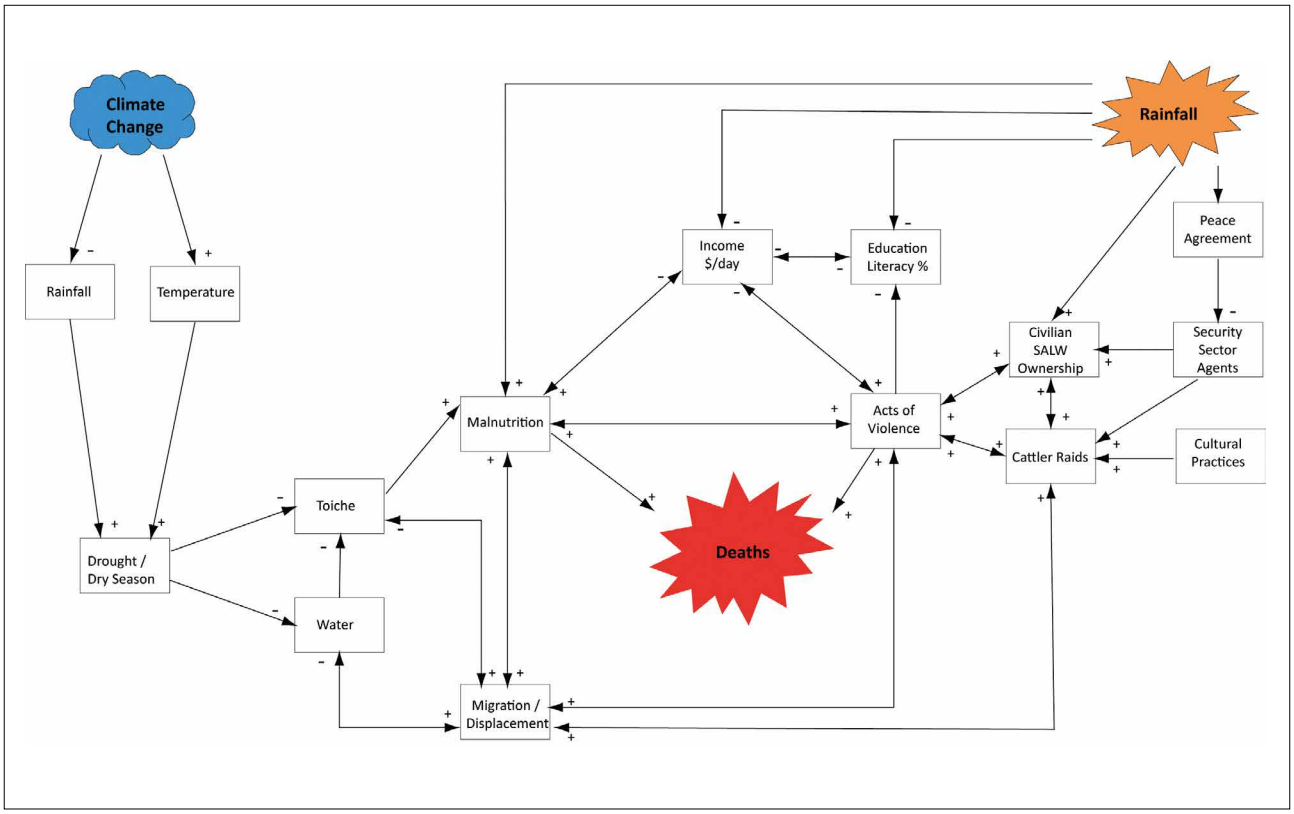
- Category 1: High exposure to floods, drought and land slide
- Category 2: High exposure to floods, medium to high drought and land degradation
- Category 3: High exposure to floods, low to medium drought and land degradation
- Category 4: Medium exposure to floods, medium to high drought and land degradation
- Category 5: Low to medium exposure to floods, drought and land degradation
- Category 6: Low exposure to floods, medium drought and high land degradation
- Category 7: Low exposure to floods, low to medium drought and land degradation
- Category 8: High exposure to drought, medium to high floods and land degradation
- Category 9: High exposure to drought, low to medium floods and land degradation
- Category 10: Low exposure to floods, drough and land degradation

One of the impacts of increased drought and a more unpredictable climate, when combined with rapid population growth and the expansion of farming, is likely to be a rise in conflicts over natural resources (Mitra, 2016). Jonglei often forces cattle herders to migrate to find fodder and water. In the toich, or the seasonally inundated floodplain surrounding the Sudd wetlands, migrating herders come into contact with existing communities leading to tensions and fighting over access to water and land (Richardson, 2011) (Box 2).

BOX 2. CLIMATE CHANGE, DROUGHT AND CONFLICT IN JONGLEI

In 2011, Richardson (2011) undertook a study in Jonglei in the context of research into the links between conflict and the environment throughout the world. He concluded that three factors were collectively contributing to armed conflict in South Sudan: climate change, arrested social and economic development, and the existing security situation in Jonglei state. The dynamic is illustrated in Figure 5 above. In the case of climate change, the drying effect of warming is reducing the amount of biomass and water, and increasing the incidence and length of drought events in Jonglei. As a result, the population suffers from increased food insecurity, malnutrition and mortality rates. To adapt to the increasingly arid environment and these social impacts, pastoral communities are migrating to wetter areas already inhabited by other communities, which often leads to conflicts. The existing security situation in the state is already compromised by the effects of years of civil war and the lack of civilian law enforcement, which means there are no lawful curbs on cattle raiding, a cultural practice often used as a means of restorative justice. Richardson noted the increase in intensity and frequency of violent acts associated with cattle raids and the related easy access to automatic weapons in the aftermath of three decades of civil war. Finally, the state of social and economic development is part of the complex dynamics of the situation, as people suffer from the lack of jobs, healthcare, sanitation and other basic human needs, which is both a cause and result of the conflict (Richardson, 2011).

FIGURE 6. FLOW DIAGRAM OF THE RELATIONSHIP BETWEEN CLIMATE CHANGE AND VIOLENT CONFLICT IN JONGLEI, SOUTH SUDAN



Source: (WFP, 2014)

3.3 Response: The Sendai Framework For Disaster Risk Reduction

At an East African Community Parliamentarian Forum on Disaster Risk Reduction on 31 May 2017, South Sudan, along with the five other members of the East African Community (Burundi, Kenya, Rwanda, the United Republic of Tanzania and Uganda), declared its intention to implement the Sendai Framework for Disaster Risk Reduction in the East African region.

Adopted in 2015, the Sendai Framework for Disaster Risk Reduction is a global agreement that seeks to stem deaths and economic losses resulting from disasters. Strengthening governance to curb risk is one of the Framework's highest priorities and it assigns a clear role and mandate to parliamentarians to help them accomplish the goals.

At the East African Community Parliamentarian Forum on Disaster Risk Reduction, member countries were encouraged to urgently begin vulnerability impact assessments in local disaster-prone hotspots and to assess the state of their early warning systems and ability to respond to national and local emergencies (Karanja, 2017).

To address these global goals at the regional level, the East African Community needs to meet the 2020 Sendai Framework target to substantially increase the number of countries with national and local disaster risk reduction strategies by 2020 (Karanja, 2017). Thus, South Sudan began developing a disaster risk management policy to prevent and prepare for natural hazards, which was being finalised in 2016. The goal of the Ministry of Humanitarian Affairs and Disaster Risk Management was to adopt the policy that would enable coordinated responses to the threats of floods, drought and extreme weather, amongst other natural hazards. Its main strategies are to build preparedness capacity, create and implement an effective early warning system to predict disasters and build the ability to mobilise resources when disasters occur (SINA, 2016). UNESCO is supporting the policy by holding training workshops to enhance knowledge and institutional capacity (UNESCO, 2016).

The seven global targets are as follows:

1. Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020-2030 compared to the period 2005-2015;

2. Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020-2030 compared to the period 2005-2015;

3. Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

4. Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

5. Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

6. Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030; and

7. Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030 (UNISDR, 2015).

3.4 Conclusion

In summary, South Sudan is susceptible to natural hazards, especially drought and floods, but climate change is exacerbating their intensity, frequency and duration. In addition, multiple socioeconomic stressors, including the ongoing conflict, poverty, famine and economic and political instability, create a state of extreme vulnerability to the impacts of these natural hazards. Given the population's dependence on seasonal rains to support their livelihoods, the severe disruption of rainfall patterns combined with increased vulnerability will jeopardise the capacity of huge numbers of people to sustain themselves, a situation that is already occurring in several parts of the country.

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Black cotton soil with the rain makes roads and airstrips unusable.
Photo credit: European Commission DG ECHO/Flickr.com/CC BY-SA 2.0

CHAPTER 4
AGRICULTURE

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4.1 Introduction

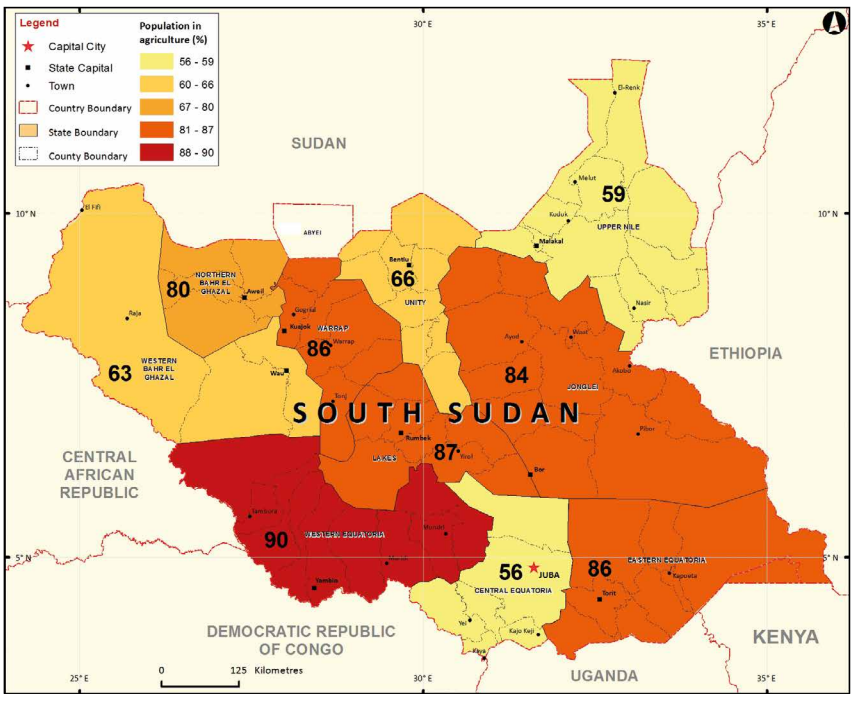
In South Sudan about 80 per cent of the population lives in rural areas where subsistence agriculture is the mainstay of people's livelihoods. The agriculture sector is characterised by small, hand-cultivating household units belonging to larger family aggregations practising different combinations of rain-fed agriculture, livestock grazing and pastoralism, wild food harvesting and fishing (MOAF, 2013); (EU, 2016). About 81 per cent of households cultivate land, 74 per cent own livestock and 22 per cent engage in fishing (RSS, 2015) (Figure 1).

Although agriculture is the backbone of the subsistence economy of South Sudan (BRACED, 2016a), production is very low. A 2012 analysis showed that the total value of agricultural production (or "realised potential") was about US$800 million (US$600 million from crops) or less than US$300 per hectare; this result is much lower than production figures in neighbouring countries (Diao, You, Alpuerto & Folledo, 2012). In 2009, the agriculture sector contributed one-third of the country's GDP (UNDP, 2012).

Table 1 provides data collected by the Comprehensive Agricultural Development Master Plan (CAMP), which represent the situation in 2008-2010 (RSS, 2015).

Household garden. *Photo credit: Amy the Nurse/Flickr.com/CC BY-NC-ND 2.0*

FIGURE 1. PERCENTAGE OF THE POPULATION LIVING IN HOUSEHOLDS WHOSE MAIN LIVELIHOOD IS AGRICULTURE AND LIVESTOCK, BY STATE, 2009.



Source: (World Bank, 2011)

TABLE 1. THE IMPORTANCE OF AGRICULTURE TO THE ECONOMY OF SOUTH SUDAN

Indicator	Estimate	
GDP	15% of GDP	
Employment	63% of working population (aged 15 and above)	
	78% of total population	
Trade (per cent of GDP)	Imports: 12%	Exports: Less than 1%
	Trade deficit: 11-12 %	
Rural population	83% of total population	
Households	Per cent of total households	Per cent of rural households
Engaged in cultivation	81	89
Engaged in fisheries	22	24
Owning livestock	74	80
Main source of livelihood	Per cent of total population	Per cent of rural population
Crop farming	69	78
Animal husbandry	7	8

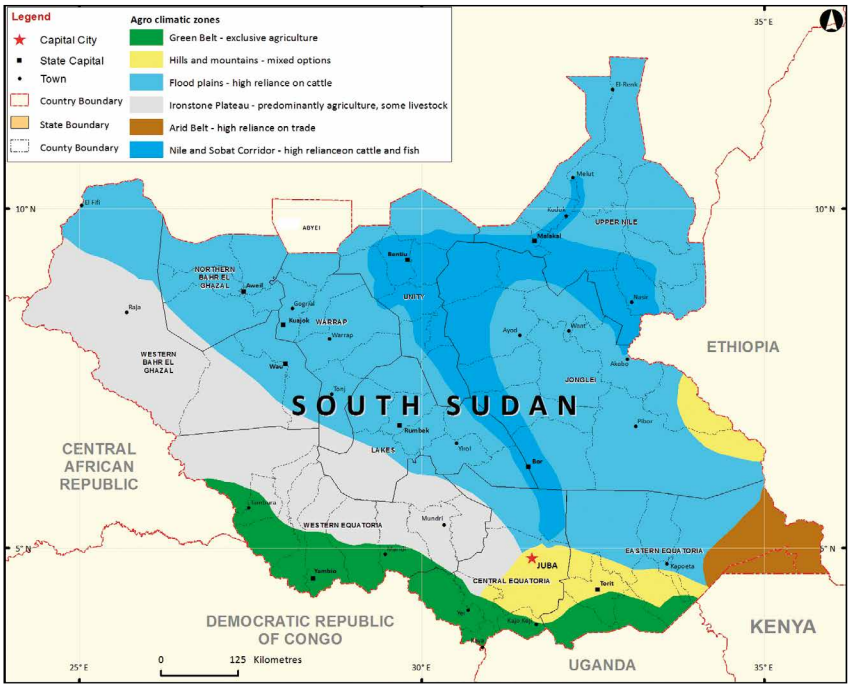
Source: (RSS, 2015)

Agro-climatic zones

Climate and soils are primary determinants of the type of agricultural occupations that can be undertaken, and how, where and when they occur. Generally, mixed cultivation takes place in the Green Belt, and livestock rearing and extensive cultivation are practised in the Ironstone Plateau and semi-arid zones (EU, 2016). Figure 2 maps the country's six main agro-climatic zones.

As described in Chapter 2, rainfall varies by region, ranging from 500 mm a year in the north to about 1,500 mm a year in the southwest (Table 2). There is thus adequate rainfall for a range of crops. The growing season in the north is from 100-150 days, and in the southwest, it is 150-250 days (ASPF, 2012).

FIGURE 2. AGRO-CLIMATIC ZONES OF SOUTH SUDAN



Source: (USAID, 2014)

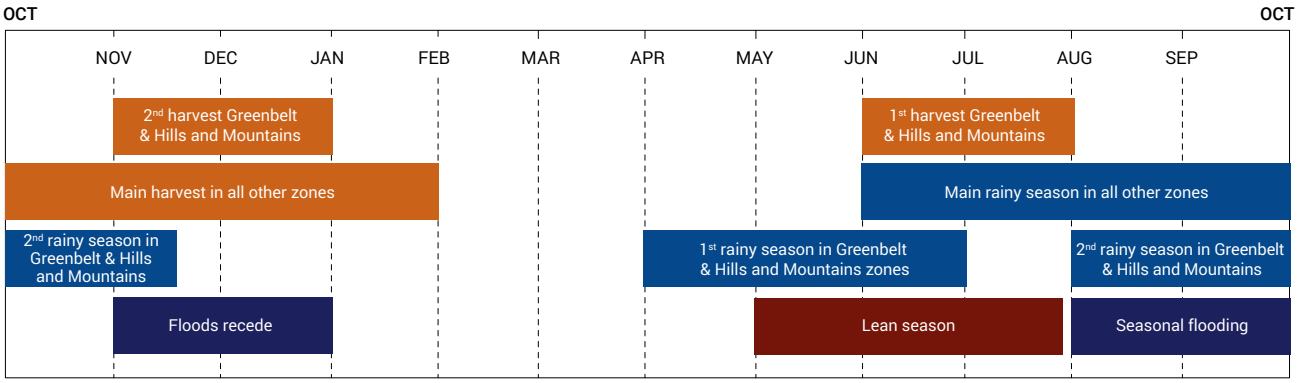
TABLE 2. RAINFALL ZONES CLASSIFIED BY RAINFALL AND MOISTURE REGIMES

Zone	Annual rainfall (mm)	Characteristics
High rainfall	> 1,500	The south-western part of the country and far southeast and Kapoeta Hills, known as the Green Belt. Although rainfall is significant, it only occurs for a limited period (7-8 months) of the year and is highly variable. Irrigation would be supplementary to the rainfall to produce a second crop and increase productivity.
Pastoralist	< 1,000	Most areas of the country in the central, eastern and western parts. Irrigation would provide livelihood options and increase food production.
Moisture deficit	< 500	The north-eastern part of the country. Rainfall is highly variable. Irrigation could secure and increase food production and improve livelihoods.

Source: (RSS, 2015)

There are two rainy seasons (Figure 3) that contribute to determining agricultural potential, the timing of crop planting and harvesting, and the movements of pastoralist peoples.

FIGURE 3. SEASONAL CALENDAR IN A TYPICAL YEAR



Source: (USAID, 2014)

Soils

Soils are important in influencing the potential for agriculture. Figure 4 maps the 34 soil types in South Sudan. Vertisols are a type of clay known as "black cotton soils" that are potentially highly productive but are prone to erosion; they are mostly found in the eastern part of the country (RSS, 2015). Fluvisols, a lowland soil in semi-arid zones that is moderately-to-highly fertile, is found along rivers, lakes and alluvial plains (FAO, 1993). Leptosols, characteristic of the southwest, are very shallow soils on top of hard rock or highly calcareous materials; they are subject to drought, runoff and desertification. Lixisols have an unstable soil structure underlain by clay washed down from the surface. They are found in the western part of the country. Regosols have no significant profile development; they are distributed from the northwest toward the centre. Cambisols are composed of medium- and fine-textured materials derived from a wide range of rocks and are found in hilly parts of the southern and central areas (RSS, 2015).The Ironstone Plateau is named for the hard, red lateritic soil called ironstone that covers almost the whole region. Lateritic soils are often thin and unsuitable for agriculture (Beswick, 2004).

Black cotton soil with the rain makes roads and airstrips unusable.
Photo credit: European Commission DG ECHO/Flickr.com/CC BY-SA 2.0

FIGURE 4. SOIL MAP OF SOUTH SUDAN

Source: (FAO, 2006).

Agricultural potential

The climatic and soil conditions mapped above show the enormous potential for agriculture in South Sudan (ASPF, 2012). By some estimates, between 70 and 90 per cent of the country's total area of roughly 658,800 km^2 is suitable for agriculture, about half of which is classified as prime agricultural land (MOAF, 2013). In 2012, it was thought that only about 4 per cent of the total land area was being cultivated and that between 55 and 80 per cent was still covered by natural vegetation consisting of trees, shrubs or grass, or occupied by rivers and wetlands, or settlements (Diao, You, Alpuerto, & Folledo, 2012); (ASPF, 2012).

A scenario exercise by the World Bank illustrated the great potential for agriculture to increase the country's revenues. It showed that modestly increasing cropland from the current 4 per cent of total land area (2.7 million ha) to 10 per cent of total land area (6.3 million ha) would increase the value of total agricultural output 2.4-fold compared to the current level (in other words, from the current US$808 million to approximately US$2 billion). If per capita yields were to simultaneously increase by 50 per cent, the value of total agriculture output would increase 3.5-fold or to US$2.8 billion. The per hectare value of crop production would also increase from US$227 to US$340. If per capita yields double in this modest cropland expansion scenario, the value of total agriculture production would increase to US$3.7 billion and would exceed the current value of agricultural production in neighbouring Uganda. Increasing productivity threefold would increase the value of agricultural production to US$5.5 billion (World Bank, 2012).

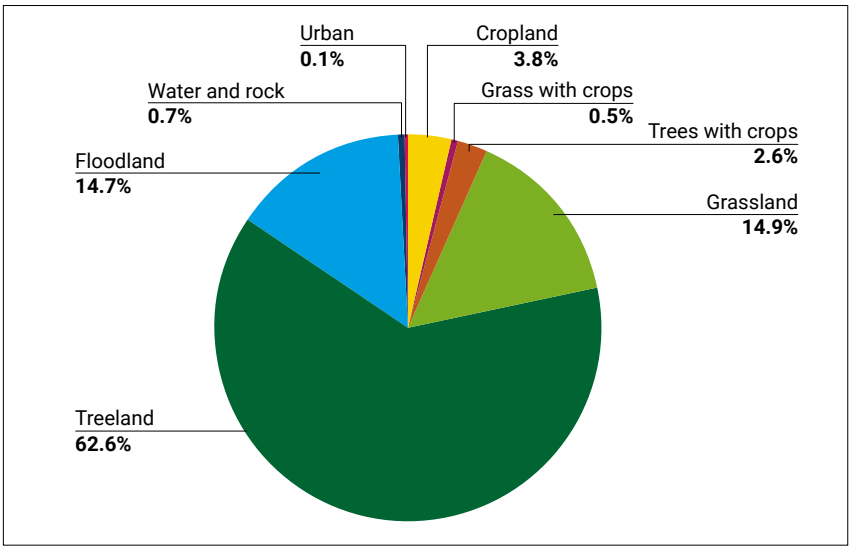
Field of Maize in Lainya County, in Central Equatoria.
Photo credit: BBC World Service via Foter.com / CC BY-NC

Figure 5 shows the estimated area and share of the country's total land area used by crops, a combination of crops and natural vegetation, grasslands and pastures, wetlands and trees and other non-agricultural land cover.

Agricultural land use

Table 3 shows the various agricultural activities taking place in each of the 6 agro-climatic zones shown in Figure 2.

FIGURE 5. AREA AND SHARE OF AGGREGATED LAND USES AS PERCENTAGE OF TOTAL LAND AREA OF SOUTH SUDAN



Source: (RSS, 2015)

TABLE 3. AGRICULTURAL USE OF THE SIX AGRO-CLIMATIC ZONES

Agro-climatic zone	States	Characteristics	Agricultural livelihoods
Arid /Pastoral	Jonglei, Eastern Equatoria	This zone receives an average of less than 400 mm of precipitation a year. The soils are shallow and unsuited for crops.	Pastoralism is the main livelihood activity, characterised by seasonal migrations of people and their livestock in search of water and pasture.
Green Belt	Western Bahr el Ghazal, Western Equatoria, Central Equatoria, Eastern Equatoria	The green belt is found in the southern parts of Eastern Equatoria, Central Equatoria and the western parts of Western Equatoria. This zone has rich soils and enjoys two rainy seasons, except for the southern part of Eastern Equatorial state, which receives little precipitation.	Farming is the main livelihood activity, especially in the southwest part of the zone, and there is often surplus production. In drier areas there is increasing reliance on root crops and exchange.
Floodplains	Western: Northern Bahr el Ghazal, Lakes, Warrap Eastern: Jonglei, Upper Nile	This is a wetland zone, which includes the vast Sudd swamp.	Livestock and crop growing, supplemented by fish and wild foods, are the main livelihoods in the western part of the Floodplain Zone; these occupations are similar in the eastern floodplain with the addition of game hunting.
Hills and mountains	Central Equatoria, Eastern Equatoria, Jonglei	Hills and mountains are found along the Nile to the north of the Greenbelt.	There are a variety of different livelihood activities in this zone, with a focus on agriculture and pastoralism. In difficult years when crops fail, people rely on cattle, trade and root crops
Ironstone plateau	Northern Bahr el Ghazal, Western Bahr el Ghazal, Warrap, Lakes, Western Equatoria, Central Equatoria, Eastern Equatoria	This zone occupies most of Bahr el Ghazal, west of the River Nile, and has thin lateritic soils.	Crop production is the main activity in this zone, which shares a border with the more productive Greenbelt from which local communities can access food surpluses when needed.
Nile and Sobat Rivers	Jonglei, Unity, Upper Nile	This zone is a corridor along the banks of the Sobat River, which flows from Ethiopia and is fed by tributaries before draining into the Nile.	This zone is mostly occupied by wetlands. Pastoralism, fishing and gathering wild foods are the main livelihood activities; there is limited crop production.

Sources: compiled from (USAID, 2014);(FEWS NET, 2013);(RSS, 2015); (Fernando & Garvey, 2013)

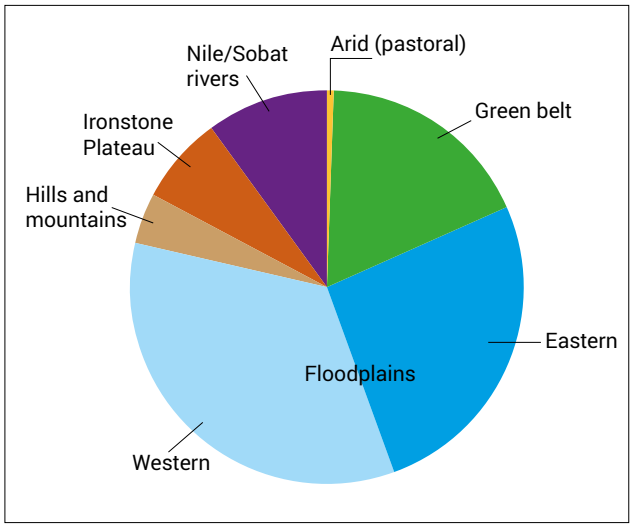
4.2 Crop cultivation: status and trends

Most farmers practise shifting cultivation (EU, 2016); (UNDP, 2012), an agricultural system based on field rotation rather than crops. Typically, crops are grown for several years or until yields decline appreciatively, and then the land is left to fallow (MOAF, 2013). A new cultivation area is prepared by burning the existing vegetation, which clears the land and fertilises it. When circumstances (population growth, conflict, other constraints) prevent farmers from shifting cultivation to a new and fertile area, they may return to previously fallowed fields before fertility has been restored, thereby degrading soil quality and threatening food security (Dima, 2006). Fertility is also maintained by applying manure; chemical fertilisers and pesticides are rarely used (RSS, 2015). Where opportunities for shifting agriculture are limited, fertility is traditionally maintained through contract-dunging by pastoralists' herds and flocks on private farmland. Animal dung is used especially in Northern Bahr el Ghazal, Western Bahr el Ghazal (Jur River County) and Warrap (FAO and WFP, 2016).

Individual households cultivate an average of between 0.84 and 2.4 hectares of cereals and other crops (UNDP, 2012). Crops are usually grown in mixed and/or sequential plantings (mixed cropping and interplanting). Sorghum and millet, the main cereal crops, are usually grown with sesame, while root crops such as cassavaare often inter-planted with groundnuts, maize, pumpkins or other vegetables. This practice conserves biodiversity; mitigates weather, pest and disease risks; provides optimal ground cover and prevents soil erosion; conserves soil nutrients; and saves on labour (MOAF, 2013); (Dima, 2006).

Over 60 per cent of cropland is found in the country's floodplains (Figure 6). The Upper Nile, Jonglei and Warrap contain about half of all cropland in South Sudan and ten states represent 71 per cent of the total area devoted to crops (Table 4). The Upper Nile grows almost all irrigated crops (mainly rice) and all the country's rain-fed rice is grown in Northern Bahr el Ghazal. Fruit trees and tree plantations are grown exclusively in Western, Central and Eastern Equatoria (Fernando & Garvey, 2013).

FIGURE 6. SHARE OF CROPLAND IN EACH AGRO-CLIMATIC ZONE



Source: (Fernando & Garvey, 2013)

A returned refugee prepares sorghum.
Photo credit: Stephen H. Padre/Bread for the World

School garden set by student's agriculture club in Juba.
Photo credit: UNMISS/JC McIlwaine

TABLE 4. SHARE OF AGGREGATED LAND USE BY STATE (PERCENTAGE), 2011

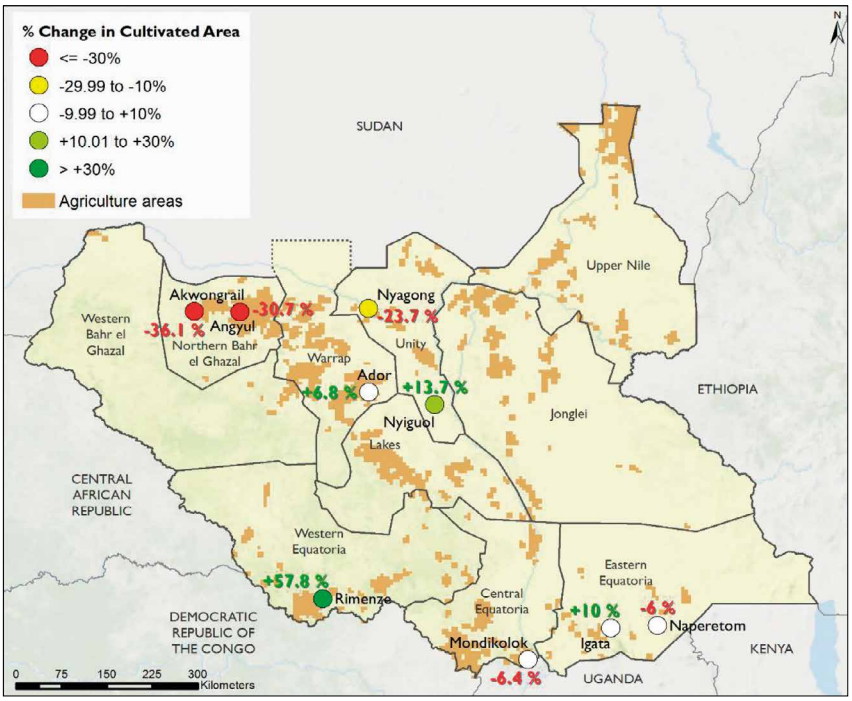
State	Cropland	Grass with crops	Trees with crops	Grassland	Tree land	Flood land	Water and rock	Urban	Total
Upper Nile	19.0	26.0	7.1	27.1	7.8	9 .0	9.5	25.8	11.4
Jonglei	14.3	25.2	7.3	14.8	19.7	26.7	17.3	8.8	19.5
Unity	4.5	16.1	2.5	7.7	3.7	14.9	6.4	17.1	6.0
Warrap	15.3	8.1	14.9	5.2	3.5	11.4	1.8	0.9	5.6
Northern Bahr el Ghazal	9.8	1.1	4.2	1.0	4.7	7.3	15.3	3.2	4.7
Western Bahr el Ghazal	2.0	4.0	12.9	4.2	18.6	13.5	18.5	10.4	14.9
Lakes	9.9	0.6	2.7	5.6	7.1	9.0	4.3	5.1	7.0
Western Equatoria	11.4	7.5	19.9	9.0	15.7	1.4	17.5	3.7	12.5
Central Equatoria	11.2	8.6	21.4	4.5	7.7	2.4	3.7	22.1	6.9
Eastern Equatoria	2.6	2.7	7.1	21.0	11.6	4.4	5.6	2.8	11.4
National average	3.8	0.5	2.6	14.9	62.6	14.7	0.7	0.1	100.0

Source: (RSS, 2015)

Trend in area cultivated area

The area of cultivated land in South Sudan has historically ranged between 1 to 3 per cent of the total land base (or 650,000 – 1,300,000 ha) (MOAF, 2013). Large-scale mechanised farms cover only a quarter of all cultivated land (UNDP, 2012). The area of land cultivated fluctuates according to a number of factors. The influx of returnees in 2008, for example, led to the expansion to about a million hectares under cultivation (MOAF, 2013). Other factors can lead to declines in the area of land cultivated. The United States Geological Survey and Famine Early Warning Systems Network analysed high-resolution imagery of specific arable areas between 2012 / 2013 and 2016 and found an overall decline of 7.7 per cent in the total area planted (Figure 7).

FIGURE 7. CHANGE IN AREA CULTIVATED BETWEEN 2012/2013 AND 2016 FOR NINE SITES IN SOUTH SUDAN



Source: (FEWS Net, 2016b)

The most significant declines in the area under cultivation were in Aweil North and Aweil West of Northern Bahr el Ghazal. The analysis attributed part of the reduction to migration out of the state during key cultivation months. In Western Equatoria, there was a substantial increase in the area cultivated in Rimenze of Yambio County, which experienced an increase of 57.8 per cent in area planted between 2013 and 2016 (Table 5). On the other hand, in the eastern counties of that state, the conflict beginning in July 2016 displaced many farming households who were forced to abandon their lands (FEWS Net, 2016b). There has been an estimated increase of 13.7 per cent in the area planted in Nyiguol of Panyijiar County between 2013 and 2016. The FEWS analysis speculates that the significant influx of Internally Displaced Persons from Koch, Mayendit & Leer in 2014 and 2015 likely accounts for the increase.

TABLE 5. CHANGES IN CULTIVATED AREA FROM 2012/2013 BASED ON HIGH-RESOLUTION IMAGERY INTERPRETATION

Area (Village, County, State)	2012/2013 Area (km^2)	2016 Area (km^2)	% Change
Nyagon, Mayom, Unity	190	145	-23.7%
Nyiguol, Panyijiar, Unity	20	591	13.7%
Angyul, Aweil North, Northern Bahr el Ghazal	87	684	-30.7%
Akwongrail, Aweil West, Northern Bahr el Ghazal	296	189	-36.1%
Mondikolok, Kajo-Keji, Central Equatoria	627	587	-6.4%
Igata, Ikotos, Eastern Equatoria	70	77	10.0%
Naperetom, Budi, Eastern Equatoria	853	802	-6.0%
Ador, Tonj East, Warrap	162	173	6.8%
Rimenze, Yambio, Western Equatoria	294	464	57.8%
Total	**3,999**	**3,712**	**-7.7%**

Source: (RSS, 2015)

The Food and Agriculture Organization of the United Nations (FAO)'s 2015 crop assessment reported that the national gross cereal production from the smallholder sector was about 1.15 million tonnes. As in its previous assessments, it assumed that post-harvest losses and seed saved to sow in 2016 account for 20 per cent of total production, leaving a net 921 thousand tonnes for local consumption, an amount that is over 9 percent below the 2014 output, but about 16 percent higher than the average production over the previous five years (Table 6) (FAO and WFP, 2016).

Aerial photo showing Farm in Yambio.
Photo credit: BBC World Service/Flickr.com/CC BY-NC 2.0

TABLE 6. CEREAL HARVESTED AREA, NET PRODUCTION (ROUNDED) AND NET YIELDS IN THE TRADITIONAL SECTOR, 2011-2015

REGION	2011			2012			2013			2014			2015		
	Area ('000 ha)	Net prod. ('000 t)	Net yield (t/ha)	Area ('000 ha)	Net prod. ('000 t)	Net yield (t/ha)	Area ('000 ha)	Net prod. ('000 t)	Net yield (t/ha)	Area ('000 ha)	Net prod. ('000 t)	Net yield (t/ha)	Area ('000 ha)	Net prod. ('000 t)	Net yield (t/ha)
UPPER NILE	**230**	**99**	**0.43**	**243**	**112**	**0.46**	**254**	**136**	**0.53**	**82**	**50**	**0.61**	**108**	**69**	**0.63**
Upper Nile	68	26	0.38	83	38	0.46	84	40	0.48	36	19	0.53	45	27	0.60
Unity	34	8	0.24	47	15	0.32	54	26	0.48	15	8	0.53	16	9	0.56
Jonglei	128	65	0.51	113	59	0.52	116	70	0.60	31	23	0.74	47	32	0.68
BAHR EL GHAZAL	**263**	**166**	**0.63**	**448**	**287**	**0.64**	**451**	**310**	**0.69**	**415**	**403**	**0.97**	**440**	**382**	**0.87**
North Bahr el Ghazal	68	40	0.59	119	78	0.66	115	85	0.74	128	113	0.88	147	120	0.82
West Bahr el Ghazal	41	35	0.86	61	48	0.79	62	50	0.81	69	75	1.09	65	58	0.89
Lakes	70	45	0.65	99	70	0.70	107	75	0.70	94	92	0.99	97	91	0.94
Warrap	84	46	0.55	169	91	0.54	167	100	0.60	124	123	0.99	131	113	0.86
GREATER EQUATORIA	**366**	**297**	**0.81**	**451**	**391**	**1.15**	**468**	**445**	**0.95**	**517**	**562**	**1.09**	**467**	**473**	**1.01**
Central Equatoria	123	78	0.63	155	114	0.92	160	150	0.94	199	223	1.12	197	218	1.11
Eastern Equatoria	115	99	0.87	135	116	1.07	139	116	0.83	151	142	0.94	139	118	0.85
Western Equatoria	129	120	0.93	161	161	1.25	169	179	1.06	167	197	1.18	131	137	1.05
TOTAL	**860**	**563**	**0.65**	**1,141**	**790**	**0.69**	**1,173**	**892**	**0.76**	**1,014**	**1,015**	**1.00**	**1,015**	**921**	**0.91**

Source: (FAO and WFP, 2016)

Crop types

A huge variety of crops are grown in South Sudan, where the diversity of soil and climatic conditions provide multiple options to grow different cereals, legumes, fruits and vegetables. Sorghum and finger millet, which are two of the world's rare and indigenous crop varieties, are important traditional foods in South Sudan. Sorghum, which represents a wide range of sorghum landraces, is the main cereal crop. When rains are late in sorghum-growing areas, groundnuts can replace them, making a significant contribution to household food security and cash income in higher areas with sandier soils. Other important crops are maize, bulrush millet, finger millet and upland rice, depending on the location (MOAF, 2013). In addition, roots and tubers (mainly cassava, sweet potato and yams), oilseeds (groundnut, sesame, soybean and sunflower), pulses (beans, cowpea and pigeon pea), fruits (mainly mangoes, citrus and avocados) and vegetables are grown, as well as coffee, tea, cotton and sugarcane (MOE, 2015). Northern farming areas typically grow cowpeas, beans, sesame, pumpkins and tobacco in addition to sorghum and finger millet (MOAF, 2013). Table 7 shows the crops usually grown in each of the six agro-climatic zones in South Sudan.

Potatoes field in Central Equatoria. *Photo credit: BBC World Service via Foter.com / CC BY-NC*

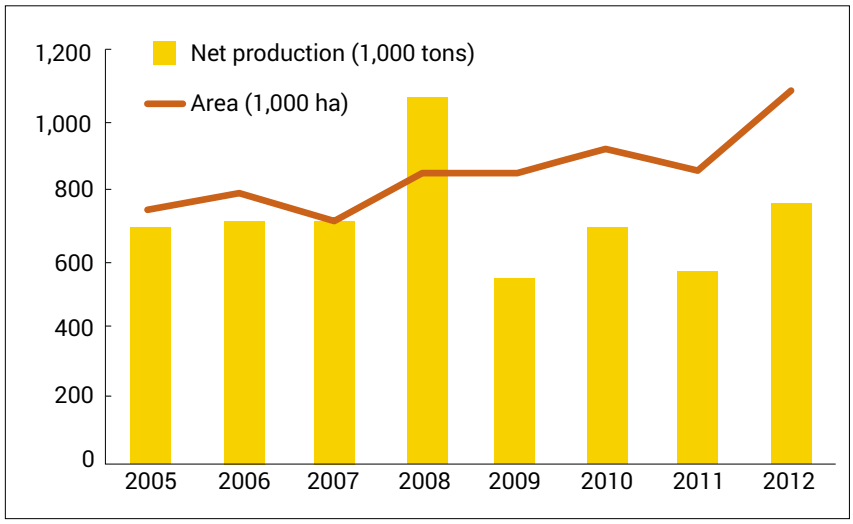
TABLE 7. **CROPS GROWN IN THE SIX AGRO-CLIMATIC ZONES**

Agro-climatic zone	Field crops	Horticultural crops
Arid	Sorghum, Dryland maize, Brush millet, Finger millet, Dryland bean, Cowpea, Pigeon pea	Pineapple, Citrus, Passion fruit
Greenbelt	Cassava, Sorghum, Maize, Bulrush millet, Finger millet, Sweet potato, Ground nut, Bambara nut, Sesame, Pea, Green gram, Upland rice	Onion, Irish potato, Carrot, Okra, Tomato, Cabbage, Leek, Eggplant, Spices, Spring onion, Chilli, Mango
Floodplains	Paddy rice, Sorghum, Maize, Finger and Bulrush millet, Sugar cane, Sweet potato	Kale, Cabbage, Various vegetables
Hills and mountains	Sorghum, Maize, Wheat, Rice, Ground nut, Finger millet, Bulrush millet, Tea	Cabbage, Kale, Irish potato, Carrot, Pea, Apple, Spinach
Ironstone plateau	Cotton, Sorghum, Maize, Finger millet, Bulrush millet, Pyrethrum, Beans, Sisal, Tobacco, Coffee	Passion fruit, Citrus, Mellon, Papaya, Mango, Guava, Eggplant, Tomato, Okra, Amaranth
Nile and Sobat Rivers	Sugar cane, Sorghum, Maize, Bulrush millet, Finger millet, Sweet potato, Coffee, Tea	Mango, Citrus, Passion fruits, Pepper, Papaya

Source: (Fernando & Garvey, 2013)

Agricultural crop yields in the traditional (non-irrigated) sector of South Sudan average about 1.01 tonnes/ha, ranging from 0.75 tonnes/ha in Bahr el Ghazal to 1.5 tonnes/ha in Yambio. By comparison, average yields for Africa range from1.04 to 1.14 tonnes/ha (MOAF, 2013). In 2012, the total net cereal production was 761,378 tonnes while the total cereal requirement for 2013 was 1,132,368 tonnes. The estimated cereal deficit in 2013 was thus 370,991 tonnes. The widespread use of seeds of local cultivars or landraces with poor genetic potential and damage by insects is a major reason for low yields (RSS, 2015); (EU, 2016). Figure 8 shows cereal production trends from 2005 to 2012 and the estimated trend in the area harvested.

FIGURE 8: ESTIMATED TREND IN CEREAL PRODUCTION AND AREA HARVESTED, 2005-2012



Source: (RSS, 2015)

Irrigated agriculture

The practice of irrigated agriculture is insignificant in South Sudan. Individual farmers use simple water-lifting techniques like hand pumps and other low-technology methods such as storage ponds and drains in floodplains to irrigate small plots of crops and vegetable gardens (Fernando & Garvey, 2013). Given the many permanent, large and small rivers, seasonal watercourses, groundwater resevoirs and vast areas of wetlands, there is a huge potential for expanding irrigation and introducing medium- and large-scale irrigation projects to boost agricultural output and help increase food security (ASPF, 2012).

The River Nile's tributaries carry large amounts of water through the Green Belt, which extends along the boundary between the foot of the mountain and plateau region, and the gentle plains. ***The Rapid Water Sector Needs Assessment and a Way Forward***, a World Bank report for the Republic of South Sudan, deemed this area (Figure 9) to have high potential for gravity irrigation schemes (Fernando & Garvey, 2013).

FIGURE 9: AREA WITH PRESUMED HIGH POTENTIAL FOR GRAVITY IRRIGATION

Source: (Fernando & Garvey, 2013)

In South Sudan, the average share of value added in agriculture as a percentage of GDP declined from 1.7 per cent in 2001-2010 to -0.2 per cent in 2011-2014 (Table 8), compared to a decline from 25.4 per cent in 2001-2010 to 23.7 per cent in 2011-2014 in the least developed countries as a whole (UN-OHRLLS, 2016).

TABLE 8. VALUE ADDED SHARE OF AGRICULTURE, PERCENTAGE DIFFERENCE IN SOUTH SUDAN, 2001-2010 AND 2011-2013

Years	Agricultural irrigated land (percentage of total agricultural land)	Value added share of agriculture, percentage difference
2001-2010	-	1.7
2011-2013	-	-0.2

Source: (UN-OHRLLS, 2016)

BOX 1. IRRIGATION POTENTIAL IN SOUTH SUDAN

In 2012, South Sudan joined the Nile Basin Initiative, which was established in 1999 to achieve and benefit from sustainable socio-economic development through the equitable utilisation of the common Nile Basin water resources.

In 2016, the Nile Basin Initiative reported the results of a multi-sector investment opportunity analysis. The report identified about 450,000 ha of potential irrigable land in Bahr el Jebel, the Sudd and Bahr el Ghazal. A pre-feasibility study of agricultural expansion showed specific potential in the following areas: the Aweil Focal Area, with a command area of 3,000 ha; the Pagarau Irrigation Scheme, with a command area of 5,000 ha; the Jebel Lado, with a command area of 5,000 ha; the Renk Irrigation Scheme, with a command area of 3,000 ha; and the Wau Irrigation Scheme, with a command area of 6,000 ha.

The Aswa Basin Multipurpose Water Resources Development project also identified additional agriculture irrigation potential and earmarked two projects that would benefit residents of Magwi town: the Nyimur project (7,000 ha of irrigation and 14,300 ha of land use management) and the Parajok project (21,800 ha of irrigation). Another project, the Fula Rapids scheme, would put 2,700 ha under irrigation for the benefit of people in the town of Nimule.

In addition, the Baro-Akobo-Sobat Multipurpose Water Resources Development Study project aimed to identify upstream key environmental and social issues in this relatively pristine area and to prepare short- and medium-term projects. Implementing these projects would benefit small-scale farmers and pastoralists in the Baro-Akobo-Sobat sub-basin.

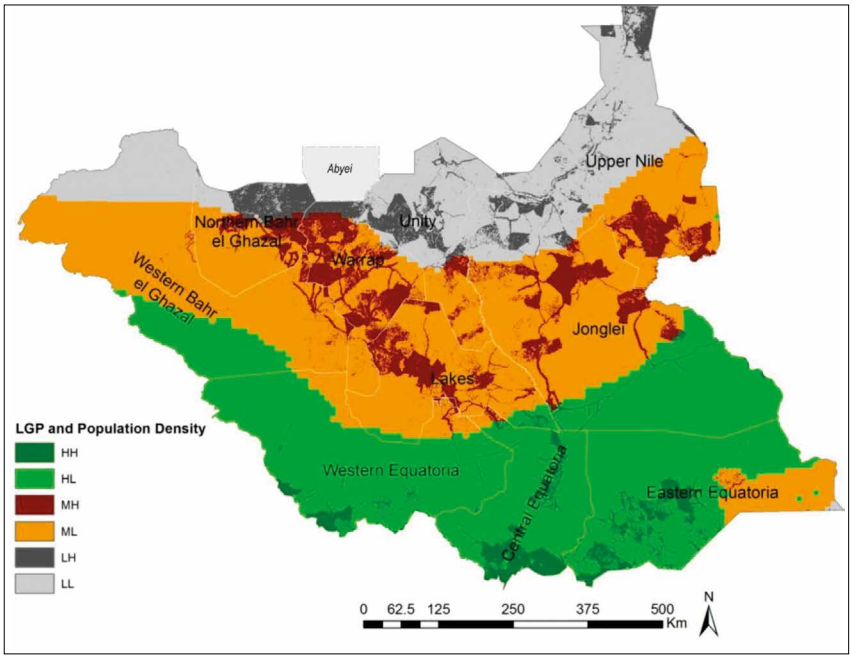
Aerial View of Nile in Jongeli. *Photo credit: Joseph King/Flickr.com/CC BY-NC-ND 2.0 Source:(NBI, 2016)*

Future potential for crop production

In 2012, a spatial analysis was carried out to assess the potential for improving crop production in South Sudan in the near future (Diao, You, Alpuerto, & Folledo, 2012). They identified six agricultural potential typologies and mapped them along with the population density in each. The research found that more than half of the current cropland area falls into three categories deemed to have the best potential for development. The areas in green in Figure 10 have the highest potential.

Two development scenarios for the next five to ten years were envisioned: one that simulated an increase in cultivated area and the other that estimated results by improving crop yields. Although the former appeared to be the easiest solution, the research noted many challenges related to increasing the area of land under cultivation, including very low population densities, high upfront costs of land clearing and low rural connectivity in some areas with high potential. Thus, the study concluded that yield improvement might be a more effective way to realise agricultural potential in South Sudan in the near future (Diao, You, Alpuerto, & Folledo, 2012).

FIGURE 10. SPATIAL PATTERNS OF AGRICULTURAL POTENTIAL AND POPULATION DENSITY



HH: High agricultural potential/ high-medium population density;

HL: High agricultural potential/ low population density;

MH: Medium agricultural potential and high-medium population density;

ML: Medium agricultural potential/ low population density;

LH: Low agricultural potential and high-medium population density;

LL: Low agricultural potential and low population density.

Source: (Diao, You, Alpuerto, & Folledo, 2012); (Tizikara & Lugo, 2013)

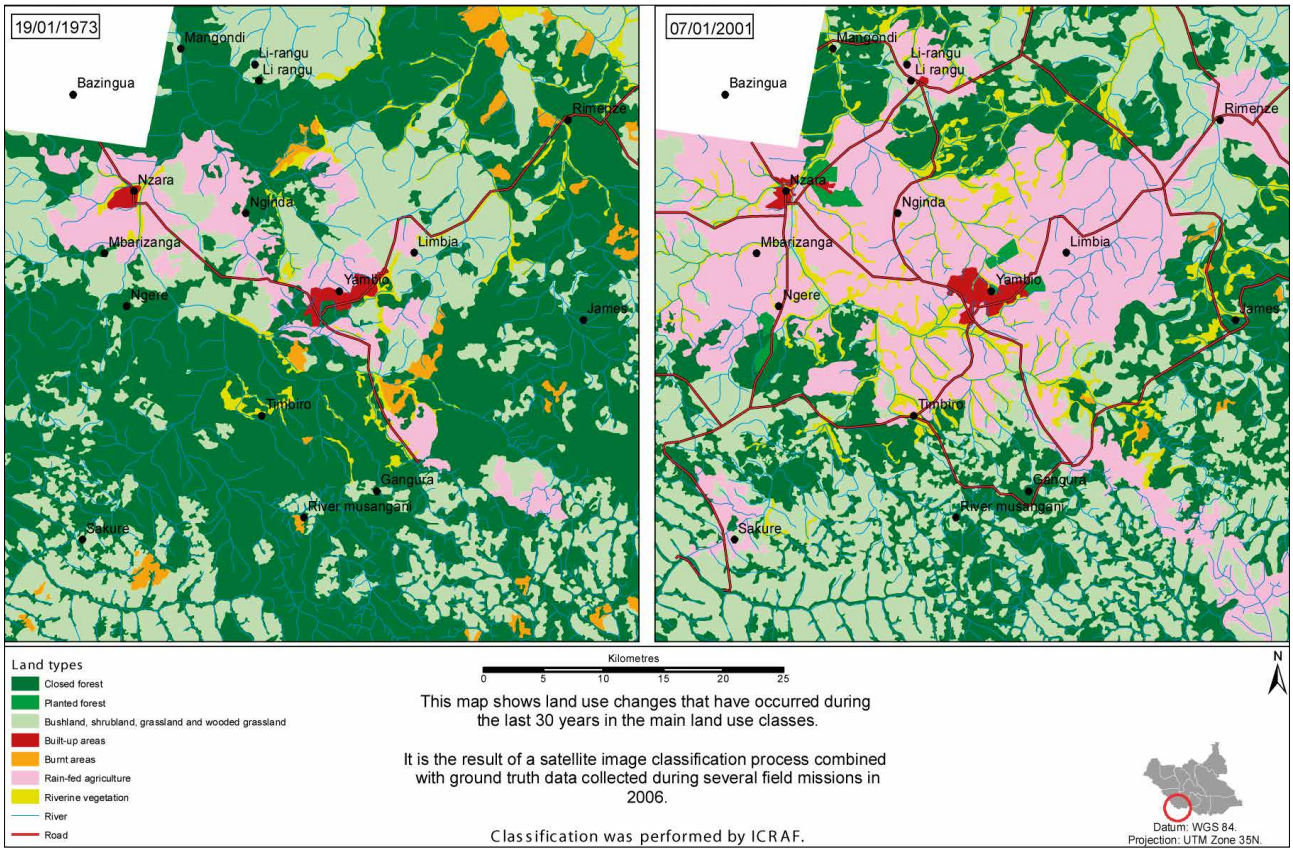
Crop Production: Pressures and impacts

Land Conversion

The CAMP reported a general trend in parts of the country towards the conversion of forested land to permanent agriculture, with resulting land degradation and a negative effect on biodiversity. It noted that population pressures in some areas, such as Yei and Yambio, had reduced the fallow period from an estimated average of 20 years to 5 years or less, which is too short a time for forests and soil fertility to regenerate. A 2006 study in Yambio estimated that cleared agricultural land increased from 6.8 per cent to 27.7 per cent of the study areas between 1973 and 2006, mainly at the expense of closed forest and wooded grasslands (Figure 11). In Wau as well, traditional agriculture has replaced forests, converting them to rangeland and degraded land (RSS, 2015).

There is evidence that in some places, the conversion of wildlife habitat to crops is threatening resident wildlife and its habitat. For example, in the Nimule National Park, a narrow, protected area of 171,600 ha on the border of South Sudan and Uganda, and home to 150 elephants, cultivation activities have blocked off essential elephant corridors (AWF, n.d.).

FIGURE 11. EXPANSION OF RAIN-FED AGRICULTURE IN YAMBIO AND RESULTING DEFORESTATION, 1973-2001



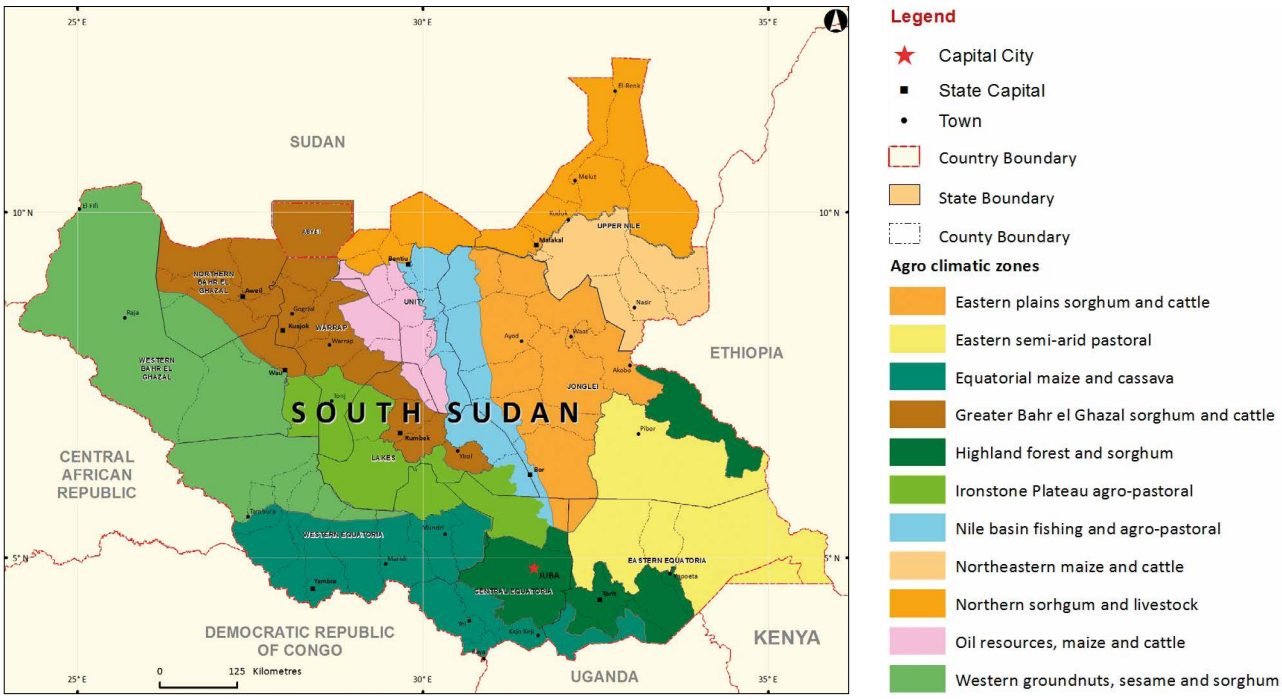
Source: (RSS, 2015)

Threatened agricultural areas

While Figure 2 at the beginning of this chapter maps the general distribution of zones defined by the potential for the climate and soils to support agriculture, Figure 12 is a finer analysis of the distribution of the main agricultural uses of the country's land base. The map was created by the Famine Early Warning Systems Network to show Livelihood Zones, which are defined as "geographic areas in which households obtain their basic survival needs, notably food and cash income, in relatively similar ways" (FEWS NET, 2013). The map defines 11 such zones and shows the proportion of land that is occupied by these various agricultural livelihood uses. The Famine Early Warning Systems Network research helped to identify the level of pressures from various sources on these zones and the impacts on agriculture and human well-being.

The Famine Early Warning Systems map (Figure 12) was developed in the context of an analytical framework called the Household Economy Assessment that helps to analyse the ways people access the things they need to survive and maintain their livelihoods. One of the project's objectives was to "determine people's food and non-food needs and identify appropriate means of assistance". It identified 5 of the 11 livelihood zones shown in Figure 12 to be at the greatest risk of food insecurity because of associated poverty, the high risk of production failure and the greatest difficulty in accessing markets (FEWS NET, 2013). Box 2 highlights some specific drivers of environmental change in South Sudan (as described in Chapter 1), including political and resource-use conflicts, flooding and drought, population migrations and cattle rustling, as well as the impacts of unsustainable land uses, such as over-exploitation of the area's natural wild foods or overgrazing. It also illustrates how the population rarely relies solely on one form of agriculture, but in general practices a mixture of cultivating crops, keeping a variety of livestock, and in some areas fishing and collecting food from the wild.

FIGURE 12. LAND USE DESCRIBED BY LIVELIHOOD ZONES, 2013



Source: (FEWS NET, 2013)

BOX 2. FIVE AGRICULTURAL LIVELIHOODS ZONES WHERE HUMAN PRESSURES AND THE DRIVERS OF ENVIRONMENTAL CHANGE CREATE THE GREATEST RISK TO FOOD SECURITY.

"Greater Bahr el Ghazal Sorghum and Cattle zone: This is a predominantly agro pastoral economy occupying a flood plain. Continuous leaching and loss of soil nutrients lead to reduced crop yields, flooding to poor crop performance and to an increased risk of livestock losses from disease, and there is overgrazing and high levels of cattle rustling. This is exacerbated by over exploitation of the natural resources, especially fish, wild foods and bush products, communal conflicts over water and grazing, and the presence of Internally Displaced People (IDP) due to political conflicts along the border with Sudan. Rural to urban migration has also deprived households of productive labour.

Eastern Semi-Arid Pastoral zone: Mainly a semi-arid livestock rearing area, with limited crop production, this zone is prone to prolonged drought, livestock losses from diseases and raiding, resource and political conflict. Multiple and frequent hazards combined with low household resilience, a heavy reliance on markets for food and difficulty with market access expose inhabitants to a high risk of food insecurity.

Eastern Plain Sorghum and Cattle zone: This zone is a predominantly agro-pastoral area, with some seasonal fishing and is highly prone to floods, livestock and human diseases, crop pests, cattle raiding and conflict which combined with low resilience due to recurring losses of crops and livestock and limited market access exposes inhabitants to higher levels of risk of food insecurity.

Northern Sorghum and Livestock zone: Livelihoods in this zone depend chiefly on sorghum production and rearing goats. Rainfall in the area is among the lowest and most unreliable within the country and frequent drought and crop failure, cattle raiding, political instability and insecurity, and changes in market conditions due to its location along the border with Sudan, expose inhabitants to food insecurity.

Nile River Fishing and Agro-pastoral zone: This zone is predominantly agro-pastoral farming and fishing zone along the Nile River. It is the least food insecure area among the five main zones. However, it is prone to flooding, particularly in low-lying areas. This can result in limited access to wild foods (fish and water lilies), crop destruction, particularly the short-term variety of sorghum which is known for its low resistance to flood water, and increases in other crop pests and livestock diseases, especially among goats and sheep."

Source: (FEWS NET, 2013)

4.3 Livestock: status and trends

Significance of livestock keeping in South Sudan

In addition to rain-fed farming, livestock keeping is the other dominant agricultural land use in South Sudan. Livestock are a productive livelihood asset, providing pastoralists with milk, which constitutes their main diet, but they also play a key role in socio-cultural life, especially for pastoralist peoples such as the Dinka, Nuer, Shilluk and Mundari (USAID, 2014); (MOE, 2014). For those who keep cattle, the animals are traditionally the most significant source of prestige, providing the currency for marriage dowries, fines and other societal dealings, which account for about 80 per cent of cattle transactions. Although there is a growing domestic livestock market, selling cattle is culturally forbidden and circumstances requiring sales are still unusual (Fernando & Garvey, 2013). A FAO study of livestock in the context of conflict in South Sudan identified the main purposes of livestock production: within the study area, which involved 554 key group informants across eight states, about 23 per cent of the population used livestock primarily for dowry payment, followed by milk and meat production (21.6 per cent), cash income (20.7 per cent), draft power and manure (18.1 per cent), social status (8.3 per cent) and finally, and least important, benefits from skins and hides (2.4 per cent) (Gebreyes, Lemma, Deng, & Abdullahi, 2016). It has been suggested that these cultural norms are in part responsible for the build-up of large herds of livestock since the 1960s and in large degree for the overgrazing of rangelands (USAID, 2014).

During the dry season, pastoralists typically migrate with their livestock to more permanent water sources and greener grazing pastures, such as the toic (or toich), the seasonally inundated floodplains surrounding the country's main rivers and inland watercourses, especially the Sudd wetlands (Table 9). In June, at the start of the rainy season, the flooded lowlands are no longer suitable for grazing given the humidity and threats from crocodiles and poisonous snakes, and herders return with their livestock to the uplands, where water and fresh pastures are again available. Migrating wildlife species follow the same seasonal pattern (USAID, 2014) (RSS, 2015). Clashes can occur about property rights over grazing lands, which are not well defined because there are historical and traditional rights to graze cattle and other animals on communal fields. Competing claims to the same territory by those for whom the land is their ancestral right, and those who have accessed it more recently and currently occupy it can lead to tensions between groups (Agbor & Taiwo, 2012).

Cattle Herders in Rumbek. *Photo credit: JennaCB123 [GFDL/ GNU.ORG/ CC BY-SA 3.0*

About 74 per cent of the population keeps livestock (RSS, 2015). In the country as a whole, an estimated average of 63 per cent of households own cattle, 69 per cent keep goats, 57 per cent have poultry, 38 per cent keep sheep and 5 per cent keep donkeys/mules (NBS, 2012). Households typically have an average of 25 animals (UNDP, 2012). Although livestock keeping is practised almost everywhere in the country, livestock numbers are greater in drier areas because of better-quality grass and fewer livestock parasites (Fernando & Garvey, 2013).

TABLE 9. TYPES OF GRAZING AREAS IN SOUTH SUDAN

Types	Description
Toic	Swampy depression areas, flooding June - October, producing pasture at end of dry season
Or	Open flood plain/bush land area dominated by clay — causing cracking and relatively dry areas — not holding water much into dry season
War	Floodplains along river courses
Rop	Forested areas, flooding August - September, often no natural water storage

Source: (Fernando & Garvey, 2013)

Significance of the state and extent of pastureland on livestock

The state of the environment and access to specific environmental resources are extremely significant factors in the health, numbers and productivity of livestock, and hence on the livelihoods of livestock-keeping peoples in South Sudan. The most important factors are the status of the toiches, intermediate lands and highlands during the grazing calendar. These include the degree of flooding in the rainy season; availability of drinking water and grazing areas in the dry season; pasture nutritive quality and palatability; plant species diversity and seasonality; crop production cycle in pastures; and the relative presence of mosquitoes and blood sucking flies (*Tabanus* and *Stomoxys spp.*).

In addition to the state of the seasonally used ecosystems, the other significant environmental factor is the extent to which cattle can access their grazing areas in the rainy season, given that seasonal crop cultivation can restrict access. Detrimental changes to these factors, such as those triggered by conflict, climate change, or other drivers, can negatively affect livestock productivity (Gebreyes, Lemma, Deng, & Abdullahi, 2016).

Cattle belonging to Dinka people.
Photo credit: Ranjit Bhaskar, via Al Jazeera English/ CC BY-SA 2.0

Livestock numbers

There are no available, recent and reliable data on the animal population or the amount of land covered by rangeland in South Sudan (MOE, 2015). Information from the 1990s suggest that the civil war and years of cattle raiding had reduced herd sizes in South Sudan; for example, about 40 per cent of families lost livestock in Northern Bahr el Ghazal during that decade (BRACED, 2016a). By some estimates, the country's cattle population is about 12.2 million, plus almost an equal number of goats and sheep (UNDP, 2012). More recently, it is suggested that there is a total of 38 million livestock in the country, compared to its human population of 12.3 million (USAID, 2016). South Sudan is considered to have the highest per capita number of livestock in Africa (USAID, 2014). The ongoing conflict is thought to be depleting livestock numbers, however, since cattle raiding is used as a weapon to destroy assets belonging to enemy communities (FAO, 2016d).

In 2014, the Crop and Food Security Assessment revised the 2009 cattle population figures by states (Table 10), revealing an annual increase of one per cent (Gebreyes, Lemma, Deng, & Abdullahi, 2016). The following year, the assessment reported that in 2015 ***"Livestock***

conditions were generally good due to adequate pasture and water availability. However, widespread events of cattle raiding and altered marketing/migration routes have been reported during the last two years in the areas of major conflict/insecurity, leading to high concentration of livestock ownership" (FAO and WFP, 2016).

The FAO study on the Impact of Conflict on the Livestock Sector in South Sudan provided alternative evidence on the trend in livestock population numbers based on data over a 60-year period from 1955 and 2014, which gives a much higher herd growth-rate than the aforementioned studies (Figure 13). The study reasons that given the discrepancy, a proper livestock census should be undertaken as soon as possible (Gebreyes, Lemma, Deng, & Abdullahi, 2016).

TABLE 10. RE-ADJUSTED CATTLE POPULATION NUMBERS FOR 2013 AND 2014 (IN THOUSANDS)

State	2013	2014	2015
Central Equatoria	881	885	885.5
Western Equatoria	891	895	895.5
Eastern Equatoria	675	679	679.4
Jonglei	1.469	1,475	1,475.8
Upper Nile	985	989	989.5
Unity	1,183	1,188	1,188.7
Lakes	1,314	1,320	1,320.7
Warrap	1,532	1,539	1,539.9
Western Bahr el Ghazal	1,251	1,257	1,257.7
Northern Bahr el Ghazal	1,583	1,590	1,590.9
Total	**11,765**	**11,817**	**11,823.6**

Source: (NBS, 2012)

Livestock industry

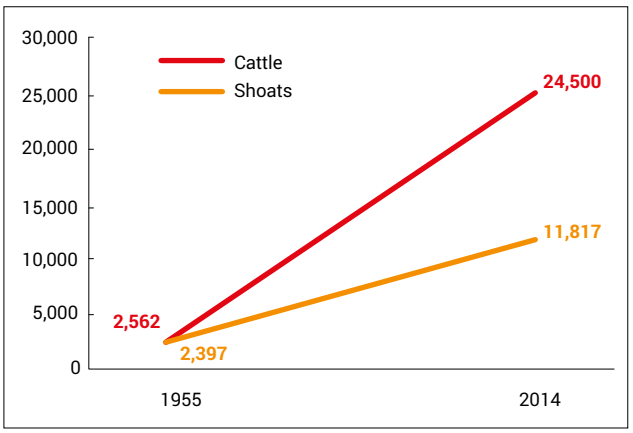
The livestock industry in South Sudan is still underdeveloped in terms of modern production and marketing. Further development of the industry could lead to greater production and exports; waged jobs; improved food security, livelihoods and income; and significant increases in GDP (MOE, 2015). Table 11 estimates that the gross value of livestock goods in South Sudan in 2013 was 7.316 billion SSP (equivalent to US$2.48 billion) (ICPALD, 2016).

TABLE 11. GROSS VALUE OF DOMESTIC LIVESTOCK PRODUCTION IN SOUTH SUDAN, 2013

Product	Value (Billion SSP)
Cattle milk	4.214095596
Camel milk	-
Goat milk	0.911953944
Subtotal estimated milk offtake	5.126049540
Cattle offtake	1.206843752
Camel offtake	-
Sheep offtake	0.457231168
Goat offtake	0.419788224
Pigs offtake	-
Poultry offtake	-
Subtotal estimated livestock offtake	2.083863144
Cattle hides and skins	0.013377995
Camel hides	-
Sheep skins	0.007454840
Goats skins	0.007237728
Subtotal estimated hides and skins offtake	0.028070563
Manure as fertiliser	0.078420966
Total Product Output	**7.316404213**

Source: (ICPALD, 2016)

FIGURE 13. SIXTY-YEAR TREND IN LIVESTOCK POPULATION NUMBERS, 1955-2014



Source: (Gebreyes, Lemma, Deng, & Abdullahi, 2016)

Livestock: pressures and impacts

Overgrazing and rangeland degradation and loss
Livestock keeping in South Sudan is sustainable when the grazing and browsing of grass, seedlings, bushes and trees allow the vegetation to re-grow. Overgrazing occurs when the livestock numbers are too high and/or the frequency of browsing the same land area is too high. This can lead to land degradation, especially in the presence of other contributing factors such as drought, fire or land clearing for other purposes. The removal of seedlings is especially destructive. Pastoralists often burn grass to promote the re-growth of perennial grasses in the dry season, but if the fires are poorly managed, they can degrade the grass cover and kill tree seedlings, reducing re-growth (Penning de Vries & Djiteye, 1982). Overgrazing can fragment the open tree savannahs and encourage their conversion to grasslands, the loss of soil fertility and structure, erosion by wind and water, and in the long run, cause land degradation and lead to desertification (Miehe, Kluge, von Wehrden, & Retzer, 2010); (RSS, 2012); (MOE, 2014). As human and livestock populations increase, so does the threat of land degradation, especially if there is conflict among communities over land resources (Dima, 2006).

As rangeland areas are reduced, if livestock numbers do not also decline, livestock stocking rates can be unsustainably high (USAID, 2014). In 2013, livestock densities were estimated at 2.6 animals per hectare of grassland in South Sudan as a whole, which is considered relatively high (USAID, 2014).

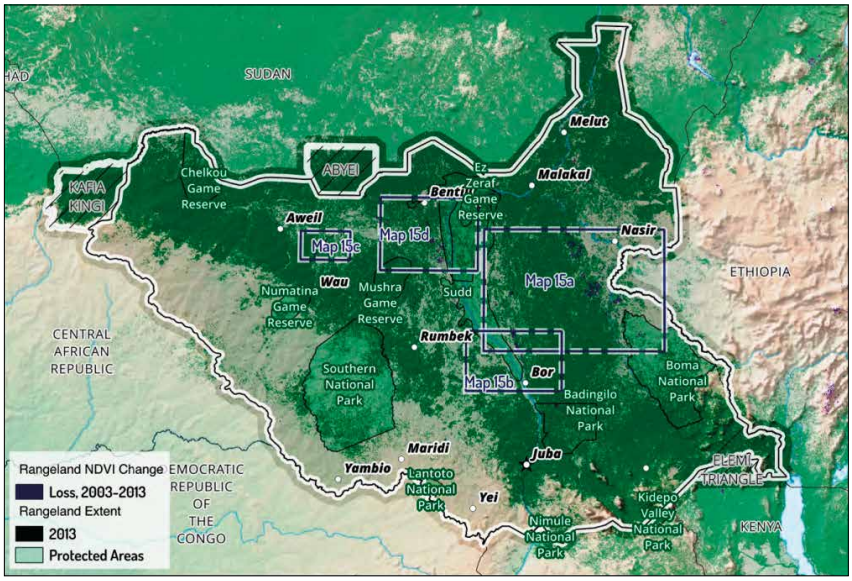
The impact of livestock grazing is less visible and more difficult to measure than is the loss of vegetation from clearing for agriculture, cutting charcoal and harvesting wood for fuel and building materials (RSS, 2012).

It is thought that rangeland areas are being depleted due to overgrazing and recurring drought (MOE, 2015). In the early 2000s, there was evidence of land degradation in many places in South Sudan. In the dry season and around watering points, especially along cattle routes to the toich, large herds were responsible for visible overgrazing in some areas (Dima, 2006).

It was estimated that between 1973 and 2006, there had been an annual loss of rangeland of 18.5 per cent due to degradation and land conversion (UNEP, 2007); (RSS, 2012). Between 2000 and 2012, it is thought that South Sudan lost approximately 175,000 ha of rangeland cover. Although the land area lost is currently relatively small, growth in human and livestock populations will increase the likelihood of land degradation and rangeland loss. Figures 16 to 20 show rangeland loss in several places throughout the country between 2003 and 2013. There is evidence that in Northern Bahr el Ghazal and the floodplains, grasslands are heavily degraded and low-quality grasses are replacing the perennial grasses, such *Andropogon gayanus* (USAID, 2014).

Cows graze on the bank of the Nile. *Photo credit: BBC World Service/Flickr.com/ CC BY-NC 2.0*

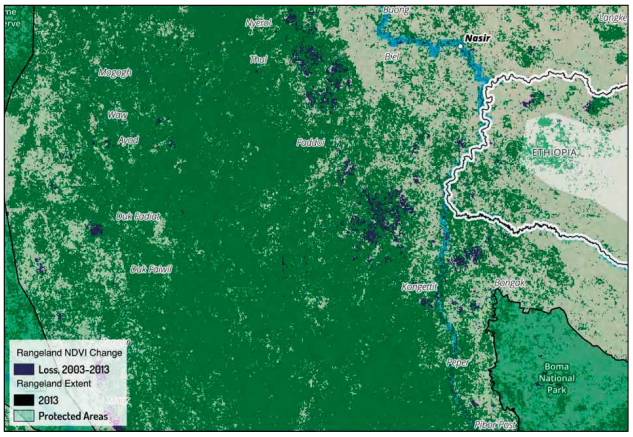
FIGURE 14. RANGELAND LOSS AND DEGRADATION, 2003-2013



Note: An analysis of change in rangeland cover was conducted with two sets of sequential-year MODIS reflectance data: 2001-2003 and 2011-2013. Mean Normalised Difference Vegetation Index (NDVI), a commonly used measure of vegetation health, was calculated per pixel for each 3-year set, and then the newer dataset was subtracted from the older.

Source: (USAID, 2014)

FIGURE 15: RANGELAND LOSS AND DEGRADATION IN EASTERN SOUTH SUDAN, 2003-2013

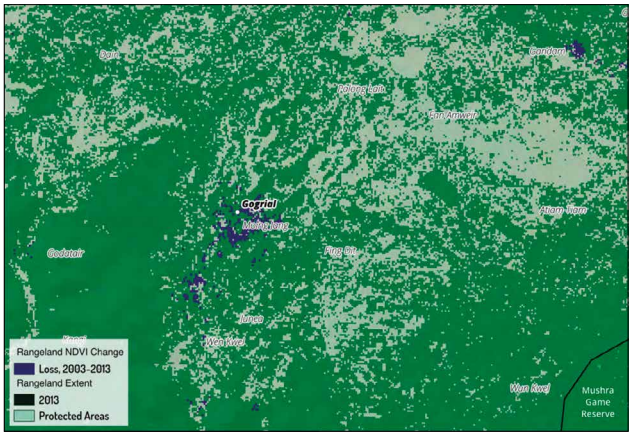


Source: (USAID, 2014)

FFIGURE 16: RANGELAND LOSS AND DEGRADATION NEAR BOR, SOUTH SUDAN, 2003-2013

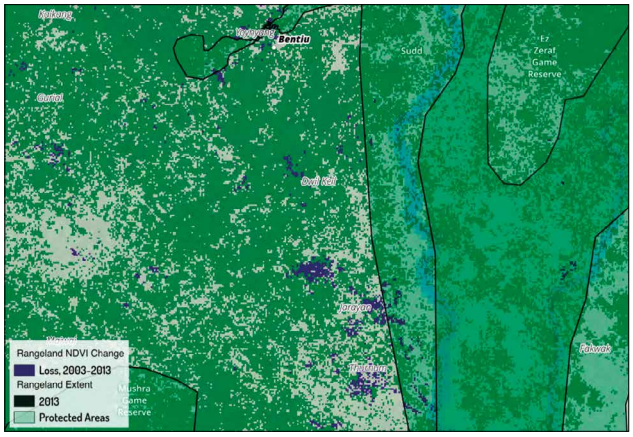
Source: (USAID, 2014)

FIGURE 17: RANGELAND LOSS AND DEGRADATION NEAR GOGRIAL, SOUTH SUDAN, 2003 - 2013



Source: (USAID, 2014)

FIGURE 18: RANGELAND LOSS AND DEGRADATION NEAR BENTIU, SOUTH SUDAN, 2003-2013



Source: (USAID, 2014)

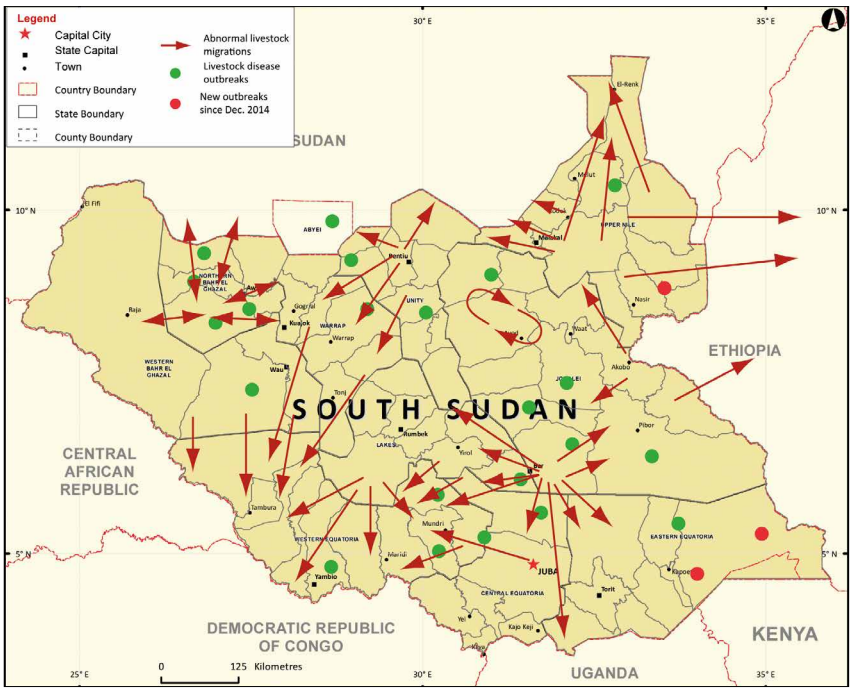
Plant and animal pests and diseases

According to the FAO, it is likely that one in every five cattle in South Sudan dies of disease (FAO, 2016d). It reports that *"endemic diseases (such as haemorrhagic septicaemia, contagious bovine pleuropneumonia, anthrax and peste des petits ruminants) are undermining livestock production, threatening the livelihoods of 65 per cent of South Sudan's population"* (FAO, 2016c). It also notes that transboundary diseases, such as foot-and-mouth disease and rabies, threaten the lives of millions of animals in the country (FAO, 2016d). The CAMP reports that the impact of livestock diseases on food security is enormous, *"with losses in meat and milk production and related costs of treatment, amounting to hundreds of millions of USD"* (RSS, 2015).

Abnormal migration and heightened tensions between settled farmers and pastoralists due to the ongoing conflict have exacerbated these disease outbreaks. Furthermore, the ability of local authorities to monitor and control them is severely limited and the appropriate technologies and adequate access to animal health and veterinary services are lacking (FAO, 2016c); (RSS, 2015).

Since December 2013, the political crisis has led to extreme rivalries amongst military and tribal groups, blocking the access of large numbers of pastoralists and their livestock to traditional water, pasture and market sources, and forcing them to change their migration patterns and flee to other areas or into other states. As a result, people and livestock from different geographical areas are intermingling with other pastoralists and farmers in confined areas, causing tensions among the different populations and affecting animal health (Figure 19). The FAO reports that from September to December 2014, there were 22 reports of livestock disease outbreaks in South Sudan and the disputed Administrative Area of Abyei compared to same period of 2013, during which there were no reports of outbreaks of any of the same diseases. The rise in animal diseases has increased the exposure of those handling raw animal products such as milk, especially women, to zoonotic diseases (FAO, 2015).

FIGURE 19. LIVESTOCK MOVEMENTS AND DISEASE OUTBREAKS IN SOUTH SUDAN, 2014 AND EARLY 2015



Source: (FAO, 2015)

Water and pasture shortages

Although the country is well endowed with water resources in its rivers, lakes, wetlands and toiches, humans and livestock in some parts of the country frequently suffer from water shortages. For example, along border areas between South Sudan and Sudan, lack of water has been a major cause of conflict between herders in the two countries (Gebreyes, Lemma, Deng, & Abdullahi, 2016).

A 2016 study of livestock, in the context of conflict, perceived that the level of exposure of the toich in the dry season (beginning in December with the most exposure around June) determines grazing accessibility. On the other hand, the proportional area of flood-free intermediate lands and highlands not growing crops determines the availability of grazing land in the rainy season. The study concluded that South Sudanese livestock are exposed to grazing shortages in the middle of both the rainy and dry seasons (Gebreyes, Lemma, Deng, & Abdullahi, 2016).

4.4 Fisheries: Status and Trends

Subsistence and capture fisheries

Fishing in South Sudan is generally a subsistence or artisanal activity; the commercial fishery industry remains relatively small. Artisanal fishers use simple fish harvesting techniques such as gillnets, throw nets and hooks. Women in the north use baskets to catch fish in stagnating pools (RSS, 2012). Dugout, un-motorised canoes constitute the bulk of the fishing fleet (FAO, 2014).

About 17.3 per cent of the population directly depends on the capture fishery. Although there are no reliable data, it is estimated that there are some 208,000 subsistence fishers and about 12,000 commercial fishers in South Sudan. Fishing takes place in the Sudd wetlands, the River Nile, other rivers, tributaries and floodplains (FAO, 2014).

There is a large variety of fish species in South Sudan's Nile and other rivers, including tilapia and Nile Perch, which are among the 100 species that are known (Nhial, 2015). It is likely that the Nile tilapia (Oreochromis niloticus) accounts for 30 per cent of the country's capture fishery. The Nile Perch and the African Catfish are the other high-value target species (FAO, 2014).

In 2014, the industry was valued at US$510 million. Although there are no data, it thought that fish production suffers large losses, perhaps up to 60 per cent, due to poor post-harvest conditions, such as the lack of cold storage and refrigerated transport (FAO, 2014).

The fishery in South Sudan is an open access regime and fishers from Sudan use fast boats on the Nile and in the Sudd wetlands. There is no licensing or taxation system, although fish retailers are taxed when selling fish on the market, and there is no institutional organisation or capacity to perform data collection, analysis or processing, etc. (FAO, 2014). There is a fishers' association in Nyamlel where members' regular contributions support an established social security system (RSS, 2012).

Key issues include under exploitation, postharvest losses and lack of data.

Fishers fishing outside Bussere in Wau.
Photo credit: Rory Mizen/Flickr.com/CC BY-NC 2.0 .

Fishing for Subsistence in Bentiu.
Photo credit: UN Photo/JC McIlwaine

Aquaculture

Some subsistence aquaculture occurs in a few places. Development partners and non-governmental organisations have built about 111 aquaculture ponds in South Sudan, 95 per cent of which are in the Green Belt. They consist of small ponds of 300 m2 or less dug into the earth, of which only 38 were functioning in 2014. They are meant to help provide food, nutrition security and livelihoods, as well as rehabilitate war returnees (FAO, 2014).

There is a large potential for aquaculture development in former Central, Eastern and Western Equatoria, Northern Bahar el Ghazal, Western Bahar el Ghazal and Warrap States. Currently there is no institutional capacity to develop the commercial industry, very little research has been done and there are no reliable statistics. There is an enormous need for government assistance, particularly in providing seed (fingerlings) and in feed production. Most producers rely on imported tilapia fingerlings and feed from Uganda (FAO, 2014); (MARF, 2012).

BOX 3: FISH FARMING IN WESTERN EQUATORIA

Although years of war hampered the development of the fishing industry of South Sudan, the country's poor road network is the main factor limiting its expansion, since the lack of roads inhibits the delivery of fish to markets in states that are far away from the Nile. In Western Equatoria, the Akorogbodi Fish Farm, a group of fish farmers made up of eleven women and four men, is turning this challenge to their advantage (Nhial, 2015).

The group hopes to revive fish farming in their state. Very soon after it opened, the farm had already become a model and a source of fingerlings for nascent fish farms. By the end of 2014, along with four other enterprises, the Akorogbodi Fish Farm had supplied a total of 42,000 fingerlings to 13 newly established fish farms in Yambio, Tambura, Ibba, Maridi, Ezo and Nzara in Western Equatoria State (Nhial, 2015).

Poor road network: road between Thiet and Tonj. *Photo credit: Steffen Emrich/Flickr.com/CC BY-ND 2.0*

Fisheries: pressures and impacts

There are reported losses in the variety of fish species in the rivers issuing from the plateau along the border with the Central African Republic. It is thought that 5 of the 15 fish species known to fishers in the area have disappeared from the River Lol, and fish size has also declined. For example, an African lungfish (*Protopterus spp.*) could previously reach 1.5 metres in length but the fish caught recently have been a maximum of 0.5 metres long. Declining water flows have been responsible for these impacts, due to a combination of factors, including forest clearing, overgrazing and forest fires that have accelerated erosion and siltation, as well as climate change that has seen less rainfall and higher evaporation (RSS, 2012).

Other potential threats to fish stocks, fish species biodiversity and fish habitat as well as the viability of the fishing industry are unsustainable fishing practices and over-exploitation, water pollution, siltation and reckless oil exploration activities in the Sudd wetlands (MOE, 2014).

4.5 Challenges and Limitations in the Agriculture Sector

Given the abundance of potentially productive agricultural land in South Sudan and the very small proportion of land that is actually cultivated, the extent of water bodies but the underdevelopment of the capture fisheries and aquaculture industry, as well as the fact that the country relies on food imports from neighbouring countries and therefore suffers from high food prices and food insecurity, it is clear that a large number of constraints conspire to limit the success of agricultural and fisheries development in South Sudan.

Currently, the situation of conflict is the key threat to food production; it forces farmers and pastoralists to move away at times of the year that are crucial for planting and grazing, disrupts markets and reduces herd sizes, amongst other impacts. Since July 2016, the increased violence has severely constrained crop and livestock activities even in areas that are normally stable. The FAO reports that the conflict has led to soaring inflation that can reach up to 800 per cent year-on-year, and that market failures are affecting people in urban areas that traditionally rely on markets to meet food needs (FAO, 2017). In addition, the poor state of roads, and the short and expensive supply of motorised transport services prevent farmers from marketing their produce and accessing basic supplies (Barnaba, 2015).

Traditionally, women and girls do the majority of the cultivation, processing and marketing of produce; thus, another contributing factor to the lack of progress in the country's agriculture sector is the discrimination and inequalities they face, including sexual and gender-based violence, which hampers the development of their farming and marketing endeavours, affecting harvests and household incomes (FAO, 2016b).

Another major limitation to agricultural development is the lack of access to land for many people, particularly returnees, internally displaced people, and women generally, especially widows. Protracted conflict has weakened customary rights to land that used to ensure equal access for all community members. Farmland is usually community owned and this category of land ownership applies to more than 90 per cent of farmers. The lack of clarity and proper procedures for acquiring land, and the lack of audit and monitoring systems have reduced transparency and accountability in land transactions. The CAMP notes that in both rural and urban areas, the "unclear and incomplete legal, policy and regulatory framework for land tenure has resulted in inconsistencies in implementation, adversely affecting land for livestock production, migration, marketing and processing" (RSS, 2015).

Other factors that affect crop, livestock and fish production are the lack of public and private investment and value added to agricultural produce; absence of agricultural financial institutions; the lack of availability and access to quality seeds, planting materials, fish fingerlings and other inputs; inadequate support services, modern tools, equipment, research, agricultural technologies, rural infrastructure, extension services and farmer schools, training opportunities and research into disease resistant crops; and an unfavourable environment for private-sector investment (UNDP, 2012); (FAO, 2016c); (FOA, n.d.); (EU, 2016); (RSS, 2015).

On the other hand, farmers in South Sudan have adapted well to some of these limitations. For example, the CAMP reported that in general, farmers in South Sudan commonly experience seasonal food insecurity; they are resilient to erratic climatic conditions and engage in a variety of activities to cope with food insecurity. In fact, they have established "vibrant rural-to-rural and rural-to-urban market economies … despite poor road conditions, lack of support services and competition with products imported from neighbouring countries" (RSS, 2015).

The impacts of climate change

Since agriculture in South Sudan is mostly rainfed and depends on seasonal rainfall, the livelihoods of farmers, pastoralists and fishers are extremely vulnerable to the impacts of climate change. Increasing climate variability, which exacerbates flooding and drought events, has significant impacts, including frequent lack of groundwater availability and the degradation of croplands and rangelands, which disrupts food production and markets, and contributes to cycles of violence, food insecurity and malnutrition (BRACED, 2016a); (BRACED, 2016b); (RSS, 2016).

The decline in rainfall and rise in temperatures associated with climate change in South Sudan (see Chapter 2) can aggravate existing tensions over land use among and between farmers and pastoralists as they compete for increasingly scarce resources (Table 12). A 2016 report on climate change risks in South Sudan suggests that this forces pastoralists to change their migration patterns in search of water and fodder, bringing them into contact with existing agricultural lands and other pastoralists. At the same time, faced with declining yields and soil quality because of the drier climate, farmers are expanding their agricultural use of land to areas formerly used as seasonal pasture. The same study cited recent evidence that yields of sorghum, the staple grain for most of the population, will decline by 5 to 25 per cent between 2000 and 2050 under the influence of climate change (USAID, 2016).

BOX 4. BRACED STUDY OF CLIMATE CHANGE IMPACTS IN SEVERAL FARMING COMMUNITIES IN SOUTH SUDAN

A 2016 anthropological study explored the perceptions and experiences of climate change, adaptation and resilience among agro-pastoralist and farming communities in Tonj South and Aweil West. It documented the experiences among six communities of the Dinka Malual and Dinka Thony (Rek), as well as the Bongo and Luo tribes. The study concluded that *"All of the observed changes were perceived to have had particularly negative effects on agricultural production. Delayed rains forced later planting, which was further compounded by earlier flash floods that washed away crops grown close to the river. Other negative effects included reductions in pasture availability, less productive fisheries resulting from smaller floods, increases in unwanted weeds, increases in crop pests, and the decline of productivity of fruit trees during years of low rainfall.... the majority of these negative effects of climate change were emphasised with much more frequency in Aweil West, where rainfall is lower, than in Tonj South".*

Source: (BRACED, 2016a)

TABLE 12. CLIMATE RISKS AND POTENTIAL IMPACTS – AGRICULTURE AND PASTORALISM

Climate Risk	Potential Impacts
Increased minimum temperatures	Loss of productive agricultural lands due to desertification
Increased rainfall variability – onset and length of rainy season	Delayed planting and earlier harvest leading to a shortened growing season
	Reduced yields and/or crop failure
Increased incidence of drought	Loss of pasture lands and reduced access to water resources for livestock
	Increased local conflicts over land use and resources between and among pastoralists and farmers

Source: (USAID, 2016)

In addition to being affected by climate change, agriculture also contributes to the changing climate. As shown in Chapter 2, the agriculture sector of South Sudan, along with land-use change such as deforestation, is the country's largest emitter of greenhouse gases. Livestock produce methane, a potent greenhouse gas, emitted from their excrement and urine. A 2013 study identified sub-Saharan Africa as a global hotspot in terms of greenhouse gas emissions from livestock. It calculated that cattle grazing in the arid lands of Ethiopia, Somalia and Sudan can release the equivalent of 1,000 kg of carbon dioxide for every 1 kg of protein they produce, compared to the emission intensity of about 10 kg for every 1 kg of protein in many parts of the developed world where cattle feed has a more efficient nutrient balance (Herrero, *et al.*, 2013). Although there are no reliable data on methane emissions from livestock in South Sudan, estimates suggest significant volumes in the order of 30,000-160,000 m^3/year (MOE, 2014).

4.6 Response to Environmental Impacts of Agriculture Sector

The Government of South Sudan has introduced various measures to address the environmental impacts of the country's agriculture sector. It is likely, however, that many government initiatives have not yet been able to advance to the implementation stage, pending the cessation of conflict.

Intended Nationally Determined Contributions (INDCs)

At the international level, in response to its obligations to reduce greenhouse gas emissions (mitigation) and promote adaptation to climate change impacts under the United Nations Framework Convention on Climate Change, South Sudan submitted its Intended Nationally Determined Contributions (INDCs) in 2015. In terms of mitigation, the INDCs commit South Sudan to undertaking a national greenhouse gas inventory. It is also committed to introducing policies and actions to limit future emissions from planned land use and land use change (among other sector-specific growth strategies), contingent upon the necessary capacity and resources. In addition, the government is developing a National Adaptation Plan of Action that will complement the INDCs in forming the basis of the country's strategy to adapt to climate change (RSS, 2016).

The Agriculture Sector Policy Framework 2012-2017 (see below) recognises climate change as an important environmental issue and the need for policy measures to mitigate its adverse effects in the medium and long-term (RSS, 2015). More specifically, the government aims to promote climate-smart agriculture (Box 5), and prioritise harvesting and retaining water through community-based watershed management, which will serve agricultural purposes in dry seasons and drought, among other uses (RSS, 2016).

BOX 5. CLIMATE-SMART AGRICULTURE

The Food and Agriculture Organization defines Climate-Smart Agriculture as *"an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. Climate-Smart Agriculture aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible"* (FAO, 2016a).

South Sudan has committed to *"promoting sustainable, climate-smart agriculture and livestock production and management. The country will prioritise the enhancement of climate resilience in the agricultural sector (crop production, livestock, and fisheries) through the promotion of climate-smart agriculture, livestock improvement, enhancement of fisheries productivity and soil erosion control. This will be achieved by building upon traditional knowledge and supporting community- based adaptation strategies"* (RSS, 2016).

Source: (BRACED, 2016a)

Policies, strategies and plans

The following policies, strategies and plans have been put in place to guide agriculture and fisheries development in the country and ensure their sustainability; the points show selected strategies specifically related to agriculture. The current conflict and lack of adequate capacity and resources, however, means there is a dearth of information about progress in implementing them.

SOUTH SUDAN DEVELOPMENT PLAN (SSDP), 2011-2013

- Prioritises the agriculture sector and infrastructure for economic development
- Prioritises fisheries for economic development

THE MINISTRY OF ANIMAL RESOURCES AND FISHERIES (MARF) POLICY FRAMEWORK AND STRATEGIC PLAN 2012-2016

- Implemented by the Department of Range Management in collaboration with relevant agencies in range and livestock research, wildlife activities and water development for livestock use
- Promotes best animal husbandry practices
- Promotes integrated range management practices
- Aims to map livestock migratory routes and grazing areas and to establish water catchments
- Will develop mechanisms for drought preparedness
- Intends to institutionalise community involvement in natural resources management
- Will promote the criminalisation of cattle rustling, and sensitise and train communities on issues related to risks of cattle rustling (MOE, 2015)

THE AGRICULTURE SECTOR POLICY FRAMEWORK FOR 2012-2017

- Aims to enhance measures to mitigate the adverse effects and impacts from climate change in the medium and long-term
- Collaborates with the Ministry of Environment and Forestry in developing a National Adaptation Programme of Action to identify priority activities that respond to the immediate needs of South Sudan to adapt to climate change and to formulate a Climate Change Country strategy
- Has outlined a green agriculture policy (adopting agricultural practices that minimise environmental pollution and promoting agroforestry practices)
- Mainstreams gender in agricultural activities
- Intends to prepare a Dry Land Initiative and an Irrigation and Drainage policy
- Protects plants, seed management and development of the plant genetic resources conservation programme and a biosafety framework
- Recommends a well-managed genetically modified organisms policy to ensure stability and diversity of the indigenous genetic resources of South Sudan for enhancing agricultural development
- Recommends the formulation of a law to regulate importation and use of genetically modified organisms in South Sudan
- Calls for the promotion and support for research in germplasm utilisation, and to enhance information exchange
- Will develop a sustainable programme for the conservation and judicious utilisation of plant genetic resources to enhance agricultural development
- Will establish a plant genetic resource centre for indigenous plants
- Will enhance the institutional framework for promoting sustainable croppest and disease management and ensuring accessibility of organic and inorganicpesticides by farmers
- Will enhance seed management inthe country by adopting EAC and internationally accepted protocols for seedtesting, multiplication and distribution
- Will formulate and adopt a Plant Protection Policy and a Seed Policy, the backbone of the conservation and protection strategy (MOE, 2015)

THE FISHERIES POLICY FOR SOUTH SUDAN 2012-2016

- Provides for a framework to manage fisheries resources so as to maximise production and avoid overfishing, and prevent destruction of wetlands and promote their conservation
- Aims to adopt measures to prevent environmental damage to aquatic systems through pollution and environmental degradation
- Will ensure that compulsory Environmental and Social Impact Assessments are undertaken for all developments that affect fisheries, including large-scale aquaculture developments
- Will observe all international treaties and protocols that protect fishing communities and fish habitats against both encroachment and pollution
- The Fisheries Bill 2012 implements the policy goals (MOE, 2015)
- Provides direction for sustainable aquaculture development and production, contributing to economic growth, poverty alleviation and food security
  1. Attract private investment to aquaculture by creating an enabling environment
  2. Attract funding for development of integrated agriculture/aquaculture in rural areas
  3. Regulate the production of feed for aquaculture
  4. Control diseases in aquaculture and improve reporting
  5. Control species introductions and transfers in aquaculture
  6. Enhance aquaculture in areas where irrigation schemes & dams are created
  7. Address environmental concerns regarding aquaculture (MARF, 2012).

COMPREHENSIVE AGRICULTURAL DEVELOPMENT

- Covers the subsectors of agriculture, forestry, livestock and fisheries
- Formulation of CAMP is undertaken by the Ministry of Agriculture and Food Security, Ministry of Livestock and Fisheries; Ministry of Environment and Forestry; Ministry of Irrigation and Water Resources; and the Ministry of Energy and Dams
- The CAMP formulation process is guided by the following principles:
  1. Government-led formulation
  2. Capacity development through the formulation process
  3. Formulation of an implementable plan
  4. Alignment with existing policies, plans and institutional arrangements
  5. Coordination with other stakeholders (RSS, 2015).

IRRIGATION DEVELOPMENT MASTER PLAN (IDMP)

- Implemented by the Ministry of Energy and Dams and the Ministry of Irrigation and Water Resources
- Will formulate master plans for the agriculture sector and irrigation development that will help to achieve steady economic growth through efficient, effective, and sustainable rain-fed and irrigated agriculture (Fernando & Garvey, 2013); (MEDIWR, 2015).

NATIONAL AGRICULTURE AND LIVESTOCK EXTENSION POLICY

- Provides direction for the management and organisation of an extension system with both public and private extension service providers
- Offers guidance for service providers and other stakeholders on matters of standards, approaches, implementation mechanisms and on how to strengthen coordination among all actors
- Key features include:
  1. Adoption of pluralistic and participatory extension services;
  2. Privatisation of extension services;
  3. Research priorities and extension messages that meet farmer needs;
  4. Developing human resources commensurate with emerging needs and on other cross-cutting issues such as gender and environment affecting agricultural development;
  5. Use of multiple approaches to meet diversified client needs and agro-ecological zones;
  6. Empowerment of clientele and service providers;
  7. Ensuring factors vital to extension service provider motivation are considered in agriculture development activities;
  8. Financing of extension services (ALETF, 2011)

4.7 Conclusion

Agriculture is the backbone of the subsistence economy of South Sudan, accounting for one-third of GDP in 2009. About 81 per cent of households cultivate land, about 22 per cent of the population is engaged in fishing and 74 per cent of the population keeps livestock. There is an estimated total of 38 million livestock in the country, compared to its human population of 12.3 million. A huge variety of crops are grown in South Sudan, where the diversity of soil and climatic conditions provide multiple options for different cereals, legumes, fruits and vegetables.

On the other hand, the country's huge agricultural potential is unexploited. Although 70-90 per cent of the country's total area is suitable for agriculture, about half of which is classified as prime agricultural land, only about 4 per cent of the total land area is cultivated. Crop yields and fish harvests are low, and although livestock densities are the highest in Africa, the country imports meat from neighbouring countries. The country has abundant water resources but the fishing industry is not developed; fishery stocks are undoubtedly stable but are probably underexploited.

There are many challenges to developing the agricultural potential of South Sudan, not least of which is the ongoing conflict. Currently, it is the key threat to marketing food products, along with the poor state of roads and lack of transportation and refrigeration.

Limitations to increasing the area of land under cultivation include very low population densities, high upfront costs of land clearing and low rural connectivity in some areas with high potential. Yields are low due to the poor genetic quality of seed stock, and lack of mechanisation and irrigation. Livestock production for food and commercial markets is hampered by cultural norms that value cattle for prestige and social transactions, and place taboos on sales. In addition, endemic diseases undermine livestock production.

Other challenges include gender discrimination and inequalities towards women who play a large role in cultivating, processing and marketing produce, hampering their progress. The lack of access to land and land-tenure regulation is another limitation to agricultural production. Increasing climate variability, which exacerbates flooding and drought events, has significant impacts on agriculture, including declines in groundwater and the degradation of crop- and rangelands, which disrupts food production and markets, contributing to cycles of violence, food insecurity and malnutrition. It is likely also a factor in declining yields and soil quality because of the drier climate, forcing farmers to expand land cultivation to areas formerly used as seasonal pasture.

There is a severe lack of recent and reliable data related to the agriculture sector, such that much of this chapter's assessment is based on estimates and "old" data. In terms of trends, there appears to have been an overall decline of 7.7 per cent in the total area planted in crops between 2012/2013 and 2016, likely accounted for by the abandonment of fields due to conflict. On the other hand, in some places cropland expanded in 2014 and 2015, no doubt due to the significant local influx of Internally Displaced Persons.

It is likely that the cultural value placed on cattle contributed to an increase in livestock numbers since the 1960s and that this rise in herd sizes was responsible in large part to overgrazing of rangelands. Between 2000 and 2012, it is thought that South Sudan lost approximately 175,000 ha of rangeland cover. More recently, renewed conflict is probably depleting livestock numbers, since cattle raiding is used as a weapon to destroy enemy assets.

The climate, soils, abundant water sources and variety of ecosystems of South Sudan make it suitable for producing a wide range of agricultural products (AfDB, 2013). Further development of the agriculture sector could lead to greater production and exports; waged jobs; improved food security, livelihoods and income; and significant increases in GDP. There is a huge potential for expanding irrigation, improving yields through seed selection and provision, developing aquaculture and taking advantage of other opportunities, such as those proposed in Table 13.

Herds of cattle in Equatoria region.
Photo credit: Fabrizio Demartis/ Flickr.com/CC BY-SA 2.0

TABLE 13. AGRICULTURAL OPPORTUNITIES IN SOUTH SUDAN

Sector	Nature of Opportunity
Cereals Oilseeds Sugar	• Wide expanses of land along river banks in the northern and central parts of the country, with rich soils and ample sunshine, ideal for cereals pulses, sugar and oilseeds (sunflower, soybean, groundnut etc.) • High rainfall areas in the south ideal for oil palm; floodplains & river valleys ideal for rice • Local and regional supply deficit and high prices (cereals, oils and sugar are the top 3 food imports to South Sudan and neighbouring countries) • WFP and Government eager to purchase locally for food aid programmes • Potential to generate own power needs from begasse/biomass waste (and sell surplus to local communities/industries) (Ogwaro, 2011)
Horticulture & Floriculture	• High altitude, high rainfall "greenbelt" along Uganda border suitable for temperate horticulture and floriculture production – within 200km of international airport at Juba • Widespread tropical fruit production – mango, pineapple, avocado, etc. • Potential to supply local markets (most produce for urban markets currently imported) and export to EU and Middle East (as in Kenya and other EAC countries) (Ogwaro, 2011)
Coffee/Tea	• Coffee & tea plantations established in Greenbelt in the 1970s, abandoned during war • Potential for investors to revive plantations and invest in coffee washing stations and tea factories (Ogwaro, 2011)
Specialty crops (gum acacia, etc.)	• Sudan as a whole is a leading exporter of sesame and gum acacia – high value crops particularly in the Middle East (Ogwaro, 2011)
Livestock	• Potential for pig farming to reduce organic food waste and produce biogas in urban and peri-urban areas and for pork to supply markets with local meat that would help reduce ruminant numbers and associated deforestation and land degradation (RSS, 2012) • Potential for livestock hides and skins, which are presently treated as waste, to be used for revenue generation (MOE, 2015)
Honeybees	• Potential for new technologies to improve the honey industry (MOE, 2015)
Fishing	• Fully developing the fishing potential in South Sudan could provide jobs and food for 80,000 people and provide the country with export earnings. The industry as a whole could be valued at about half a billion USD a year (FAO, 2012)

Source: (NBS, 2012)

The government's development plans and strategies identify developing the country's agricultural and livestock potential as the most feasible option for broad-based economic growth and food security in the short- to medium-term. The strategy aims to substantially expand the area under cultivation; increase yields in areas already being cultivated; ensure high productivity on newly farmed lands; expand markets for livestock and fish; and promote climate-smart agriculture to address the impacts of climate change. It will also promote adding value to the sector by fostering food and raw materials processing to provide jobs and increase earnings (AfDB, 2013). The government has instituted a range of policies, plans and strategies to accomplish these aims, the implementation of which is currently stalled or hampered by a situation of ongoing conflict and a state of famine in large parts of the country.

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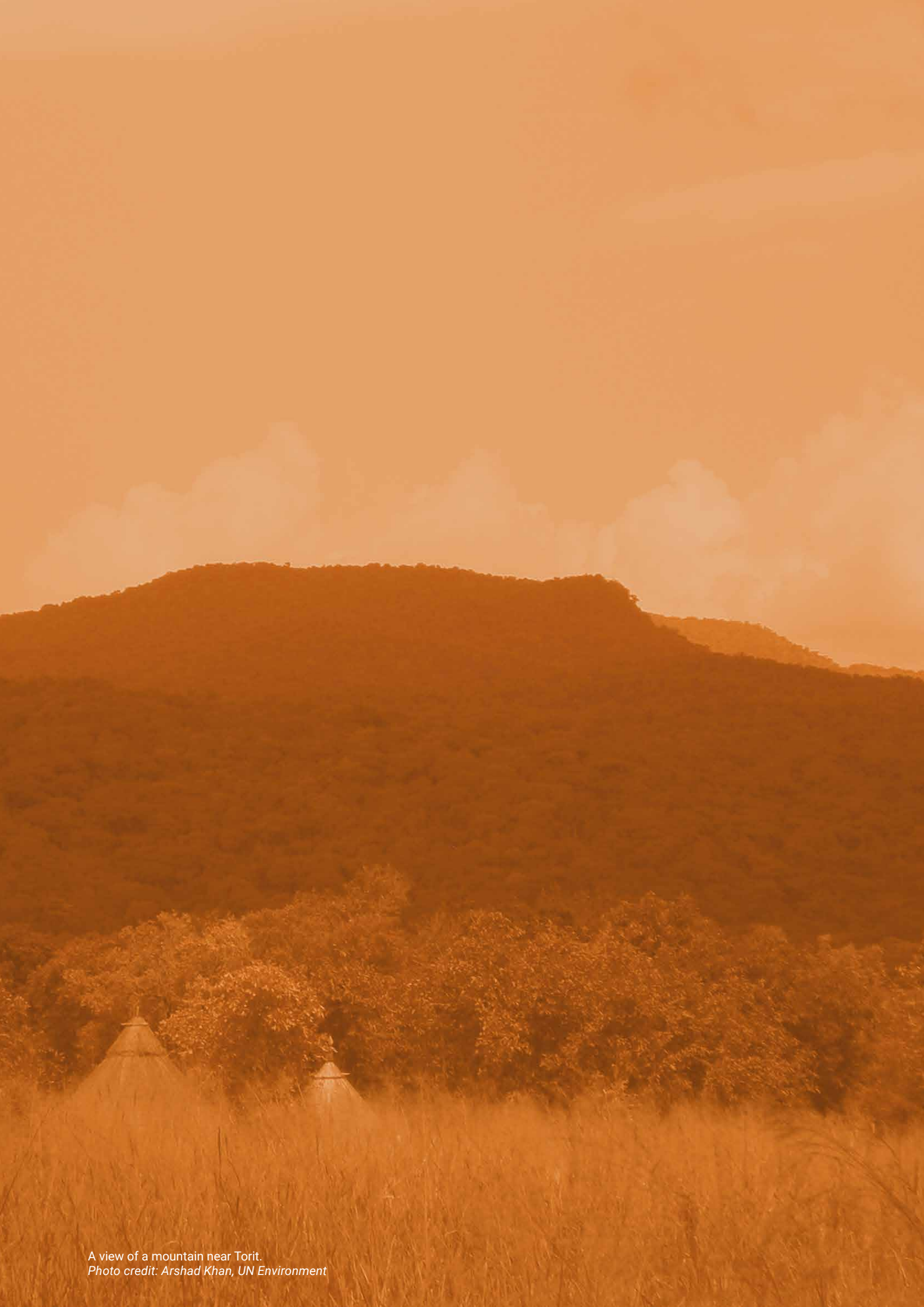

A view of a mountain near Torit.
Photo credit: Arshad Khan, UN Environment

CHAPTER 5
FORESTS

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FORESTS

5.1 Introduction

Forests and woodlands of various types cover a large proportion of South Sudan's vast territory (RSS, 2015). Its natural forests have high levels of biodiversity and wildlife habitat, and generate important ecosystem goods and services. These include provisioning of goods (shelter, timber, fuel, food, medicines etc.) and services, carbon sequestration, hydrological cycling, soil stabilisation and cultural services. More than 90 per cent of the country's population directly depends on forests for fuelwood and charcoal production, timber for construction, and non-timber forest products for food and nutrition security; however, this resource is fast disappearing (FAO, 2016).

On the other hand, large areas of the country's forests and woodlands have remained untouched for decades. These natural forests, as well as current and future plantations, could play much more significant roles in South Sudan's economic development, but they will need to be managed sustainably so they maintain their valuable ecological attributes, and do not continue to degrade and disappear (RSS, 2016b).

Natural Forest in Easter Equatoria.
Photo credit: Ministry of Environment and Forestry.

5.2 Status and Trends

Forest area

There are no reliable data on the extent of forests in South Sudan, since a detailed forest survey and inventory has never been carried out. Depending on the source, estimates of the proportion of forest-covered land area in South Sudan vary from 11.1 per cent to 35 per cent. If "other wooded land" is added to the equation, the proportion can rise to as high as 90 per cent (Table 1).

TABLE 1. COMPARISON OF FORESTLAND ESTIMATES FOR SOUTH SUDAN FROM A VARIETY OF SOURCES

Source	Forest		Other Wooded Lands (OWL)		Total Forest and OWL		Ref. Year	Comment
	Area (ha)	%	Area (ha)	%	Area (ha)	%		
(USAID, 2014) and (AfDB, 2013)	20,742,000	32.2	-	-	-	-	-	AfDB is for trees USAID Table 11
(USAID, 2014) and (MOE; UNDP, 2012)	20,742,000	67.5	14,518,339	22.5	35,260,339	90.0	-	USAID Table 9
(FAO, 2015b)	7,157,000	11.1	32,582,000	50.6	39,739,000	61.7	2013	Based on remote sensing
(IRG, 2007)	22,870,000	35.5	-	-	-	-	2007	Section 2.4.1 page 20. Africover
(Doki, 2012)	-	-	-	-	19,166,700	29.7	2009	Gives Ministry of Agriculture and Forestry as the source (forest and OWL)
(Verjee, 2013)	20,000,000	31.0	-	-	-	-	-	Gives Ministry of Agriculture and Forestry as the source (approx. figure)
(MOE, 2015) (Diao, You, Alpuerto, & Folledo, 2012)	-	-	-	-	40,526,900	62.9	-	Table 1 Tree land

Note: the percentages in Table 1 are based on a total land area estimate for South Sudan of 644,329,000 ha

Analyses based on remote sensing exist, which provide different estimates, but they have not been verified on the ground, so the accuracy of such products is unknown. Figure 1 is a satellite image that suggests the total area of tree cover in South Sudan is almost 20,000,000 ha (19,166,700 ha or 191,667 km^2), which represents about 30 per cent of the country's total land area (MOE, 2015). This includes natural forests and woodlands, tropical moist forests on the hills, in the mountains and in the Nile-Congo watershed, and forests in National Parks and game reserves.

FIGURE 1. TREE COVER BASED ON SATELLITE DATA IN SOUTH SUDAN

Source: University of Maryland, USA

The latest Forest Resource Assessment of the Food and Agriculture Organization of the United Nations (FAO) found that 7,157,000 ha of land in South Sudan qualified as forest. A further 32,582,000 ha of land were wooded to varying degrees, totalling almost 40,000,000 ha (39,737,000 ha). The criteria for the FAO definition of forestland are shown in Box 1.

The FAO's trend data from 1990 to 2015 show no change in these amounts (FAO, 2014). Thus, forests and wooded areas represent 11.3 per cent and 51.6 per cent of the total land area, respectively (FAO, 2015b). This amount of forest equates with 13,494.66 million tonnes of carbon stock (FAO, 2015c). In 2012, the Government of South Sudan reported similar figures; forests covered 40,562,900 ha of land, which represented 62.6 per cent of South Sudan's total national land area (RSS, 2015). The Government of South Sudan has provided definitions for forests and trees that give national criteria for measuring vegetation cover in the country (Box 2).

BOX 1: THE UNITED NATIONS FOOD AND AGRICULTURE ORGANIZATION (FAO) CRITERIA FOR FOREST AND OTHER WOODED LAND

FOREST: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds *in situ*.

OTHER WOODED LAND: Land not defined as "Forest", spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of 5-10 percent, or trees able to reach these thresholds; or with a combined cover of shrubs, bushes and trees above 10 percent.

Source: (FAO, 2015a)

BOX 2: GOVERNMENT DEFINITIONS OF FORESTS

"Tree" means forest trees, including bushes, palms, bamboos, shrubs, brushwood, creepers and climbers at all stages of their growth. The definition of "forest land" is any land containing a vegetation association dominated by trees of any size, including woodlands, whether exploitable or not, that is capable of producing wood or other products, are potentially capable of influencing climate, which exercise an influence on the soil and water regime and provide habitat for wildlife.

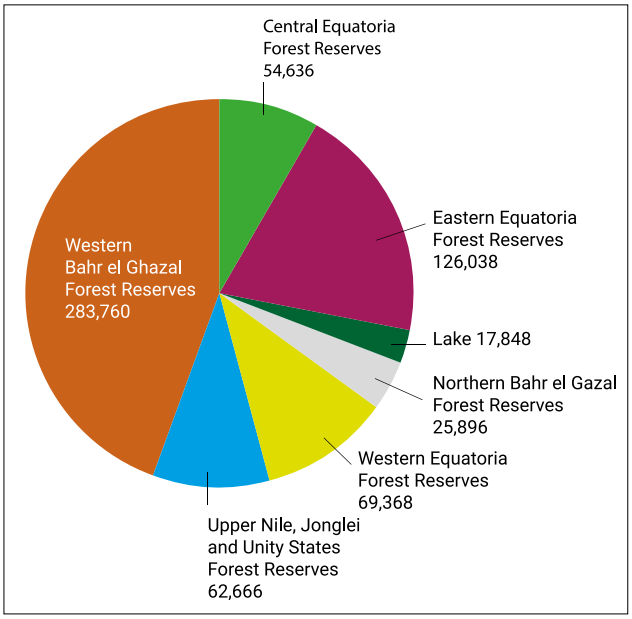
Sources: (GOSS, 2009); (CAMP Task Team, 2013)

Protected forests

Some of the country's forested areas have been set aside as Forest Reserves under the 2009 Forest Bill. A Forest Reserve is any area set aside to conserve, protect and manage natural forests, the habitat it provides and the forest environment. Tree cutting and other activities that potentially endanger the forest habitat and ecosystems are prohibited or controlled (GOSS, 2009). Protected areas, including forest reserves.

Gazetted Forest Reserves in South Sudan represent a comparatively insignificant portion of the total forest area, covering approximately 640,000 ha (Figure 2) (MOE, 2014) and representing 3.1 per cent of the total forest area (USAID, 2014).

FIGURE 2. AREA IN GAZETTED FOREST RESERVES

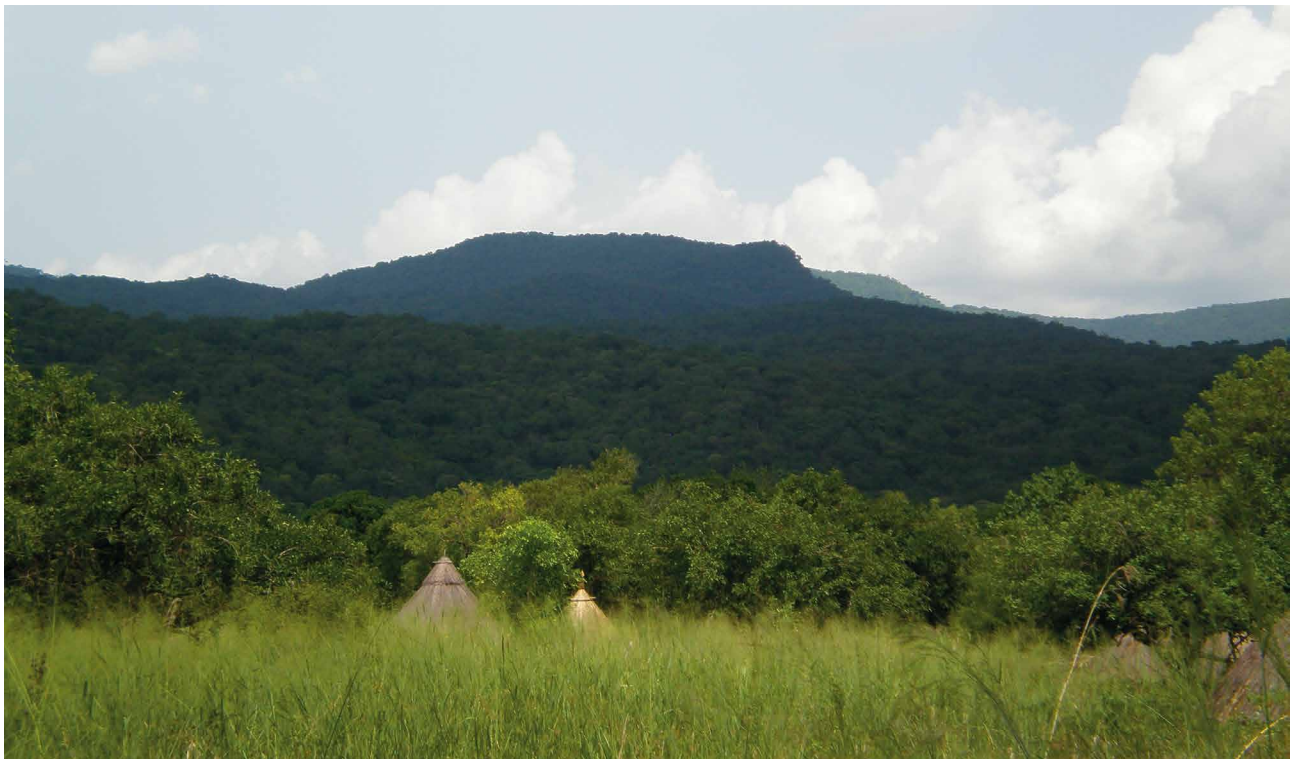


Source: (USAID, 2014)

Forest ecosystems and uses

Natural forests

Natural forests form the vast majority of South Sudan's forest estate. They are located mainly on the Ironstone plateau of Central and Western Equatoria. In addition to the forests west of the Nile, Eastern Equatoria has a significant forested area. A mixture of Congolean forest species and fire climax species characterises the natural forests of the Equatorias. The forests of the Imatong Mountains, which are a mixture of both natural and plantation blocks, are of particular importance for their biodiversity and ecosystem services (Adkins, 2015).



A view of a mountain near Torit. *Photo credit: Arshad Khan, UN Environment*

Forest uses and management

For management purposes, the Directorate of Forestry in the Ministry of Environment and Forestry categorises the forests of South Sudan as follows:

- Commercial forests: intensively managed plantation and natural woodlands that provide timber for commercial purposes. Sub-categories include industrial and non-industrial plantations, reserved natural forests and those managed for other purposes e.g. Gum Arabic, tannins, fuel wood, etc. Silviculture (reforestation, afforestation, thinning, pruning, operation of forest tree nurseries, etc.) is practised in these forests.
- Community forests: These are plantations in or around major settlements for productive functions, such as fuel wood supplies and poles for construction for local communities.
- Protection forests: these are plantation and natural forests managed to protect other land uses from the potential damage caused by winds (the trees act as windbreaks); to anchor soils and protect them from creeping sands and soil erosion; to replenish soil fertility (as is the case with tree planting along the Jonglei Canal); and to provide water conservation services.
- Recreational forests: Plantations established purely for recreation or aesthetic purposes, e.g., shade trees, habitat for zoos and trees planted in national parks (MOE, 2015).

Plantations

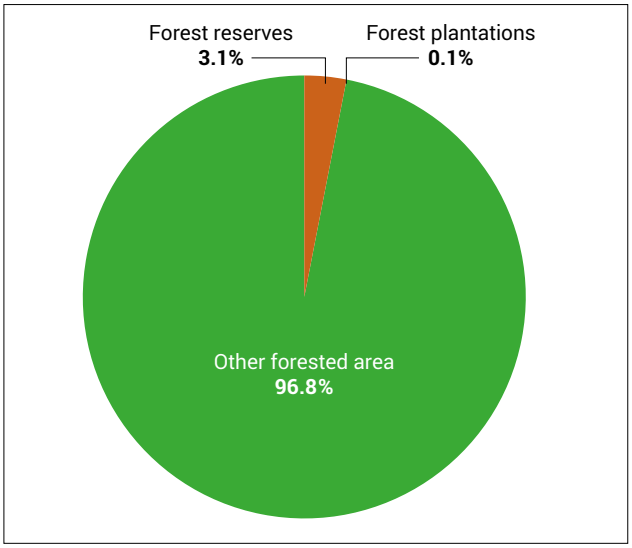
Plantation forests are those that have been established through forestation or reforestation for commercial purposes. Plantations include both indigenous and exotic species. The world's largest plantations are planted with Acacia used for producing Gum Arabic (FOA, n.d.). Plantations were mainly established to relieve pressure on natural forests by providing fuelwood, charcoal, construction materials and non-timber forest products to local communities and to protect ecosystem services, such as soil retention and water storage (MOE and UNDP, 2012). Since they comprise relatively few tree species, plantation forests contain significantly less biodiversity than natural forests. Compared to natural forests and forest reserves, the area covered by plantations in South Sudan is very small, estimated at no more than a few thousand hectares, mainly planted in teak (MOE, 2014); (FOA, n.d.). By another estimate, there are 23,000 ha of plantation forests, representing 0.1 per cent of the total forested area (USAID, 2014).

An estimated 187,850 ha of plantations were established in the past, with *Acacia nilotica* planted under irrigation systems and teak, eucalyptus, pines, and other species planted in regions with higher rainfall. The Oakland Institute noted that there were still some 15,000 ha of mature plantations, mainly of *Afzelia africana, Cedrella tona, Acacia nilotica* and *Eucalyptus*; 6,500 ha of mature teak (*Tectona grandis*); and 600 ha of softwood plantations, mainly *Pinus petula, Pinus radiate* and *Cupressus lusitanica* (Ogwaro, 2011).

The largest plantations in South Sudan are composed of Teak *(Tectona grandis)*. South Sudan's teak forests were originally planted by British colonialists before Sudan's independence in 1956; they are the oldest teak forests in Africa and the largest of its kind in the world (Verjee, 2013); (FOA, n.d.). However, the exact area covered by teak plantations is unclear. A number of satellite mapping exercises have been undertaken to estimate the areas of specific teak plantations. In 2004, satellite maps identified thirteen teak plantations and in 2007, a further five plantations were mapped with different satellite technology, covering a total of 7,680 ha (76.8 km^2). More recently, a 2014 study reported that there are 30,250 ha (302.5 km^2) of plantation teak (Deng, 2014), while USAID cites a total of 23,000 ha in forest plantations (Figure 3).

Most of the mature teak plantation trees standing today are between 35 and 50 years old. If expanded and sustainably managed, teak plantations have significant potential to boost the economy. In 2007, it was estimated that the existing teak had the potential to generate up to US$50 million per year in export revenue (Verjee, 2013).

FIGURE 3. **TYPE OF FOREST LAND-USE IN SOUTH SUDAN**



Source: (USAID, 2014)

Agroforestry

Agroforestry involves the integration of agriculture and forestry into one land-use system. It is a very sustainable alternative to traditional agriculture and modern mechanised agriculture and forestry systems since it provides a variety of products for food and household use, significantly reduces erosion and contributes to a favourable microclimate (MOE and UNDP, 2012). There are no data on the amount of land that is devoted to agroforestry in South Sudan. Although not formally categorised as agroforestry, the widely-practised tradition of shifting agriculture in South Sudan includes the inter-planting of some fruit trees and shrubs with vegetables and other crops. For example, a 2006 study of land-use systems in South Sudan noted that tree planting is an important activity in the country, although it is limited to fruit trees like mangoes, citrus fruits, guavas and other popular fruit trees (Dima, 2006). Box 3 describes the attempt to promote agroforestry in Jonglei State.

Agro-forestry practice in Eastern Equatoria. *Photo Credit: Ministry of Environment and Forestry*

BOX 3: THE JONGLEI CENTRAL NURSERY'S TREE SEEDLING INITIATIVE

In 2012, an investigation in the context of a university thesis was carried out on the potential of agroforestry to increase household food security, socioeconomic stability and peace building in Jonglei state. It involved the participation of six Farmer Group Discussions, among other qualitative research methods. The results showed that most farmers in the study were widows who were acting as the head of households made up of large numbers of orphans. They had adopted agroforestry techniques to increase food and income security, as shown in *Table 2*, which provides testimony from some of the Farmer Group Discussions. The thesis concluded by suggesting that the most suitable system for smallholder farmers in Jonglei is to adopt agroforestry technologies, such as improved fallow, fodder banks and biomass transfer methods. Fodder banks refer to the practice of growing and maintaining leguminous trees and shrubs, which are allowed to become well established and mature. The trees and shrubs are then harvested to provide protein-rich fodder supplements to livestock during the dry season. Biomass transfer involves applying nutrient-rich leaves from agroforestry trees or shrubs directly to the soil as "green manure" to fertilise the soil (Wel, 2012).

TABLE 2. OBSERVATIONS ABOUT THE VALUE OF AGROFORESTRY FROM A STUDY OF SMALLHOLDER FARMERS IN JONGLEI STATE

Question	Themes	Illustrative Farmers' Comments
Why	Food insecurity	"Food insecurity is the main cause of intertribal conflict in Jonglei" (FG1)
	Cattle rustling	"Growing numbers of unemployed youth in Jonglei perpetrate cattle rustling as means of livelihoods" (FGD1.3.7)
	Environmental stress	"Seasonal droughts in Jonglei causes food insecurity that cause conflict" (FGD 2.3.7) Seasonal floods in Jonglei causes food insecurity that leads to conflict" (FGD4.2.4)
	Extreme Poverty	"Prevalence of extreme poverty increases incidence of inter-ethnic violence due to low opportunity cost for conflict (FGD1.2.3)
	Breakdown in the traditional system	"Break down in the traditional systems that use to mitigate conflict... encourages intertribal conflicts with impunity" (FG1)
	Marginalisation and social exclusion	"Socioeconomic marginalization of communities in rural areas in Jonglei constitutes the bases of frustrations and induces intertribal conflict" (FG1)
How	Low food crops productivity	"Low food productivity due to land degradation has been one the causes of food insecurity in Jonglei" (FGD.5.2.1)
	Food Crops failures	"Crops failure due to environmental hazard means food insecurity which induces intertribal conflicts as means of access to food security" (FGD4.3.2)
	Intertribal conflict	"Intertribal conflicts leads to food insecurity through killing of farmers and distraction of their productive assets" (FG2)
	Lack of access to productive assets	"Lack of access to productive assets such as land, credits and information increases the rate of chronic poverty trap in the rural communities in Jonglei" (FG1)
	Youth unemployment	"Increasing numbers of unemployed armed former youth rebels fighters are perpetrating intertribal conflict as means of livelihoods" (FG1)
	Competition over natural resources	"Competition over pastures and water-points between tribes triggers interethnic conflict in the dry season grazing pastures in toiches" (FG2)

Note: FGD refers to the numbered Farmer Discussion Groups that took part in the study. *Source: (Wel, 2012).*

In September 2012, the Ministry of Agriculture and Forestry in Jonglei State announced that the Jonglei central nursery had thousands of seedlings of a variety of timber and fruit trees and shrub species, including Teaks, Mango, Paw Paw, Cypress, Lemon and Tamarind to sell at affordable prices to low-income families. The purpose was to provide an alternative to the unsustainable harvesting of trees in the natural forests in and around Bor, the state's capital city. Cutting for charcoal was devastating these forests, especially after the influx of returnees and Internally Displaced People (IDPs). The nursery would also be used as a demonstration farm for students taking Agriculture and Forestry courses at the university (ST, 2012).

During the subsequent crisis and fighting, however, the central nursery was destroyed. In 2015, Jonglei State revamped the nursery and resumed its effort to encourage agroforestry to reduce deforestation and degradation by offering 25,000 tree seedlings for sale. Tree types included fruits, shelterbelt and shade trees, and ornamentals used in public and private institutions. The World Agroforestry Centre reported, "There are plans to open other nurseries in other counties to supply villagers with much-needed seedlings. Already, training and support in tree planting and management is being provided to village farmers" (WAC, 2015).

Forest products

Local communities harvest timber for building purposes, fuelwood for cooking and making charcoal, and wild foods and medicines (Non-Timber Forest Products) from the forests and woodlands in their vicinities. Data on the demand and consumption of these forests products in South Sudan is not known.

Lack of employment opportunities is forcing people to charcoal making in which economic returns are high and quick. Family members in village located between Juba and Nimule making charcoal from the nearby forest.
Photo credit: Arshad Khan, UN Environment.

Tree cutting in Bor Region to fire brick kilns.
Photo credit: Justin Samuel, Ministry of Environment and Forestry

There are some figures on fuelwood and charcoal, products which are used daily by most of the population, and there are some informed estimates about timber products that are used in established commerce. The Comprehensive Agricultural Development Master Plan (CAMP) provides baseline estimates of production and trade using best available figures to give the most recent demand levels, as shown in Table 3. All volumes are in roundwood equivalent (RWE), which refers to the volume of raw material roundwood it takes to make the final product after the wastage produced during processing is removed (CAMP Task Team, 2015).

Table 3 shows that fuelwood and charcoal account for over 80 per cent of all wood used in South Sudan. In 2009, 62 percent of rural and 39 per cent of urban households used fuelwood as a source of energy; it is also heavily used in a few key informal industries, especially brick-making and bakeries. An estimated 108,000 tonnes of charcoal were consumed in the country in 2009, 79 percent of which was consumed in urban areas and the rest in rural areas. Juba and surrounding areas consumed 45 per cent of the national total followed by the urban areas in the former Upper Nile state (mostly Malakal), which consumed

TABLE 3. ANNUAL CONSUMPTION IN ROUND WOOD EQUIVALENT (RWE), 2010

Product	m^3	Per cent of South Sudan total consumption
Wood Fuel	7,020,000	80
Charcoal	360,000	4
Saw and Veneer Logs	252,000	3
Other Industrial Roundwood	936,000	11
Sawnwood (i.e. lumber)	45,000	0.5
Wood-Based Panels	40,500	0.5
Paper and Paperboards	225,000	2
Total, roundwood equivalent	**8,878,500**	**100**

Source: (CAMP Task Team, 2015)

14 per cent. In these two areas, annual consumption per household was 854 kg and 461 kg, respectively, the highest use in the country. As a rule, fuelwood availability determines the rate of consumption, which is highest in the rural areas of former Western Bahr el Ghazal, Western Equatoria, and Eastern Equatoria states (CAMP Task Team, 2015). The extensive use of firewood and charcoal has been unsustainable, however, resulting in forest degradation and loss (MOE, 2015).

Sawn timber accounts for the bulk of timber removal from natural forests, and both local and imported woods are some of the major industrial forest products consumed in the country (MOE, 2015).

Preliminary estimates of the volume of sawn and veneer logs suggest that it is approximately one quarter that of other industrial roundwood (CAMP Task Team, 2015).

Non-timber forest products from forests and woodlands include Gum Arabic, one of the major export products of South Sudan for which there remains significant unexploited potential. Gum Arabic is one of several varieties of sap harvested from the bark of *Acacia senegal* and *Acacia seyal* trees. It is used commercially in the manufacture of soft drinks, pharmaceuticals and cosmetics, and in many other products, particularly in the food industry (CAMP Task Team, 2015). It is estimated that significant amounts of *A. senegal* and *A. seyal* are available in seven of the former states in South Sudan (Nkamleu & Mugisha, 2015).

Other non-timber forest products are other resins and gums, shea nuts (locally known as "Lulu" fruits, Box 4), fibres, grasses, honey and oils, sand, gravel and forest soils. Most non-timber forest products are harvested for local use and, to some extent, for trade (CAMP Task Team, 2015).

BOX 4: SHEA NUTS IN SOUTH SUDAN

The *nilotica* subspecies of the shea tree (*Vitellaria paradoxa ssp. nilotica*) is endemic to East Africa, growing in a broad "shea belt"of about 100,000 km^2 stretching across the Sahel-Savannah ecozone in Central and Eastern Africa. Called "Lulu" in Arabic, shea grows widely in South Sudan, on the ironstone plateau and the alluvial plains across the three Equatoria states, through Lakes and Warrup states and into Western and Northern Bahr el Ghazal (GSA, 2013).

Shea is a deciduous tree that rarely exceeds 15 m with a lifespan estimated at 200-300 years. It takes 15 to 20 years of growth before the Lulu tree produces fruit (Swahili African Modern, 2016). For centuries, the South Sudanese have cherished and protected Lulu trees because the fruits mature during the yearly dry season and the nutritious foil from the seeds or nuts ensures food security (BMCE, n.d.). It was particularly important during civil war in Sudan (Swahili African Modern, 2016).

Shea nut is increasingly popular in the international health food and cosmetic market because of its healthy fatty-acid profile and its use as a balm, soap and other cosmetic products. It is usually exported whole from South Sudan and elsewhere in East Africa to be processed in other countries (BMCE, n.d.). The shea industry has doubled in the past 10 years (GSA, 2017).

South Sudan's shea resource has an enormous potential to be developed for economic and job opportunities due to the availability of large volumes of nuts and the market demand both within the country, which currently imports most of its edible oils and soaps, and abroad (GSA, 2013).

For the past decade, a collective of South Sudanese women has been hand processing raw, Grade A, virgin, African shea butter, under the umbrella of "Lulu Works", which created the infrastructure for a sustainable shea butter industry in South Sudan. The women thus continue their role as traditional guardians of the Lulu tree and earn an income that ensures household food security (Swahili African Modern, 2016).

5.3 Pressures and impacts

Deforestation

Deforestation is the reduction of forest cover from its original status (GOSS, 2009). The continuous use of wood as fuel for cooking and the seasonal burning of forests by pastoralists to regenerate pastures for their herds has degraded or deforested parts of the country's natural forest areas and woodlands. Other pressures are the conversion of forests and woodlands to urban and rural settlements, the introduction and spread of exotic invasive tree species and uncontrolled fires (MOE, 2014); (RSS, 2016b).The main drivers are population growth, the associated increased demand for charcoal for domestic use, export and illegal trade, and the traditional system of animal husbandry practised by pastoralists (RSS, 2016cb); (MOE and UNDP, 2012). The impacts of deforestation include localised soil erosion, accelerated loss of biodiversity and altered hydrological and nutrient cycles (MOE, 2014). In arid zones, uncontrolled fires destroy trees and their capacity to regenerate (MOE, 2015). The removal of vegetation around IDP camps is another threat to forests and woodlands in South Sudan.

A Toposa woman selling firewood in Kapoeta.
Photo credit: Steve Evans/Flickr.com/CC BY-SA 2.0

There are reports of the removal of trees and woody vegetation around towns housing armed forces as a strategy to improve visibility and the harvesting of teak for income (MOE, 2014); (RSS, 2016cb). Armed conflict has the potential to threaten forests and woodland resources, but there is a dearth of evidence.

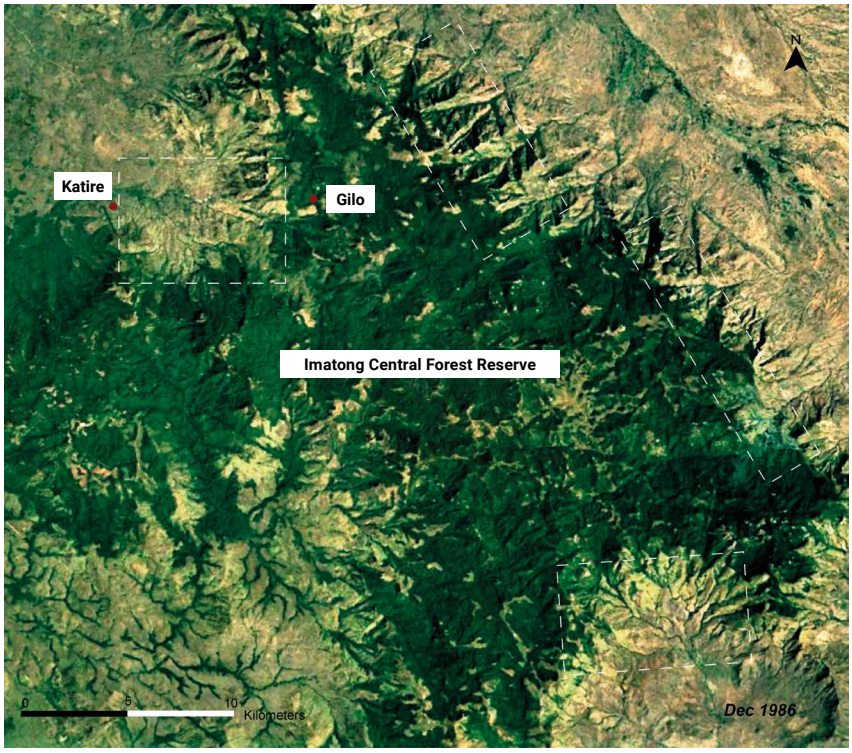
Box 5 shows the interpretation of satellite data and population trends in a forested area of South Sudan where hostilities have taken place

BOX 5: FOREST DISTURBANCE FROM ARMED CONFLICT IN A MONTANE FOREST ECOSYSTEM

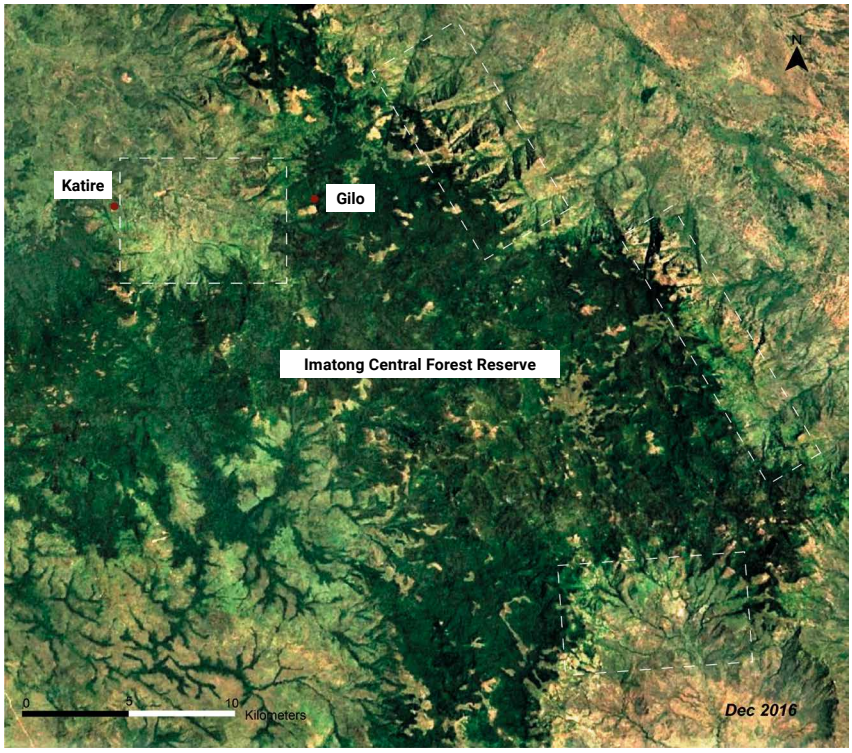
Satellite remote sensing is a useful tool with which to measure the impacts of armed conflict on ecosystems where access during wartime is restricted. A study of a biologically diverse montane ecosystem covering the Imatong Central Forest Reserve (ICFR) in South Sudan and nearby Dongotana Hills and the adjacent Agoro-Agu Forest Reserve in Northern Uganda used satellite and human population data to assess the impact of armed conflict on similar forest ecosystems during and after hostilities. It analysed the location and extent of forest cover loss and gain in three areas for two key time periods from the mid-1980s to 2001 and from 2003 to 2010. The researchers report that "the rate of forest recovery was significantly higher than the rate of disturbance both during and after wartime in and around the ICFR, and the net rate of forest cover change remained largely unchanged for the two time periods. In contrast, the nearby Dongotana Hills experienced relatively high rates of disturbance during both periods; however, post war period losses were largely offset by some gains in forest cover. For the Agoro-Agu Forest Reserve in Uganda, the rate of forest recovery was much higher during the second period, coinciding with the time people began leaving overcrowded camps." The study concludes:"The diversity and merging of floristic regions in a very narrow band around the Imatong Mountains makes this area biologically distinct and of outstanding conservation importance; therefore, any future loss in forest cover is important to monitor — particularly in South Sudan where large numbers of people continue to return following the 2005 peace agreement and the 2011 Referendum on Independence."

Source: (Gorsevski, Kasischke, Dempewolf, Loboda, & Grossmann, 2011)

Imatong Forest Recovery



Imatong Central Forest Reserve, 1986



Imatong Central Forest Reserve, 2016

Note: Green colour generally represents vegetation, brown: human settlements or fields and dark blue: water.
Source: Landsat, United States Geological Survey

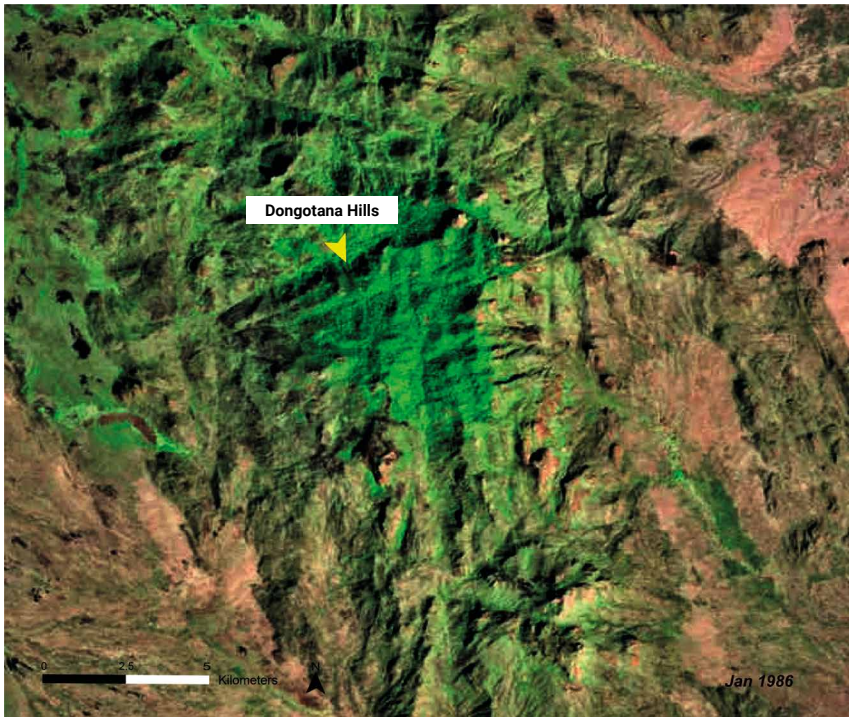
Historical and current satellite images of Imatong area show forest recovery

The Imatong Central Forest Reserve (ICFR) spans around 1000 km^2. Some studies found that the rate of forest recovery was significantly higher than the rate of disturbance both during and after wartime in and around the ICFR and the net rate of forest cover change remained largely unchanged for the two time periods. One possible explanation for the high rates of forest recovery within the ICFR interior is a reduction in human-induced fire activity leading to the spread of vegetation in previously open areas.

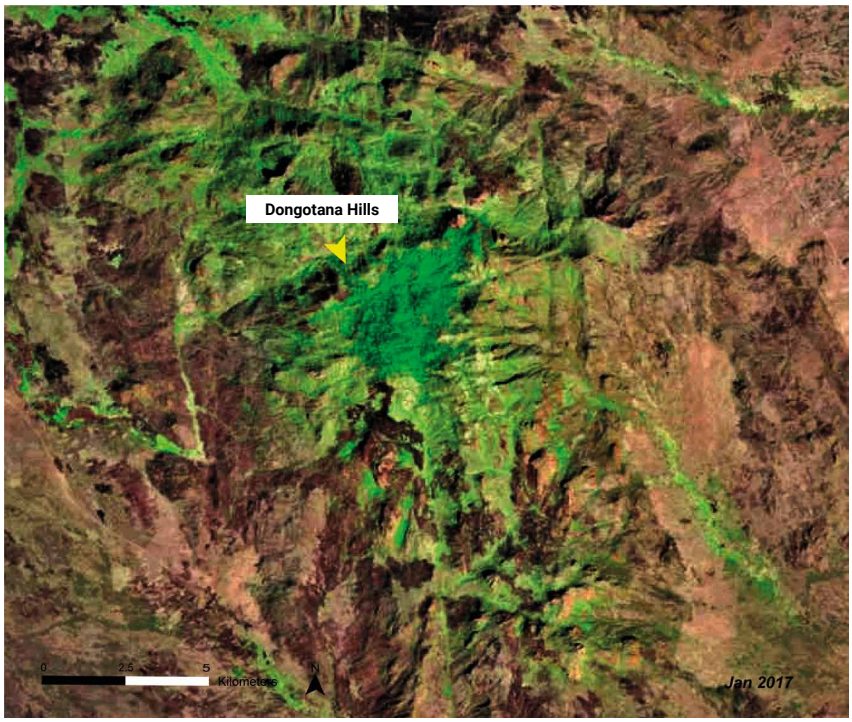
The Imatong Central Forest Reserve is situated southeast of Juba on the Ugandan border. The Imatong Mountains are deeply faulted and many perennial rivers flow in the highest areas. Because the region is at the meeting point of several biomes and there is a wide range of altitudes, the Imatong Mountains are highly biodiverse. The range of vegetation types include albizi-terminalia woodland and mixed khaya, lowland, semi-evergreen forest in the areas up to 1,000 m; podocarpus and croton-macaranga-albizia montane forest between 1,000-2,900 m; and at higher altitudes, hagenia woodland, erica thicket and areas of bamboo (Mahgoub & Riak, n.d.).

Mount Kinyeti, the highest peak in South Sudan, is part of the Imatong Mountains and its forests are largely intact. Recently, however, significant land-use changes and deforestation in the Kinyeti River watershed, which forms much of the Imatong Mountain's upper water catchment, are thought to be responsible for altering water flows and affecting other ecosystem services. Clearing the lower slopes of forest and other vegetation for predominantly agricultural purposes threatens to impact the currently perennial flow of the Kinyeti River and other rivers draining off the Imatong Mountains (INR, 2014).

Forest loss along the edge of Mount Dongotana



Deforestation in Dongotana Hills, 1986



Deforestation in Dongotana Hills, 2017

The forested area of Dongotana Hills is approximately 2,100 ha. It experienced relatively high rates of disturbance during conflict and post-conflict periods. Dongotana Hills were largely cleared by 1986, and in 2010 small farmers continued deforesting their eastern side. This area is easily accessible to people who depended on the forest and forest products during the war to survive and continue to use the forest to rebuild their communities.

Note: Green colour generally represents vegetation, brown:human settlements or fields, and dark blue: water.
Source: Landsat, United States Geological Survey

Charcoal production

Fuelwood and charcoal make up approximately 80 per cent of the country's energy supply due to the lack of alternative sources of energy, such as electricity, wind and solar power, and gas. Charcoal is the main fuel used in urban centres and its use in brick making is growing (MOE, 2015). Its production requires large quantities of wood, and the harvesting of trees to make charcoal likely contributes significantly to deforestation. Charcoal is the favoured fuel for a number of other reasons, including the lack of licensing requirements to generate it; the simple technology and tools used in its production; and the perception that it is a "free" primary resource, since forests are not privately owned. As a result, charcoal making is an attractive economic activity. With population growth, more people are becoming involved in charcoal production, accelerating deforestation and erosion, and contributing to climate change from land-use change (MOE, 2015); (MOE and UNDP, 2012).

A south Sudanese standing near a charcoal pile that is ready for packing and selling. *Photo credit: Arshad Khan, UN Environment.*

Forest fires

There is a lack of authoritative information about the extent of forest loss to uncontrolled fires in South Sudan. The Republic of South Sudan's (RSS) Ministry of Environment and Forestry reports that bush fires pose a major threat to forests throughout the country. Fires are used in the traditional practice of shifting cultivation, for hunting and to rejuvenate grazing areas. Other triggers for uncontrolled forest fires are lightning, smokers used by honey collectors, and in some cases, communities deliberately set forest fires to signal discontent with policies and regulations (MOE, 2015).

Recent research shows that on average, 52.8 per cent of the country's area is burnt annually. Areas with annual rainfall between 0.6 and 1.4 m provide the optimal conditions for fire to spread, while fire hardly occurs in urban and frequently flooded areas. Areas in which fires occur with a frequency of > 0.5 per year account for almost 80 per cent of the total area and fires tend to occur more often in forests and densely vegetated regions than in those with less dense vegetation (Wulf, Jörg, & Leiterer, 2015). In terms of timing, fire distribution is predominantly in the early dry season (November/December). Humans cause more than 90 per cent of all fires in South Sudan, whether deliberately, by accident or incidentally. Regular, uncontrolled annual fires, especially hot, late, dry-season fires, impede the natural regeneration of woody formations (seedlings and saplings), seriously hampering sustainable forest management (Bloesch, 2017).

Internally displaced people (IDP) camps

There are reports that the need for building materials, domestic energy and agricultural land around IDP camps for about 200,000 people in the counties of Maban and Pariang has led to rapid deforestation within and around the camps (Wulf, Jörg, & Leiterer, 2015). Compared to the national annual average of 52.8 per cent quoted in the previous section, the average annual area burnt in Maban and Pariang counties amounts to 57.9 per cent and 67.0 per cent, respectively.

In February 2017, the number of IDP in South Sudan was 263,214 (UNHCR, 2017). Average firewood consumption is about 1.8 kg/person/day; thus, the total annual domestic energy needs for these IDPs would be 53,373.95 metric tonnes, not counting the demand of local communities or the high but unknown quantity of wood used for commercial charcoal making (Bloesch, 2017).

Trends in forest loss

There are no reliable estimates of forest loss and annual deforestation rates in South Sudan. However, a study conducted by the World Agroforestry Centre (ICRAF) in 2006 provides information about the trend in deforestation between 1973 and 2005 for selected sites in South Sudan (Table 4). The case studies reveal the extensive conversion of forest and woodlands to grasslands, pasture and rainfed agriculture. Extrapolated to the whole country, the figures suggest an annual linear deforestation rate of about 2 per cent and a total of 40 per cent loss over the period (UNEP, 2007).

Aweil – Change of forest land for agricultural use.
Photo credit: Arshad Khan, UN Environment.

TABLE 4. SUMMARY OF DEFORESTATION RATES IN SELECTED STUDY SITES IN SOUTHERN SUDAN, 1973-2005

Area	Original and final forest and woodland cover (%)	Annual linear deforestation rate + (period loss)	Comments
Aweil, Northern Bahr el Ghazal	11.9 to 7.2 from 1972 to 2001	1.38 % (39.4 %)	Closed forest changing to wooded grassland and pasture.
Wau, Western Bahr el Ghazal	76.5 to 51.8 from 1973 to 2005	1.00 % (32.3 %)	Closed and riverine forest and wooded grassland replaced by traditional rain-fed agriculture.
Renk, Upper Nile	6.5 to 0 1973 to 2006	> 5 % (100 %)	Wooded grassland and riverine forest replaced by degraded land.
Yambio, Western Equatoria	80.2 to 51.5 from 1973 to 2006	1.12 % (35.8 %)	Closed forest and wooded grassland replaced by traditional rain-fed agriculture.
Yei, Central Equatoria	29.8 to 19.3 from 1973 to 2006	1.53 % (35.2 %)	Closed forest and wooded grassland replaced by open forest and traditional rain-fed agriculture.
Southern Sudan case study averages		> 2 % (40 %)	Rapid and consistent deforestation approximately 40 per cent complete by 2006. Extrapolated near total loss within 50 years.

Source: (UNEP, 2007)

More recently, FAO's 2010 Forest Resources Assessment estimated that between 2005 and 2010, a high rate of up to 277,630 ha (2,776 km^2) of forests and other wooded lands was being lost annually in South Sudan (Table 5) (Doki, 2012). As well, the Global Forest Watch published remote sensing results (Table 6) that estimate losses of 13,652 ha per year between 2001 and 2005 (GFW, 2017). Finally, in 2016, a spokesperson from UN Environment Programme (UNEP, now UN Environment) reported that the current annual deforestation rate was between 1.2 and 1.5 per cent, one of the highest in the world (UNDP, 2016). Thus, there appears to be a wide divergence in the estimates of forest cover loss, depending on the definitions and methodologies used.

TABLE 5. AREAS OF FOREST AND OTHER WOODED VEGETATION IN SOUTH SUDAN REGIONS (FAO, 2005) AND ANNUAL LOSS OF FOREST COVER (FAO, 2010) IN HECTARES AND PERCENTAGE

Area	Forest (ha)	Other wooded land (ha)	Total Forest and Other wooded land (ha)	Annual loss (ha)	Annual percentage loss
Bahr el Ghazal	14,048,291	4,829,122	18,877,413	113,958	0.60
Upper Nile	15,165,707	6,333,033	21,498,740	76,192	0.35
Equatoria	14,256,099	3,356,184	17,612,283	87,480	0.50
Total	43,470,097	14,518,339	57,988,436	277,630	0.48

Source: (MOE and UNDP, 2012)

TABLE 6. GLOBAL FOREST WATCH ESTIMATES OF CHANGES IN LANDS WITH 10 PER CENT OR GREATER TREE COVER IN SOUTH SUDAN, 2000-2015.

Attribute	Ha	Year
Total area with 10 per cent tree cover	43,000	2000
Forest loss	10,647	2001
	191,122	2001-2015
Forest gain	3, 829	2001-2012
Rate of forest loss	13,652 ha per year	2001-2015

Source: (MOE and UNDP, 2012)

There are no data on the rate of deforestation due to charcoal production. A team of researchers conducted a study in the Northern Bahr el Ghazal to try to offer a rough estimate of the rate of deforestation due to charcoal production in the region. It concluded that a family of five uses approximately one bag of charcoal per week and about 1.5 trees are needed to make a bagful. The team calculated that one family's annual use of charcoal accounts for 2.6 ha of deforestation in that area. In the humid savannahs of Central Equatoria, tree densities are 10-50 times higher, so the deforestation rate is lower (MOE and UNDP, 2012).

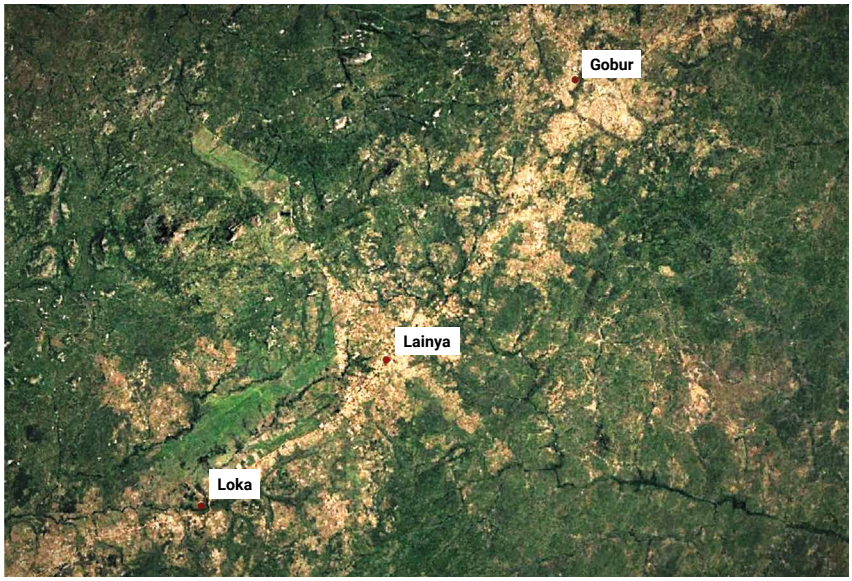
Deforestation near Bor, 2002

Deforestation near Bor, 2016

Note: Deforestation occurring around Bor. The influx of returnees and IDPs has put a strain on the tree cover loss.
(Data Source: Landsat, United States Geological Survey)

Deforestation near Lainya, 1984

Deforestation near Lainya, 2016



Note a significant loss of tree cover along the road from Loka to Gobur.
(Data Source: Landsat, United States Geological Survey)

5.4 Response

Progress by South Sudan in addressing forestry issues

In 2015, the United States Agency for International Development (USAID) offered an analysis of the management by South Sudan of its forestry sector and identified the following gaps:

- The lack of a comprehensive national-level legal framework stipulating rights, roles and responsibilities, and revenues (benefit sharing).
- The lack of investment in the sector from both national government and external investors.
- The lack of a long-term strategy to address the challenges that will be associated with climate change in South Sudan.
- A significant knowledge gap on the state of forests and forest resources at a national level in South Sudan as a baseline against which to measure interventions (Adkins, 2015).

The Land Governance Assessment Framework

Another assessment of the progress of South Sudan in protecting its forests has come from the Land Governance Assessment Framework. To evaluate a country's performance in various aspects of land governance, a large number of international food and agriculture-related organisations collaborated to develop the Land Governance Assessment Framework. The Framework is a diagnostic instrument that adopts seven thematic areas to measure performance: Legal and Institutional Framework; Land Use Planning, Management and Taxation; Management of Public Land; Public Provision of Land Information; Dispute Resolution and Conflict Management; Large-scale Acquisition of Land Rights; and Forestry.

Table 7 shows South Sudan's score for Forestry as reported in 2014, according to the following scale:

A: has met the requirements for good land governance;
B: has mostly met the requirements;
C: is struggling to meet the requirements;
D: there has been no progress or there is limited progress in meeting requirements for good land governance (World Bank, 2014).

The results of the scorecard suggest the need for South Sudan to strengthen its commitments to sustainability and climate change mitigation; improve recognition of forests through laws and protection; and control illegal logging and other forest crimes by clearly demarcating the boundaries of forest estates (World Bank, 2014).

The Government of South Sudan recognises these gaps and is addressing them in its policies, laws, regulations, strategies and actions plans.

TABLE 7. **THE LAND GOVERNANCE ASSESSMENT FRAMEWORK FORESTRY GOVERNANCE SCORECARD FOR SOUTH SUDAN**

LGI-Dim		Topic	Score A	B	C	D
Commitments to Sustainability and Climate Change Mitigation						
1	i	Country signature and ratification of international conventions			■	
1	ii	Implementation of incentives to promote climate change mitigation through forestry			■	
Recognition of Public Goods Aspects of Forests and Promoting their Sustainable Use						
2	i	Public good aspects of forests recognised by law and protected			■	
2	ii	Forest management plans and budgets address the main drivers of deforestation and degradation		■		
Supporting Private Sector to Invest Sustainably in Forest Activities						
3	i	Country's commitment to forest certification and chain-of-custody systems to promote sustainable harvesting of timber and non-timber forest products		■		
3	ii	Country's commitment to SMEs as a way to promote competition, income generation and productive rural employment		■		
Livelihood Aspects of Local, Traditional and Indigenous Forest-Dependent Communities						
4	i	Recognition of traditional and indigenous rights to forest resources by law		■		
4	ii	Sharing of benefits or income from public forests with local communities by law and implemented		■		
Forest Land Use, Tenure and Land Conversion						
5	i	Boundaries of the countries forest estate and the classification into various uses and ownership are clearly defined and demarcated				■
5	ii	In rural areas, forest land use plans and changes in these plans are based on public input		■		
Controlling Illegal Logging and Other Forest Crimes						
6	i	Country's approach to controlling forest crimes, including illegal logging and corruption			■	
6	ii	Inter and intra agency efforts and multi-stakeholder collaboration to combat forest crimes, and awareness of judges and prosecutors			■	

Source: (World Bank, 2014)

International commitments

Intended Nationally Determined Contributions on mitigation and adaptation on forests
The First National Communication by South Sudan to the United Nations Framework Convention on Climate Change laid out how the country intends to address the causes and impacts of deforestation and forest degradation. Some of the key actions and expected results are as follows:

- Declare approximately 20 per cent of natural forests as reserve forests to protect them from deforestation;
- Initiate an ambitious reforestation and afforestation project to plant 20 million trees over a period of ten years (2 million trees in each of its 10 states) as outlined in the National Environmental Policy, to help restore watershed and water catchment areas, sequester carbon, and reduce emissions from deforestation and forest degradation;
- Support forest governance and improve the enforcement of environmental regulations;
- Reduce over-reliance on forest products by providing alternative income-generating activities;
- Encourage planting climate-resilient tree species;
- Develop mechanisms to ensure equitable sharing of benefits accrued from forest resources;
- Promote agroforestry practices to diversify land production systems and promote alternative livelihood options;
- Promote afforestation of degraded landscapes/ watersheds using multiuse forest species to increase community safety-nets and diversify livelihoods;
- Promote alternative sources of energy to reduce deforestation and the consequent loss of livelihood options (RSS, 2016a).

Forest resource planning by a community in a village near Laniya. *Photo credit: Arshad Khan, UN Environment*

National forestry governance

TABLE 8. SUMMARY OF THE LEGAL AND POLICY FRAMEWORK FOR FORESTRY IN SOUTH SUDAN

Legal and policy framework for forestry in South Sudan		Period		
		Pre-CPA*1 (Before Jul. 2005)-*2	Southern Sudan AR*3 (Jul. 2005 - Jul. 2011)	Republic of South Sudan (After Jul. 2011)
Constitutional framework	Constitution of the Republic of Sudan, 1998	Established		
	The Comprehensive Peace Agreement, 2005		Established	
	Interim Constitution of Southern Sudan, 2005		Established	
	Interim National Constitution, 2005		Established	
	Transitional Constitution of the Republic of South Sudan, 2011			Established
Forest policies	Forest Policy, 1986	Established	Applicable	Applicable
	Forest Policy Framework, 2007		Established	
	Forest Policy, 2013			Established
	Forest Policy 2015			Draft
Forest laws	Woods and Forests Ordinance, 1901	Established	Repealed	
	Forest Law and Ordinance, 1902	Established	Repealed	
	Forests Ordinance, 1908	Established	Repealed	
	Forest Conservation Rules, 1917	Established	Repealed	
	Central Forests Act, 1932 (CFA 1932)	Established	Repealed	
	Provincial Forests Act, 1932 (PFA 1932)	Established	Repealed	
	Forest Law and Regulations, 1972	Established	Repealed	
	Forest Act, 1989 (FA 1989)	Established		
	Forests National Corporation Act, 1989 (FNCA 1989)	Established	Repealed	
	Forests and Renewable Natural Resources Act, 2002	Established		
	Timber Utilization and Management Act, 2003 (SPLM law)	Established	Not applied	
	Forest and Environment Act, 2003	Established	Applicable	Applicable
	Forestry Commission Act, 2004 (SPLM law)	Established	Not applied	
	Forestry Training Centre Act, 2004	Established		
	Forestry Bill, 2009 (draft)			(draft)
Related policies and laws	Land Settlement and Registration Act, 1925	Established	Applicable	
	Limitation and Prescription Ordinance, 1928	Established	Applicable	
	Land Acquisition Ordinance, 1930	Established	Applicable	
	Unregistered Lands Act (ULA), 1970	Established		
	Civil Transactions Act (CTA), 1984	Established	Applicable	
	Local Government Act, 2006			
	Land Act, 2009		Established	Applicable
	Land Policy (under preparation)		Established	
	Customary laws	Established	Established	Established
Regulations and executive orders	Ministerial Order No. 284, 1986	Established	Applicable	Applicable
	Official Circular on the Rule of Law Institutions, 2006		Established	
	Ministerial Decree, 2006		Established	
Strategies and plans	Forest Sector review, 1984-86	Established		
	Ministry of Agriculture and Forestry Strategic Plan 2007-2011		Established	
	South Sudan Development Plan 2011-2013 (SSDP)			Established
	Ministry of Agriculture, Forestry, Cooperatives and Rural Development Strategic Plan 2012-2018 (Draft			(draft)
	South Sudan Development Initiative 2013-2020 (final draft)			(draft)

Note: *1) CPA: Comprehensive Peace Agreement. *2) Anglo-Egyptian Sudan (condominium of Egypt and the United Kingdom) period is 1899-1955, and the year of Republic of the Sudan's independence is 1956. *3) AR: Autonomous
Source: (UNEP, 2007)

The National Forest Policy, January 2015

In January 2015, the RSS introduced its National Forest Policy, which recognises the importance of forests for commerce, communities and conservation. It provides a nationwide framework for managing forests at all levels across the country and sets forth a series of implementation and institutional measures, as follows

Ownership and management:

- There will be differentiated ownership of forest reserves throughout South Sudan ranging from National Forest Reserves to community forests.
- The Republic of South Sudan (RSS) owns all previous Central Forest Reserves and will ensure their effective management and protection as National Forest Reserves.
- The Ministry of Agriculture, Forestry, Cooperatives and Rural Development (MAFC&RD) will delineate and gazette other National Forest Reserves with the goal of ensuring that 20 per cent of the country's land area is covered by forests.
- The MAFC&RD will forge and sustain cross-sector working linkages to ensure the sustainable management of forests and related sectors.
- State Governments will implement forestry programmes and plans on State Forestry Reserves and may assist in the administration of forests managed by sub-state authorities and private individuals.
- The institution of the South Sudan National Forest Corporation is advocated, to operate as a semi-autonomous, self-supporting and income-generating institution operating under a Board of Directors.
- South Sudan National Forest Corporation will enter into partnerships with State Governments, communities, and the private sector to implement national and state forest plans.
- The South Sudan National Forest Corporation will provide regulation and operational standards for a vibrant forest sector; it will also administer and implement the National Forest Reserves.
- The South Sudan National Forest Corporation will compile and update information on all forest reserves to inform their management planning and for sharing of forest revenues.
- A National Forest Fund will be established to support capacity building, forest conservation and forest management activities now and in the future.

Forest revenues:

- Radical changes in the allocation of forest revenue are advocated, such as a forest income retention scheme, in consultation with the Ministry of Finance and Economic Planning.
- A unified and effective forest revenue collection and sharing system will be adopted throughout South Sudan.
- Financial management mechanisms will be introduced so forest revenues are retained at various levels of government to support sustainable forest management.
- Forest revenue-sharing arrangements will account for land/forest ownership, responsibilities and inputs in forest management and protection, rights of local communities and other factors.
- RSS and State Governments are encouraged to take account of the full value of forest services in their accounting and budgeting systems.
- The prices of forest products and services will be regulated and reviewed to ensure transparency and fair play among the various stakeholders; all cases, pricing policy will be driven by free market forces taking into account fair production and processing costs.

Monitoring progress:

- National and State Governments are required to formulate, implement, and monitor progress with sound forest strategic plans and national forest programmes.
- The Ministers responsible for forests will present annual reports to respective Legislative Assemblies on the state of forests and progress in implementing forest plans.

Enhancing socioeconomic development:

- Community forestry and agroforestry practices will be introduced among rural communities to meet their forest and tree needs.
- The development of forest plantations in National Forest Reserves, State Forest Reserves and other public lands, community lands and in urban and peri-urban areas will be accelerated to meet present and future local wood demands, and for export.
- The RSS and State Governments are encouraged to enter into collaborative forest management agreements and arrangements with communities to sustainably manage forests and ensure increased benefits to communities from forests.
- Private sector investment in forestry in National Forest Reserves, State Forestry Reserves, and other public and community lands, under public-private-community partnerships will be promoted through fair, transparent, and legally secure long-term planting and harvesting concessions on public and community lands.
- RSS and State Governments will promote and facilitate access to emerging benefits from global forest services, such as carbon sequestration and biodiversity conservation funds.

Protecting forests from environmental and other threats:

- Strategies and plans to protect forests from the threat of wildfires will be introduced that include engaging community leaders and communities in preventing and managing wildfires.
- Strict measures are introduced to protect the permanent forest estate and prevent changes in forest boundaries by stipulating that only the RSS Minister responsible for forests has the power to change forest boundaries, upon approval of the National Legislative Assembly.

Technical and human resources:

- The best knowledge and technical skills need to be made available so forestry research and training institutions should be rapidly developed.
- RSS will explore bilateral and regional arrangements for knowledge and skill sharing with neighbouring countries.
- South Sudan National Forest Corporation and State Governments are recommended to take urgent measures to develop the human capacities needed to implement this policy.
- South Sudan National Forest Corporation, with MAFC&RD involvement and oversight, will forge working linkages with donors, non-governmental organisations, and community-based organisations to quickly develop human resources needed to implement this policy (MAFC&RD, 2015).

5.5 Conclusion

One of the key conclusions of this chapter's assessment of the forest resources of South Sudan is the lack of reliable data. It is known that South Sudan is blessed with extensive forests and wooded lands, and it is widely believed that deforestation is taking place at a rapid pace, but currently there are no reliable estimates available about either the extent of its forest resources or the rate of forest loss.

The importance of forests to the population is very clear: more than 90 per cent of the country's population directly depends on forests for timber, fuelwood, charcoal and non-timber forest products. Fuelwood and charcoal account for over 80 per cent of all wood used in South Sudan. In addition, the country's forests provide untold benefits in other ecosystem goods and services.

The total area of forest cover in South Sudan is thought to be almost 20,000,000 ha, which represents about 30 per cent of the country's total land area. Of this total, gazetted forest reserves account for 3.1 per cent and plantation forests represent 0.1 per cent. Plantations consist mostly of teak forests thought to be the oldest such forests in Africa and the largest plantations of its kind in the world. Acacia plantations for Gum Arabic are also important.

South Sudan's forests are in danger of disappearing; the annual deforestation rate is likely between 1.5 and 2 per cent. The main drivers and pressures are population growth and the increased demand for fuelwood and charcoal, the conversion of forests to urban areas, uncontrolled fires and timber harvesting. This has led to the degradation or deforestation of parts of the country's natural forest areas and woodlands, localised soil erosion, biodiversity loss, and altered hydrological and nutrient cycles.

Sustainably managing its forest resources offers South Sudan the opportunity to provide jobs and income, and to maintain the ecological goods and services they provide. The Government of South Sudan is cognisant of the need to stem deforestation, and there is a plethora of legal and policy frameworks, including the comprehensive 2015 National Forestry Policy. The RSS aims to set aside about 20 per cent of natural forests as reserve forests to protect them from deforestation and it has an ambitious afforestation programme, amongst other plans and strategies. It has also made ambitious commitments related to forests under its Intended Nationally Determined Contributions for climate adaptation and mitigation. However, on-going conflicts prevent the forests from being developed and sustainably managed to provide goods and services for future generations. To accomplish this, South Sudan needs to commit to sustainability and climate change mitigation, and implement laws that recognise the public aspects of forests and that protect the land. Demarking boundaries will help in the process. As pointed out in Vision 2040, there is clear need to implement the policies that conserve forests and the rest of the environment (RSS, 2016b).

Forest in Eastern Equatoria. *Photo Credit: Ministry of Environment and Forestry*

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Migration of the white-eared kob.
Photo credit: WCS

CHAPTER 6
BIODIVERSITY AND PROTECTED AREAS

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6.1 Introduction

South Sudan is endowed with a natural environment rich in biological resources. These include a large variety of ecosystems, a vast array of globally important species of flora and fauna and an unknown lode of genetic diversity. It is home to the Sudd swamp, one of the world's largest tropical wetlands, and to one of the greatest circular migrations of wildlife on the planet. Most of the population lives close to the natural environment, directly depending upon forests and woodlands for fuel and food products, local soils in which to grow their crops, pastures for their livestock and nearby water sources for household needs. These ecosystem goods and services constitute the foundation of South Sudan's socioeconomic development (MOE, 2014).

Shoebill Stork in front of Papyrus. *Photo credit: Mark Jordahl/Flickr.com/CC BY 2.0*

6.2 Status and Trends

Biological diversity is defined as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"(CBD, 1992).

Ecosystem diversity

South Sudan is covered in a rich diversity of ecosystems, which are dynamic complexes of plant, animal and microorganism communities, and their non-living environment, interacting as functional units. South Sudan's large range of ecosystems is most commonly divided into the following categories:

- Lowland forest
- Mountain forest
- Savannah woodland
- Grassland savannah
- Sudd swamps and other wetlands
- Semi-arid region.

Migration. *Photo credit: WCS South Sudan*

Dry lands. *Photo credit: Amy the Nurse/Flickr.com/CC BY-NC-ND 2.0*

Mt. Lotukei. *Photo credit: By Nalimaakono/ /Wikimedia commons/ CC BY-SA 2.0*

Equatoria region. *Photo credit: By Akashp65/ CC BY-SA 3.0*

TABLE 1. **THE ECOSYSTEMS OF SOUTH SUDAN**

Location/Distribution	Characteristics	Status/Threats
	1. Lowland Forest	
In the southwest near the borders with the Central African Republic (CAR), the Democratic Republic of the Congo and Uganda and in the foothills of the Imatong Mountains. Also in small patches on the Aloma Plateau near Yei, the Azza Forest in Maridi County and the Yambio area, and some areas at the foothills of the Imatong Mountains in the Loti, Talanga and Lobone areas of Eastern Equatoria.	They are the northernmost of the Congo Basin forests and have similar fauna and flora. Species include the lowland bongo *(Tragelaphus eurycerus eurycerus)*, forest buffalo *(Syncerus caffer nanus)*, giant forest hog *(Hylochoerus meinertzhageni)*, red river hog *(Potamochoerus porcus)* and a number of forest monkeys.	Threatened species include the eastern chimpanzee *(Pan troglodytes schweinfurthii)*, elephants *(Loxondota africana africana and Loxondota africana cyclotis)*. A number of forest communities are also threatened.
	2. Montane forest	
Imatong, Dongotona, Acholis, Didinga and Jebel Gumbiri mountains in the southeastern part of former Eastern Equatoria state.	Part of the Eastern Afromontane ecozone, which is one of Africa's biodiversity hotspots. The largest continuous closed canopy forest in South Sudan. Rich with wildlife and endemic plants because of its bio-geographic isolation from similar African montane forests. Home to more than half of the recorded plant species in South Sudan. Common tree species are *Podocarpus milanjianus, Juniperus procera* (pencil cedar), *Croton, Macaranga, Albizia and Arundinalia alpina* (bamboo) as well as *Vernonia, Hagenia* and *Erica* shrub species. Common animals include the Blue duiker and the bushbuck.	Highly defragmented and deforested due to the widespread practice of valley farming, uncontrolled fires coupled with shifting cultivation and land clearance. Soil erosion on the slopes of the Imatong mountains due to cultivation. The Dongotona lost two-thirds of its forest cover from 1986 to 2011; it is likely to be cleared of all vegetation by 2020.
	3. Savannah woodland	
South Sudan's largest ecological region. It is found between the patches of lowland forest to the west and grassland savannah and floodplains to the east in equatorial, Upper Nile and Bahr el Ghazal, where rainfall ranges from 900-1,300 mm. The low-rainfall woodland savannah mainly occurs in Upper Nile and covers about 2.9 per cent of the country's total land area while the high-rainfall savannah occupies 52.6 per cent.	Has a rich diversity of flora and avifauna, reptiles, amphibians and invertebrates. Common large mammals of the wooded savannah include the elephant, *(Loxodonta africana)*, hippopotamus *(Hippopotamus amphibius)*, waterbuck *(Kobus ellipsiprymnus)*, giraffe *(Giraffa spp.)*, bushbuck (*Tragelaphus scriptus)*, Oribi *(Ourebia ourebi)*, duikers *(Cephalophus spp.)*, Uganda kob *(Kobus kob thomasi)*, warthogs *(Phacochoerus africanus africanus)*, hartebeest *(Alcelaphus buselaphus lewel)*, giant eland *(Taurotragus derbianus)*, buffalo *(Syncerus caffer)*, various species of primates and carnivores. The dominant species of the high-rainfall wooded savannah are *Celtis zenkeri, Chrysophyllum albidum, Mildbraediodendron excelsum* and *Holoptelea grandis.* Other common species are *Terminalia glaucescens, Albizia zygia, Combretum binderianum, Bridelia scleroneuroides* and *Dombeya quinqueseta.*	In 2007, the natural forests in Western Bahr el Ghazal were intact (they were not affected by the civil war) while mahogany was being harvested in Northern Bahr el Ghazal. The high rainfall forests (i.e. rainforests) have undergone a phase shift due to human-influenced degradation.

Location/Distribution	Characteristics	Status/Threats
	4. Grassland savannah	
A contiguous area of the northern, eastern and south-eastern parts of South Sudan's floodplain habitats.	Open short grasslands with scattered trees and shrubs, representing the largest area of intact savannah ecosystem left in east Africa. Dominant woody species include *Acacia, Balanites* and *Combretum*. Dominant perennial grasses include *Hyperrhenia, Andropogon* and *Panicum*, amongst others. Some of South Sudan's ungulate migrations partially occur here, including migrations of the White-eared kob *(Kobus kob leucotis)* and the Tiang *(Damaliscus lunatus tiang).*	Various mammal species are globally threatened, such as the cheetah *(Acynonix jubatus)*, wild dog *(Lycaon pictus)*, lion *(Panthera leo)*, leopard *(Panthera pardus)*, elephant *(Loxodonta Africana)*, Nubian giraffe *(Giraffa camelopardalis camelopardalis)* and the Kordofan giraffe *(Giraffa camelopardalis antiquorum)*.
	5. Sudd Swamp and other wetlands	
These include the Sudd and Machar swamps	*Typha dominguensis*, the dominant vegetation, covers about three-quarters of the total swamp. *Cyperus papyrus* forms the central core. There is a diversity of small and juvenile fish and macro-invertebrate fauna. Wildlife includes elephants *(Loxodonta africana),* buffalos *(Syncerus caffer)* and several other mammal species. The Nile crocodile *(Crocodylus niloticus)* and African rock python *(Python sebae)* are among the species of snakes and amphibians. There is a diversity of resident and migratory birds, including the globally important and largest population of shoebill stork *(Balaeniceps rex)* in Africa, with an estimated population of 5,000, the white stork *(Ciconia ciconia),* black tern *(Chlidonias nigra),* saddlebill stork *(Ephippiorhynchus senegalensis)* and black-crowned crane *(Balearica pavonina).*	Invasive alien plant species and encroachment of cattle threaten the swamp's wealth and diversity. Water hyacinth *(Eichornia crassipes)* now forms an almost ubiquitous floating fringe along its river channels and lakes. Threatened species include the Hippopotamus and near-threatened species include the sitatunga *(Tragelaphus spekei).* The Jonglei canal project would threaten the Sudd wetland's future. Threatened species include the endangered white pelican *(Pelecanus onocrotalus),* which flies over 2,000 km from Eastern Europe and Asia to reach the Sudd's floodplains and the vulnerable black-crowned crane *(Balearica pavonina).*
	6. Semi-arid region	
Occupies the extreme southeastern parts of Eastern Equatoria in and around the Ilemi Triangle and around Renk in the north.	Patches of open short grasslands and Acacia bushland. An extension of the northeastern Kenyan semi-arid zone, so it shares the same fauna and flora. The most abundant large mammal species is Grant's gazelle *(Gazella granti),* followed by Beisa Oryx *(Oryx beisa),* and lesser kudu *(Tragelaphus imberbis).* Elephant *(Loxodonta africana)* and common eland *(Taurotragus oryx)* are also present in Loelle (Ilemi triangle area).	Depending on the unpredictable annual rainfall, the groundcover is generally poor. There is also ongoing elephant poaching.

Sources:(Grossmann, et al., 2009);(MOE, 2015); (USAID, 2014); (CEPF, 2016); (PhysOrg, 2016)

Wetlands

Wetlands are one of the most extensive and significant of South Sudan's ecosystems, covering 14.7 per cent of the country's land area (RSS, 2015). The definition of wetlands adopted by the Ramsar Convention on Wetlands is "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Ramsar, 1971). Wetlands are of critical importance for their ecosystem goods and services (Box 1).

BOX 1: THE IMPORTANCE OF WETLANDS

The Ramsar Convention on Wetlands stresses that wetlands are vital for human survival. They are indispensable for countless benefits or "ecosystem goods and services", including regulating and purifying water, and replenishing groundwater, thus providing humans with water resources and water for food security from crops and fisheries. Wetland services include cycling nutrients and mitigating the impacts of climate change by storing vast quantities of carbon. They provide essential habitats for a vast array of wetland species. Their benefits to humans include job security (fisheries, agriculture) and a range of cultural benefits, including knowledge (scientific and traditional), recreation and tourism, and formation of cultural values, including identity and spiritual values.

The wetlands of South Sudan provide rich habitats for fish, mammals, birds, reptiles and amphibians, and for many rare and threatened species. Their hydrological and ecological functions, such as water quality improvement and food provision, contribute to ensuring ecological and sociocultural stability in the region (MOE, 2014). These wetlands provide invaluable natural resources that support the livelihoods of thousands of people, most significantly for pastoralists and their Nilotic cattle that depend on the wetlands for dry season grazing.

The Sudd wetland has the potential to be of great economic value to South Sudan if it is managed for environmental, economic and social sustainability. A meta-study of similar ecosystems estimated the potential economic value of a number of the Sudd wetland's benefits – including its symbolic value for the national identity, its role in climate change mitigation, the regulation of the flow of the White Nile and the support it provides to the country's unique wildlife and cultures – to be nearly US$ 1 billion per year. This figure represents only a fraction of the total value of the Sudd's non-economic values (UN Environment, 2015).

The Sudd swamp, one of the world's largest wetlands. *Photo credit: Peter Gilruth*

FIGURE 1. WETLAND COMPLEXES IN SOUTH SUDAN

Figure 1 shows the location and distribution of South Sudan's principal wetlands, the most important of which are the Sudd and Machar swamps.

Source: Map created from data provided by WCS.

The Sudd wetlands

The Sudd wetlands are formed by the discharge from the Nile and its tributaries, which flows down from highlands in Ethiopia, Uganda and the Central African Republic, and is held in a low clay basin in the south, in the lower northward-flowing reaches of Bahr el Jebel (MOE, 2015). Beyond the Sudd, the river flows to Khartoum in Sudan and merges with the Blue Nile to form the main stem of the Nile River. From there, the Nile flows through Egypt to the Mediterranean Sea. There are many extensive wetland ecosystems across the basin, from Lake Victoria in the south to the Nile Delta in the north, but the swamps and floodplains of the Sudd form the largest wetland ecosystem in the Nile basin and one of the largest tropical wetlands in the world (Rebelo, Senay, & McCartney, 2012). The Sudd swamp covers an average area of 57,000 km^2, but grows to as large as 130,000 km^2, depending on the outflow from the Albert Nile in Uganda (MOE, 2015).

In the rainy season, rising water levels flood the extremely flat plains that border the Sudd, creating the toic (or toich), an extensive temporary seasonal wetland surrounding the Sudd swamp (Osiro, 2014a). The toich covers an estimated area of a 16,000 km^2 (Rebelo, Senay, & McCartney, 2012). The soils retain enough moisture during the dry season to support grasses that feed grazing livestock and wildlife. By retaining water and releasing it slowly throughout the year, the wetland regulates the flows of the White Nile (CGIAR, 2013).

The wetland is part of the Jonglei Plains, a much larger ecozone that is three times the size of the Serengeti National Park and represents Africa's largest intact area of savannah (see the Hotspot case study). It also encompasses a variety of sub-ecosystem types, including open water with submerged vegetation, floating fringe vegetation, seasonally inundated woodland, rain-fed and river-fed grasslands and floodplain scrubland (Riak, n.d.).

The Sudd is a unique and highly biodiverse ecosystem. The permanently inundated swamps are dominated by *Cyperus papyrus*, *Typhadomingensis*, and other cattails (*Typha spp.*). The seasonally flooded grasslands are dominated by *Oryzalongistaminata* and *Echinochloapyramidalis*. The permanently inundated grasslands are dominated by *Hyparrheniarufa*. There are also large stands of *Balanitesa egyptiaca* and *Acacia seyaland*, mixed stands of *Ziziphus mauritiana, Combretum fragrans, A.seyal* and *B.aegyptiaca* (Grossmann, Elkan, Tiba, & Awol, 2011).

It harbours over 400 resident and migratory bird species, and about 100 mammal species (Rebelo, Senay, & McCartney, 2012). Located on the eastern flyway between Africa and Europe/Asia, the Sudd is one of the most important wintering grounds in Africa for Palearctic migrants, providing essential habitats for millions of migrating birds (Table 1) (Rebelo, Senay, & McCartney, 2012).

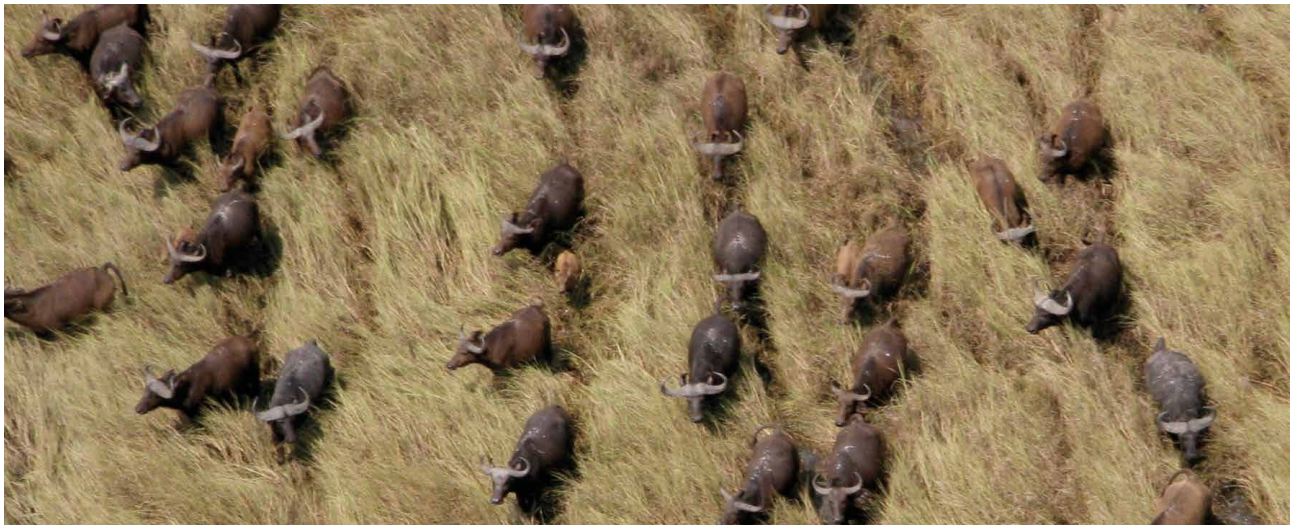
Scientific surveys have shown that since the early 1980s, the number of wildlife species has reduced significantly in many formerly key wildlife areas of the country:

- A country-wide survey in the 1970s estimated some 80,000 elephants. Elephant population estimates for these areas have since declined from 20,000 in the 1980s to less than 2,500 in 2007.
- Buffalo population estimates have declined from 96,000 to less than 10,000.
- Giraffe have declined from an estimated 13,000 to some 500.
- Migratory antelope populations of White-eared kob, Tiang, and Mongalla gazelle estimated to be some 1.5 million in the 1980s, have also been heavily poached during the recent years of armed conflict

The 2007 survey indicated:

- Nile sitatunga were observed over a wide range across the Sudd in and around the Zeraf Game Reserve, with an estimated population of 603
- the Hippopotamus population is estimated at about 497
- the Sudd, including areas of Zeraf Game Reserve, contained 3,830 Shoebills (Grossmann, Elkan, Awol, & Penche, 2008); (Grossmann, Elkan, Tiba, & Awol, 2011);(WCS, 2017b).

Elephants. *Photo credit: WCS South Sudan*

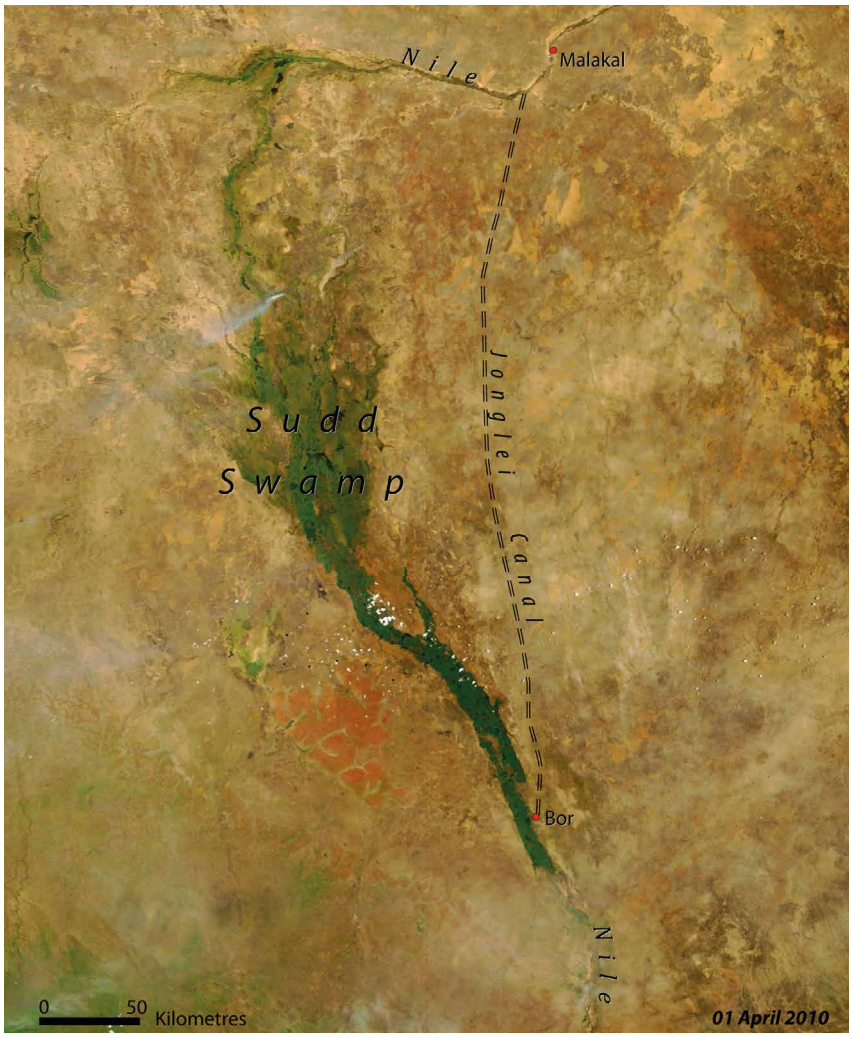


Buffalo. *Photo credit: WCS South Sudan*

Other large mammals included the near-endemic Nile lechwe *(Kobus megaceros)*, a threatened antelope with a population of some 4,000 in the Sudd, and the sitatunga *(Tragelaphus spekii)*, a medium-sized antelope. Among the International Union for Conservation of Nature Red List vulnerable species (IUCN, 2016) are the Mongalla gazelle *(Eudorcasal bonotata)*, African elephant *(Loxodonta africana)*, hippopotamus *(Hippotatamus amphibius)* and shoebill *(Balaeniceps rex)* (Riak, n.d.).

It is estimated that more than one million people, especially the Nilotic peoples who live in and around the swamp, are almost entirely dependent on the wetland for their socioeconomic and cultural lives. Most communities in the area are livestock owners and fishers who depend on the annual floods that regenerate floodplain grasses to feed their cattle, and provide domestic and livestock water supplies, as well as fish for food security (Osiro, 2014a). Many fish species migrate from the surrounding rivers to the nutrient-rich floodplains to feed and breed during the seasonal floods. The Sudd is one of the Nile's only water bodies that is not overfished. In the early 2000s, it was estimated that the potential fish yield (based on a surface area of 30,000 -40,000 km^2) was 75,000 tonnes per year (Rebelo, Senay, & McCartney, 2012).

Its uniqueness and global significance led to a core area of 57,000 km^2 of the Sudd to be designated a Ramsar Wetland of International Importance in 2006. The greater Sudd ecosystem contains three protected areas: the Zeraf Game Reserve (8,000 km^2) within the central Bahr el Jebel drainage, the Fanyikang Game Reserve (570 km^2) along the northern border, and the Shambe Game Reserve (1,800 km^2) on the west side of the Nile River (Fay, Elkan, Marjan, & Grossmann, 2007).



Green colour generally represents vegetation, brown: sparse vegetation, bare ground, fields or human settlements and dark blue: water.

Sudd swamps observed from space

Toich vegetation

There is a high diversity of flora in the toich surrounding the Sudd. The depth and duration of flooding on the toich determines the distribution of grass species, which consists of three distinct groups:

- *Echinochloa* toiches: The dominant grass species are *Echinochloa stagnina* and *Echinochloa pyramidalis,* with other associated species such as *Oryzabarthii, Oryzapunctata* and *Vossia cuspidata. E. stagnina* and *V. cuspidata* generally occur at shallow flood levels and *E. pyramidalis* and *Oryza spp.* at deeper flood levels. During the dry season, the pasture produced by *Echinochloa* toiches is the only reliable source of green grazing for livestock in all regions.
- *Phragmites* toiches: The dominant species on these toiches is *Phragmites communis*, with some *Echinochloa pyramidalis* and *Sorghum spp.* and at times, *Hyparrhenia spp.* Small trailing and climbing species, such as *Luffa cylindrica* and *Vignan ilotica,* also occur.
- *Hyparrhenia* toiches: The dominant species in these toiches is *Hyparrhenia rufa,* but there is a considerable amount of *Vetiveria nigritana* as well. Other species include *Sporobolus pyramidalis, Sorghum spp.* and in some areas, small patches of *Imperata cylindrica* (Gebreyes, Lemma, Deng, & Abdullahi, 2016).

Savannah ecosystems

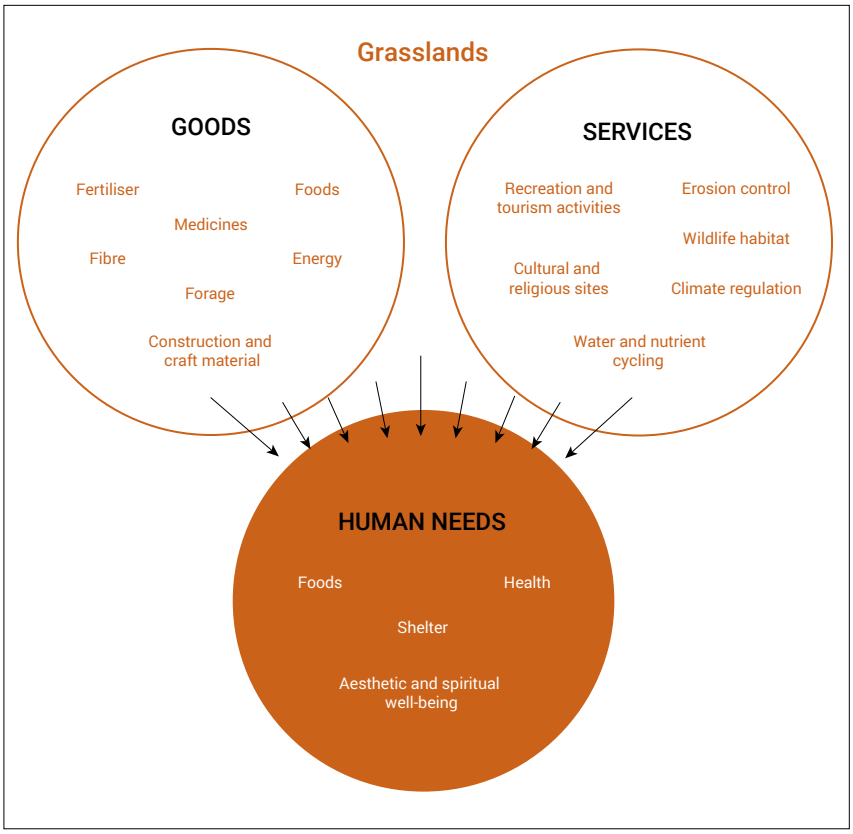
South Sudan's savannah ecosystems are part of a broad "grasslands" category of terrestrial ecosystems that cover some 40 per cent of the earth's surface (excluding Greenland and Antarctica). They are characterised by dominant herbaceous and shrub vegetation, and maintained by fire, grazing, drought and/or freezing temperatures. This definition includes some savannahs, woodlands, shrublands and tundra, as well as more conventional grasslands (White, Murray, & Rohweder, 2000). Grasslands, which include savannah ecosystems, provide a wealth of ecosystem goods and services (Box 2).

At a regional level, the savannahs of South Sudan are part of an ecoregion that the World Wide Fund for Nature has termed the Sudanian Savannahs. Ecoregions are large areas of relatively uniform climate that harbour a characteristic set of species and ecological communities. This extensive area of tropical and subtropical grasslands, savannahs and shrublands contains a large diversity of flora and fauna that are found nowhere else in the world. The characteristic vegetation is acacia woodland, with most other trees being deciduous with an understory of grasses, shrubs and herbs. There is a pronounced dry season and it is known for the mass seasonal migration of animals, along with the large number and variety of migrant birds. The World Wide Fund for Nature deems the ecoregion as a whole to be generally in a critical or endangered state. Although there remain large blocks of relatively intact habitats, there has been a significant loss of areas of original wooded savannah habitats. Threats include seasonal shifting cultivation, over-grazing by livestock, logging, burning for charcoal, uncontrolled wild fires, poaching and climatic desiccation.

BOX 2: **THE IMPORTANCE OF SAVANNAHS**

Among the ecosystem goods that grasslands provide are forage for domestic livestock, which in turn support human livelihoods with meat, milk, wool and leather products. They are habitats for breeding, migrating and wintering birds, soil fauna and wild herbivores. Their ecosystem services include cycling water and nutrients and building and stabilising soils. Grassland vegetation, above and below ground, as well as the soil itself, store vast quantities of carbon, helping to limit global warming (White, Murray, & Rohweder, 2000). Tropical savannah systems such as the savannahs of South Sudan, possess significant wild faunal diversity that supports subsistence livelihoods (food, medicinal plants, and construction material), cultural, regulating and supporting services, as well as nature-based tourism revenue (both extractive and non-extractive) (IPCC, 2007) (Figure 2).

FIGURE 2: ECOSYSTEM GOODS AND SERVICES PROVIDED BY GRASSLANDS



Source: (White, Murray, & Rohweder, 2000)

In South Sudan, the Sudanian Savannah is made up of tropical and subtropical grasslands, savannahs and shrublands. The country's grasslands cover about 15 per cent of the country's land area (RSS, 2015). Table 1 divides this large system into three ecosystems: savannah woodland; grassland savannah; and the semi-arid region. It provides information about the status and trends in their biodiversity.

Species diversity

South Sudan's wide range of habitats supports a very rich diversity of both animal and plant species, as described in Table 1, however, the variety and number of different species is unknown. A glimpse of the richness of species is provided in a 2015 study by biologists, who took 105,000 motion-controlled photos in an area of about 7,770 km^2 of dense forest in former Western Equatoria State. They found a total of 37 species, including four species never before documented in South Sudan: the African golden cat *(Caracal aurata)*, water chevrotain *(Hyemoschus aquaticus)*, red river hogs *(Potamochoerus porcus)*, and giant pangolin *(Manis gigantea)*. It also captured chimpanzees, bongos, leopard, forest buffalo, honey badger and the rare forest elephant (Howard, 2015); (Patinkin, 2015). Forest elephants *(Loxodonta cyclotis)* are smaller than savannah elephants and tend to inhabit densely wooded rain forests. They play a crucial role in the ecosystem because they are voracious fruit eaters whose dung spreads tropical fruit tree seeds extensively. Numbers have declined dramatically over the last two decades however, and the species is critically endangered. Their presence in Western Equatoria is far to the north and east of forest elephants' previously known range (Patinkin, 2015).

As part of national commitments to the United Nations Convention for Biological Diversity, member countries submit reports on their biodiversity resources. In 2015, South Sudan's fifth such report to the Convention on Biological Diversity described its biodiversity resources thusly: "Some of the endemic fauna species in the country include the Hoogstral's striped grass mouse *(Lemniscomys hoogstraali)* and a recently discovered African climbing mouse *(Dendromus ruppi)*. South Sudan is known to be the only country in Africa with both species of eland — the common eland *(Taurotragus oryx)* and the Derby's (giant) eland *(Taurotragus derbianus)*. The world's population stronghold of the shoebill and black-crowned crane occur in the Sudd wetland. While South Sudan shares many of its fauna species with her neighbours to the south and west, other species like the Nile lechwe and the White-earedkob are endemic to South Sudan and Ethiopia. South Sudan is also thought to be the centre of giraffe evolution. Reptiles endemic to South Sudan include the Torit gracile blindsnake *(Letheobia toritensis)* and the Mount Kinyetic chameleon *(Trioceros kinetensis)*. Freshwater fish known exclusively from South Sudan include *(Barbus tongaensis)* and *(Labeo tongaensis)*" (MOE, 2015).

Considering the country's flora species, the report to the Convention on Biological Diversity noted that the "Imatong Forest is a major biodiversity hotspot supporting over 2,000 vascular plant and 500 bird species, and is one of the largest intact *Podocarpus* forest in Africa. Endemic flora of South Sudan includes *Chloroselasta posana,* and *Lepidochrysops nigritia.* Among the vascular plant species restricted to South Sudan are *Aloe diolii, Aloe macleayi,* a cycad *Encephalartos mackenziei, Chlorophytum superpositum, Scillachloranthа* and *Panicumbambusiculme*. Wild Arabica coffee grows in the forests of the Boma Plateau and Imatong Forest" (MOE, 2015).

The IUCN Red List of Threatened Species for South Sudan lists 4 critically endangered species and 11 endangered species. The hooded vulture *(Necrosyrtes monachus),* Rüeppell'sgriffon *(Gyps rueppellii),* white-backed vulture *(Gyps africanus)* and white-headed vulture *(Trigonoceps occipitalis)* are all critically endangered. Endangered species include three mammals: the Cape hunting dog *(Lycaonpictus),* common chimpanzee *(Pan troglodytes)* and the Nile lechwe *(Kobus megaceros);* six birds: Basra reed warbler *(Acrocephalusgriseldis),* Egyptian eagle *(Neophronpercnopterus),* lappet-faced vulture *(Torgostracheliotos),* Natal thrush *(Geokichla guttata),* Saker falcon *(Falco cherrug)* and Steppe eagle *(Aquila nipalensis)*. Two plants, *Aloe erensii* and *Aloe macleayi,* while currently not threatened, are restricted to South Sudan (IUCN, 2016).

Genetic diversity

Generally, farmers worldwide have shifted from growing locally adapted and developed populations (landraces) of crop and livestock varieties to modern, more-widely adapted varieties produced through formal breeding systems. This has led to a global decline in genetic diversity, especially among cultivated species (MA, 2005). There is almost no information regarding the state of genetic diversity of both wild and domestic species in South Sudan. The food security of a large proportion of the population depends on little known indigenous wild fruits and vegetables, pastures and forages, medicinal plants, and especially on rare and indigenous crop varieties like finger millet and sorghum, as well as introduced crops such as maize. It is important to characterise the genetics of these plants and document their status, so as to conserve genetic diversity within domestic crop species and avoid a trend toward genetic uniformity from new commercial crop varieties (MOE, 2015).

Species abundance and seasonal mass migrations

Species abundance, which refers to the number of individuals per species, is an important aspect of the phenomenon of mass migrations of animals that is one of South Sudan's iconic and most significant environmental features. Globally, the mass seasonal and round-trip migration of animals between discrete areas of savannahs, steppes and grasslands is threatened by a number of human activities that either reduce a significant number of the migrant population or restrict their access to food and water. These include overhunting and habitat loss from livestock, agriculture and fencing. In fact, many migrations have already disappeared. A global audit of mass migrations of mammals found that the migrations of six species of mammal have been completely eradicated and nearly all have lost some aggregated migrations (Harris, *et al.,* 2009).

The remarkable mass migration of white-eared kob *(Kobus kobleucotis)*, tiang *(Damaliscus lunatus)* and Mongalla gazelle *(Gazella thomsonii albonotata)* that occurs in the Boma-Jonglei Landscape in South Sudan is of global significance and still thought to be thriving, but it faces numerous threats.

The Boma-Jonglei landscape and the mass migration of antelope

The Boma-Jonglei-Equatoria Landscape of South Sudan covers an extension of just under 200,000 km^2 in Jonglei, Eastern and Central Equatoria, Lakes and Unity; and it encompasses over 68,000 km^2 of protected areas, at a national level. These include: Boma, Badingilo and Nimule National Parks (and their proposed extensions), Zeraf and Kidepo Game Reserves, Imatong Forest Reserve, and the proposed Loelle protected area.

This landscape of global importance contains the Sudd, one of the world's largest tropical wetlands; as well as the largest cohesive wooded savannah remaining in Africa.The migration of the White-eared kob, Tiang and the Mongalla gazelle is one of the three largest ungulate migrations in the world. The others are the wildebeest *(Connochaetes taurinus)* in the Serengeti-Masai Mara ecosystem in East Africa and the caribou *(Rangifer tarandus)* in Alaska, USA. Much less is known about South Sudan's mass migration than about the other two phenomena (Marjan, 2014).

The white-earedkob, a sub-species of the kob *(Kobus kob),* is a gregarious medium-sized antelope that roams in large herds of hundreds to tens of thousands of animals. Males have large, curving horns in the shape of an "S", and are black and white in colour. Females are light brown, smaller in size and have no horns. The IUCN's Red List of Threatened Species categorises the population as "least concern".

The tiang is a larger antelope, sub-species of the topi *(Damaliscus lunatus).* Its body slopes back from the higher head and shoulders and it has vertically rising horns that curve evenly backwards. Tiang is categorised in the IUCN Red List as "least concern".

These antelopes migrate enormous distances over large areas of the Boma-Jonglei Landscape, moving between two distinct dry and wet season ranges (Marjan, 2014); (Schapira, Monica, Rolkier, & Bauer, 2017) (Figure 4) during their yearly migrations. The White-eared kobs migrate westwards from their dry-season habitat in Boma National Park to the plains near the White Nile and are joined by herds of tiangs in Badingilo National Park as they migrate southwards from their dry-season habitat in the Sudd swamps (Blair, 2015).

It is thought that there are two distinct groups; the largest number of white-eared kob aggregations move toward the East into Boma National Park, some reaching as far as Ethiopia, to then return to their wet season range via the southern section of Boma National Park. A second group mainly formed

Aerial view of Sudd Wetlands in Jonglei. *Photo credit: UN Photo/ Martine Perret*

by tiang and white-eared kob in smaller numbers, move northwards towards the Sudd area (Grossmann, Elkan, Tiba, & Awol, 2011), (Wildlife Conservation Society aerial survey and reconnaissance data). The results of tracking collared kob individuals reveal a total migration distance of 895 km, representing the longest migration in Africa (Marjan, 2014).

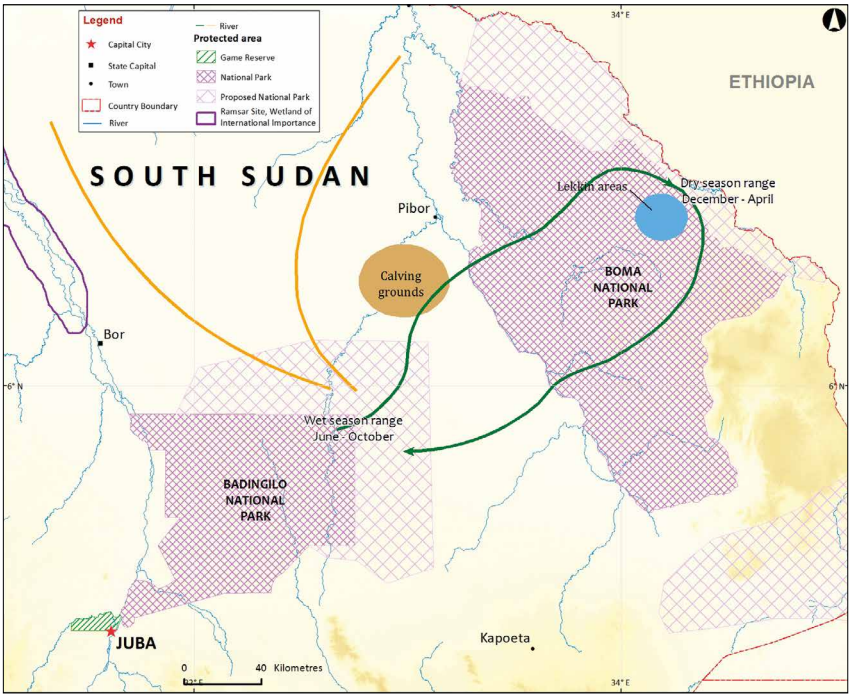
It was once thought that the civil war and subsistence hunting carried out by local people and combatants had decimated the population numbers of these antelopes. However, in 2007, the Wildlife Conservation Society conducted the first aerial survey after the civil war, and estimated there were over 1 million migratory ungulates, revealing high numbers of white-eared kob and tiang remained despite the many years of fighting (Fay *et al.*, 2007). A later survey of the wet season range carried out by the Wildlife Conservation Society in 2010, increased this estimate to over 1.5 million white-eared kob, and 125,000 tiang (Grossmann, Elkan, Tiba, & Awol, 2011).

Some migration patterns include areas across the border into Ethiopia's Gambella region, although the major population of white-eared kob migrates within South Sudan (Rolkier, 2015). The results of tracking collared kob individuals reveal a total migration distance of 895 km, representing the longest antelope migration in Africa (Marjan, 2014).

FIGURE 3: THE BOMA-JONGLEI LANDSCAPE AND PROTECTED AREA NETWORK

Source: Map redrawn from WCS

FIGURE 4: MAJOR ECOLOGICAL ZONES AND THE MIGRATION RANGE



Source: Redrawn from map by WCS

Migration of the white-eared kob. *Photo credit: WCS*

6.3 Pressures and impacts

The diversity of ecosystems, species and genes in South Sudan is threatened by a number of human pressures. The lists below describe the threats as well as their impacts on wildlife biodiversity and abundance.

Direct threats

- Bushmeat and ivory poaching and trafficking (both internally and transboundary, and including armed groups involvement)
- Ivory trafficking (and links for armed actors)
- Over-exploitation of wildlife species for commercial gain and subsistence
- Rapidly expanding charcoal production/deforestation (groups controlling)
- Uncontrolled natural resource extraction (minerals (gold), timber, ivory, etc.)
- Habitat loss and fragmentation
- Community conflicts over land and natural resources
- Pollution from extractive industry (oil, mining, etc.)
- Climate change (WCS, 2017b)

Indirect threats

- Ongoing armed conflict in some areas
- Natural resources used to finance and support conflict
- Food insecurity
- Displaced people
- Tribal violence (cycles underlying and current armed conflict)
- Conflict over land and water
- Governance confusions (Federal, State, Global Programme of Action (GPA), etc.)
- Economic crisis (rampant inflation)
- Inadequate land, environment, and natural resource management capacity
- Inadequate regulatory framework for natural resource management
- Poor governance and insecurity in remote rural areas
- Uncontrolled concession allocation and poor management
- Poorly planned major development projects (e.g. dams, road networks)
- Lack of employment and economic opportunities in rural areas
- Lack of transparency and monitoring of extractive industry (WCS, 2017b)

Pressures and impacts on the Boma Jonglei Landscape and the ungulate migration

Since 2007, the Wildlife Conservation Society has demonstrated that current key wildlife distributions include areas both within and outside of protected areas. Most notably, this includes the entirety of the Sudd wetland ecosystem (including the current Zeraf Game Reserve, Shambe National Park, north Meshra Game Reserve area and Sudd Ramsar Site) and Boma, Badingilo, Southern and Nimule National Parks, as well as the Loelle Zone. In addition, there are a number of particularly critical and currently unprotected wildlife migration corridors and elephant ranging areas. These include the white-eared kob corridor between Boma and Badingilo National Parks, and the Tiang corridor between Badingilo National Park and the Sudd grasslands (northern Bor County). During a recent survey conducted by the Wildlife Conservation Society (WCS, 2017b), human pressures and poorly planned development projects in the centre of Boma National Park were documented which, if not controlled and limited, will threaten the connectivity of the wildlife migrations. Poaching and commercial wildlife trafficking in South Sudan is expanding, as are illegal charcoal production, timber harvesting, and mining activities. Further, wildlife in South Sudan face a continued and expanded threat from opportunistic and large-scale poaching by both armed groups and civilians. The migratory tiang antelope are particularly vulnerable as they cross some of the conflict zones on their annual migration route from Badingilo Park to the Sudd and back (WCS, 2017a). If these trends continue, the results will be wildlife depletion, environmental degradation, increased conflict over natural resources and land, and the loss of opportunities to develop ecotourism based on this globally significant migration phenomenon.

Wetland Degradation near Bor

Satellite images how the degradation and loss of vegetative cover between 2002 and 2016 around Bor due to influx of population. Green colour generally represents vegetation, brown: human settlements or fields and dark blue: water.

Bor wetland, 2002

Bor wetland, 2016

(Source: Landsat data from United States Geological Survey)

Satellite images of Mushra Game Reserve

The satellite images show the change in vegetation cover on the Mushra Game Reserve between 2000 and 2016. The green colour generally represents vegetation, brown: human settlements or fields, and dark blue: water.

Mushra Game Reserve, 2000

Mushra Game Reserve, 2016

(Source: Landsat data from United States Geological Survey)

BOX 3: CONFLICT AND THE THREAT TO UNGULATE POPULATIONS

The first aerial assessment by the Wildlife Conservation Society of the impact of South Sudan's current civil war on the country's wildlife and other natural resources showed that significant wildlife populations have so far survived, but poaching and commercial wildlife trafficking are increasing (WCS, 2017b). During the civil war, the Sudanese Armed Forces, Sudan People's Liberation Army, and civilians used automatic rifles to hunt wildlife for food. These patterns of large-scale wildlife hunting by armed forces and civilians have continued up to the present day, with such activity being widely reported throughout the recent 2013 to 2015 civil war and ongoing armed conflict (WCS, 2014); (WCS, 2016). Further, since the outbreak of the conflict in December 2013, numerous law enforcement reports of poaching and bush meat trafficking in different parts of the country have been recorded. Declines in kob and tiang populations could seriously upset the food chain, threatening the survival of the country's remaining large predators such as lions, cheetahs (both of which are vulnerable species) as well as African wild dog, an endangered species.

Surveys and information gathering by the Wildlife Conservation Society indicate that poaching and commercial wildlife trafficking in South Sudan are expanding, with numerous reports of poaching and commercial bushmeat trafficking recorded throughout the country. These documented cases indicate that South Sudan's wildlife faces continued and expanded threats from opportunistic and large-scale commercial poaching. Historically, during the Sudan Civil War, both parties hunted wildlife, though Sudan People's Liberation Army soldiers were ordered to refrain from hunting certain vulnerable species such as elephants. Hunting for bushmeat by armed forces, as well as by civilians, have persisted after the war, and have intensified since the outbreak of the conflict in December 2013, with all species being targeted. The white-eared kob migration is at risk throughout its migratory route as both Government and Opposition armed forces, other armed group forces, and civilians have started to target the migration, while wildlife law enforcement efforts by the South Sudan National Wildlife Service have weakened since the start of the conflict in December 2013. Reports indicate wildlife, particularly tiang, is also being poached in the areas along the Juba-Bor road with important bush meat trading hubs in that area, as well as north of Jonglei towards the Sudd. The area along the Bor-Pibor road also sees high levels of poaching (WCS, 2017b).

Threats to elephants and other species

Elephants in Africa play an important role as "keystone" species, meaning they help to maintain the balance of all other species in the ecosystem. In the 1970s, there were an estimated 80,000 African elephants *(Loxodonta africana)* in South Sudan. Earlier surveys and applied research conducted by the Wildlife Conservation Society and the South Sudan Wildlife Service estimated an elephant population of some 2,300 elephants in the country prior to the civil war, which began in December 2013; down from an estimated 79,000 in the 1970s (WCS, 2017b). Elephants face continued and expanded threats. The latest aerial surveys carried out by the Wildlife Conservation Society in 2015-2016 confirmed the status of several key elephant populations with a minimum count of 730 elephants (WCS, 2017b). However, with poaching and commercial wildlife trafficking on the rise, and an increase of illegal charcoal production, timber harvesting, and mining activities, the future of wildlife in South Sudan, and the potential of wildlife based ecotourism as a source of revenue generation and local community development may be lost forever if the wildlife populations are not immediately secured.By doubling our efforts, and protecting South Sudan's wildlife heritage, the wildlife and natural resources of the country will directly contribute to peace and sustainable development in the country.

Along with elephants, other species at greatest risk include giraffes *(Giraffacamelo pardalis),* the Nile lechwe *(Kobus megaceros)* and tiang; the latter is one of the main targets of poachers (Casey, 2014). The Boma-Jonglei Landscape is one of the county's largest elephant ranges, but oil exploration is being carried out in the central floodplains of Jonglei, Lakes and Upper Nile, posing a threat to elephant habitat and that of other wildlife species, as well as to local community livelihoods.

Declines in wildlife populations in South Sudan

Results of aerial surveys conducted recently by the Wildlife Conservation Society – South Sudan compared to surveys conducted in the 1980s by other investigators show that animal populations have dropped considerably (Table 2) (Fay, Elkan, Marjan, & Grossmann, 2007); (Grossmann, Elkan, Awol, & Penche, 2008); (Grossmann, Elkan, Tiba, & Awol, 2011); (WCS, 2017b). Generally, resident species (for example, giraffe, elephants, Roan antelope and buffalo, amongst others) suffered more than the migratory species, such as white-eared kob and Mongalla gazelle. Table 2 shows the critical decline in giraffe and elephant numbers, of 99.7 and 97 per cent, respectively.

TABLE 2. **INITIAL AND CURRENT POPULATION ESTIMATES, AND PERCENTAGE DECREASE IN POPULATION ESTIMATES, 1980s**

Species	Initial population estimate	Current population estimate	Per cent decrease
Giraffe	100,000	300	99.7
Elephant	80,000	<2,500	97
Tiang	200,000	155,000	92
Mongalla Gazelle	900,000	275,000	60
White-eared Kob	1,000,000	800,000	20

Sources: (Fay, Elkan, Marjan, & Grossmannm, 2007); (Grossmann, Elkan, Awol, & Penche, 2008); (Grossmann, Elkan, Tiba, & Awol, 2011)

Latest information from Wildlife Conservation Society aerial surveys and applied research undertaken over the past ten years of key wildlife areas of the country including Boma, Badingilo, Southern, Shambe, and Nimule National Parks, the Zeraf Game Reserve and Loelle area. Full surveys need to be conducted to assess the status of wildlife populations and the impact of the civil war from 2014 to the present day. The observed declines in populations of most wildlife species is due to several factors. First, armed conflict over the past two decades that led to large-scale displacements of people and livestock has significantly impacted the lives of both local communities and wildlife (Morjan, Nicholas, Solomon, & and Lam, 2004). Second, hunting played and continues to play an important role in human survival, providing as it does a cheap source of animal protein — many wildlife species have thus been hunted for their meat.

Game hunting for food security

Table 3 shows the proportion of South Sudan's tribes (out of fifteen named tribes) that consume game animals and the status of threat to those species as defined by the International Union for the Conservation of Nature (IUCN), in order of most threatened to least threatened. It reveals that many species threated with extinction to some degree are being hunted for food in South Sudan. The Black Rhino is critically endangered, but all 15 tribes continue to hunt and consume this animal. Two ungulates that make up significant populations of the massive migration in the Boma-Jonglei landscape, the tiang and the Nile lechwe, are endangered species. The tiang provides food for 11 of the 15 tribes and the Nile lechwe for 7 of the 15 tribes.

Bushmeat of an antelope species. *Photo Credit: Courtesy of Mr. Demetry, 2010*

There is also an endangered species, but it is not hunted for food. The common hippopotamus and the red-fronted gazelle, which are consumed by all but one of the fifteen tribes, are vulnerable species. The cheetah and lion are also vulnerable, but only one or two tribes use them for food. A number of species are in the category of "near threatened", including the white rhino and elephant, both of which are hunted for food by all 15 tribes. All but one tribe partakes of the lesser kudu, a near threatened species. Other near threatened species includes the bongo, marsh mongoose, tree pangolin and leopard, all of which are consumed by about half the tribes. Only two tribes eat striped hyena, which is also near threatened. All the other species listed in Table 3 are of "least concern".

African Wild Dog. *Photo credit: Bernard DUPONT/flickr.com/CC BY-SA 2.0*

TABLE 3. GAME HUNTED FOR FOOD BY SOUTH SUDAN'S VARIOUS TRIBES

Species/proportion of tribes that consume this species	Scientific name	IUCN Conservation Status
All tribes consume this species		
Bush pig	*Potamochoerrus larvatus*	Least Concern
Giant forest hog	*Hylochoerus meinertzhageni*	Least Concern
Warthog	*Phacochoerus africanus*	Least Concern
Blue Duikers	*Philantomba monticola*	Least Concern
Yellow-backed Duikers	*Cephalophus silvicultor*	Least Concern
Greater Kudu	*Tragelaphus strepsiceros*	Least Concern
Roan Antelopes	*Hippotragus equinus*	Least Concern
Kobs	*Kobus kob*	Least Concern
Buffalo	*Syncerus caffer*	Least Concern
White Rhino	*Ceratotherium simum*	Near Threatened
All but one or two tribes consume this species		
Common Hippopotamus	*Hippopotamus amphibius*	Vulnerable
Giraffe	*Giraffa camelopardalis*	Least Concern
Gunther's Dik-dik	*Madoqua guentheri*	Least Concern
Kirk's Dik-dik	*Madoqua kirkii*	Least Concern
Oribi	*Ourebia ourebi*	Least Concern
Giant Bush buck	*Tragelaphus scriptus*	Least Concern
Lesser Kudu	*Tragelaphus imberbis*	Near Threatened
Water buck	*Kobus ellipsiprymnus*	Least Concern
Bohor Reedbuck	*Redunca redunca*	Least Concern
Mountain Reedbucks	*Redunca fulvorufula*	Least Concern
Common Reedbucks	*Rudunca rudunca*	Least Concern
Red-fronted Gazelle	*Eudorcas rufifrons*	Vulnerable
Grant's Gazelles	*Nanger granti*	Least Concern
African Bush-tailed Porcupine	*Atherurus africanus*	Least Concern
North African Crested Porcupine	*Hystrix cristata*	Least Concern
African Savanna Hare	*Lepus microtis*	Least Concern
Bunyoro Rabbit	*Poelagus marjorita*	Least Concern
About three-quarters of the tribes consume this species		
Tiang	*Damaliscus korrigum*	Endangered
Hartebeest	*Alcelaphus buselaphus*	Least Concern
Patas Monkey	*Erythrocebus patas*	Least Concern
Red-tailed Monkey	*Cercopithecus ascanius*	Least Concern
Blue Monkey	*Cercopithecus mitis*	Least Concern
De Brazza's Monkey	*Cercopithecus neglectus*	Least Concern
Grivert Monkey	*Chlorocebus aethiops*	Least Concern
Tantalus Monkey	*Chlorocebus talantus*	Least Concern
Olive Baboon	*Papio anubis*	Least Concern
Striped Ground Squirrels	*Xerus erythropus*	Least Concern
Unstriped Ground Squirrels	*Xerus rutilus*	Least Concern
Gambian Sun Squirrel	*Heliosciurus gambianus*	Least Concern
Red-iegged Sun Squirrel	*Heliosciurus rufobrachium*	Least Concern
Boehm's Bush Squirrel	*Paraxerus boehmi*	Least Concern
Forest Giant Squirrel	*Paraxerus stangeri*	Least Concern

Species/proportion of tribes that consume this species (see key)	Scientific name	IUCN Conservation Status
About half of tribes consume this species		
Suni	*Nesotragus moschatus*	Least Concern
Klippspringer	*Oreotragus oreotragus*	Least Concern
Sitatanga	*Tragelaphus spekii*	Least Concern
Bongo	*Tragelaphus eurycerus*	Near Threatened
Common Eland	*Taurotragus oryx*	Least Concern
Giant Eland	*Taurotragus derbianus*	Least Concern
Nile lechwe	*Kobus megaceros*	Endangered
Aardvark	*Orycteropus afer*	Least Concern
Marsh Mongoose	*Manis gigantea*	Near Threatened
Ground Pangolin	*Manis temminckii*	Lower Risk
Tree Pangolin	*Manis tricuspis*	Near Threatened
African Clawless Otter	*Aonyx capensis*	Least Concern
Spotted-necked Otter	*Hydrictis maculicollis*	Least Concern
About a third of the tribes consume this species		
Abyssinian Genet	*Genetta abyssinica*	Least Concern
Common Genet	*Genetta genetta*	Least Concern
Rusty-spotted Genet	*Genetta maculata*	Least Concern
Fewer than a quarter of tribes consume this species		
Burchell's Zebra	*Equus burchellii*	Least Concern
Side-striped Jackal	*Canis adustus*	Least Concern
Bat-eared Fox	*Otocyon megalotis*	Least Concern
Ratel	*Mellivora capensis*	Least Concern
African Civet	*Civettictis civetta*	Least Concern
African Palm Civet	*Nandinia binotata*	Least Concern
Spotted Hyena	*Crocuta crocuta*	Least Concern
Striped Hyena	*Hyeana hyaena*	Near Threatened
Lion	*Panthera leo*	Vulnerable
Four-toed Hedgehog	*Atelerix albiventris*	Least Concern
Only one tribe consumes this species		
Pousargues Mongoose	*Dologale dybowskii*	Data Deficient
Marsh Mongoose	*Atilax paludinosus*	Least Concern
Slender Mongoose	*Galerella sanguinea*	Least Concern
Common Dwarf Mongoose	*Helogale parvula*	Least Concern
Egyptian Mongoose	*Herpestes ichneumon*	Least Concern
White-tailed Mongoose	*Ichneumia albicauda*	Least Concern
Banded Mongoose	*Mungos mungo*	Least Concern
Leopard	*Panthera pardus*	Near Threatened
Cheetah	*Acinonyx jubatus*	Vulnerable
Golden Jackal	*Canis aureus*	Least Concern
Black-backed Jackal	*Canis mesomelas*	Least Concern
None of the tribes consume this species		
Aardwolf	*Proteles cristata*	Least Concern
African Wild dogs	*Lycaon pictus*	Endangered
Caracal	*Caracal caracal*	Least Concern
Wild cat	*Felis silvestris*	Least Concern
Serval	*Leptailurus serval*	Least Concern

Among 64 tribes in South Sudan, 15 tribes – Dinka, Nuer, Shilluk, Lotuka, Madi, Jurchol, Didinga, Acholi, Bari, Murle, Toposa, Moru, Lango, Pari, Azande predominantly hunt for food.

Other pressures on wildlife include hunting for skins and disease outbreaks. Some animals, such as pythons and Nile crocodile, are hunted for their skins.

Skins of poached python species.
Photo credit: Courtesy of Mr. Demetry, 2010

Skins of poached Nile crocodile.
Photo credit: Courtesy of Mr. Demetry, 2010

Attitudes to wildlife in protected areas

Two studies that looked at attitudes towards wildlife in Nimule National Park revealed that over 70 per cent of people living in and around the park had negative attitudes towards wildlife, resulting mainly from encounters with large cats, pythons, crocodiles, warthogs, buffalos, hippopotamus and elephants on their properties, affecting livestock and crops, but also causing human mortalities (Stephen, 2016); (Tomor, 2015).

6.4 Response

Protected Areas

One of the most effective means of protecting biodiversity and species abundance is to create and enforce the conservation of wildlife habitat. The Ministry of Environment and Forestry for South Sudan defines a protected area as "an area of land or water in South Sudan specifically protected for the maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means including national parks and game reserves" (MOE, 2015). In South Sudan, at the national level, there are the following types of protected areas: National Parks, Game Reserves and Forest Reserves. Sudd wetland is a Ramsar site, which is an international classification (Figure 5).

FIGURE 5: SOUTH SUDAN'S PROTECTED AREAS AND PROPOSED EXTENSIONS

Source: Redrawn map from Wildlife Conservation Society

In total, the existing and proposed protected areas cover about 174,119 km^2, which represent about 28 per cent of the country's land area (Table 4). Existing and proposed bird sanctuaries are estimated to cover about 5,000 km^2, game reserves 24,565 km^2, national parks cover 83,954km^2, nature conservation areas 2,500 km^2, the Sudd Ramsar site 57,000 km^2 and forest reserves 1,100 km^2.

The 2015 World Database of Protected Areas lists 26 national-level protected areas as well as the one area (the Sudd wetlands) designated under international and regional agreements or conventions (in this case, the Ramsar Convention) (UNEP; WCMC, 2015).

TABLE 4: SOUTH SUDAN'S EXISTING AND PROPOSED PROTECTED AREAS

Type	Existing area			Proposed or expansion			Total		
	No.	Km^2	% of SS total land area*	No.	Km^2	% of SS total land area*	No.	Km^2	% of SS total land area*
Bird Sanctuary	0	0	0	1	5,000	0.8	1	5,000	0.8
Game Reserves	12	24,565	3.9	0	0	0	12	24,565	3.9
National Parks	7	60,380	9.5	3	23,574	3.7	10	83,954	13.3
Nature Conservation Area	0	0	0	2	2,500	0.4	2	2,500	0.4
Ramsar	1	57,000	9.0	0	0	0	1	57,000	9.0
Forest Reserves	1	1,100	0.2	0	0	0	1	1,100	0.2
Total	21	143,045	22.6	6	31,074	4.9	27	174,119	27.6

*Percentages are based on 633,580.5 km^2 for the total land area in South Sudan.

Source: (UNEP-WCMC, 2017)

National Parks

According to the provisions of South Sudan's Wildlife Conservation Act of 2003, a "Park" means any area set aside to conserve, protect, propagate and manage wildlife and wild vegetation or to protect sites, landscapes and geological formations of particular scientific value, for the benefit and enjoyment of the general public. Hunting or capturing animals, destroying or collecting plants, creating human settlements and certain other human activities that disrupt wildlife and natural habitats are prohibited or strictly controlled (New Sudan, 2003a).

Kapoeta South, plains and mountains. *Photo credit: ArsenieCoseac/Flickr.com/ CC BY-ND 2.0*

Boma National Park

The Boma National Park is part of the vast Boma-Jonglei Landscape. Two-thirds of the park is covered by a flat floodplain punctuated by a number of isolated hills. In the east, the hills rise up to the Boma Plateau at about 1,100 m. The Boma Hills emerge from the plateau in the southeast and the catchment drains into the Oboth and Akobo Rivers and from there into the Guom swamps. In the west, drainage is towards the Kangen River. The vegetation in the open grassland of the western plains is characterised by *Hyparrhenia, Pennisetum, Sporobolus* and *Echinochloa spp.* Woodlands dominate the eastern parts, with *Combretum* and *Ficus* species. Around the isolated hills are patches of dense thickets of *Ziziphus spp., Acacia seyal, A. zanzibarica, A. drepanalobium* and *A. fistula* and small areas of evergreen forests grow on the western slopes of the Boma Hills (Mahgoub & Riak, n.d.).

In the 1970s, the Boma ecosystem was declared as a Game Reserve to help protect the kob populations and in 1978 it achieved National Park status (Marjan, 2014). In the mid-1960s, it was estimated that there were two million antelopes (Turnbull, 2014). In 1982, there were also an estimated 20,000 zebra (van Dorp & Balch, 2013). In 2007, the Wildlife Conservation Society conducted the first aerial surveys in 25 years. In addition to populations of tens of thousands of kob, tiang and gazelle (see the hotspot case study); it recorded the presence of large numbers of elephants, ostriches, lions, leopards, hippopotamus and buffalos. Zebras were no longer present in the Park (Fay, Elkan, Marjan, & Grossmannm, 2007); (Grossmann, Elkan, Tiba, & Awol, 2011); (van Dorp & Balch, 2013).

Badingilo National Park

Badingilo National Park was established in 1992. *"In the early 1980s the wildlife authorities of Southern Sudan were considering establishment of the Badingilo National Park covering a large area including the Badigeru and Mongalla Reserves as well as extending north and eastwards to provide protection to the ungulate migrations. This process was disrupted by the outbreak of the civil war."* (Grossmann *et al.* 2008)

A 2014 research study of the kob migration in South Sudan observed that both the Boma and Badingilo National Parks have not been well developed for conservation purposes. It speculated that political instability and protracted civil wars, as well as the previous uneven development programmes and policies in the former Sudan constrained economic development in the region. While livestock is a major source of livelihood, people still depend on hunting and gathering within the protected areas (Marjan, 2014).

Badingilo National Park.
Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0

Nimule National Park

Nimule National Park is a very small park of about 256 km^2 with a buffer zone of 154 km^2. It was established as a Game Reserve in 1935 and gazetted as a National Park in 1954. Some studies have, however, shown that it was first established as a reserve in 1946 and later gazetted as a national park in 1954. The reserve status appears in the Sudan Government report of 1955, which reveals that *"the Game Department had already advocated that the Reserve should be converted into a National Park without delay. The administration and parks and game authorities in Uganda strongly support the proposal, as Nimule is recognised internationally as having unique features"* (Grossmann, Elkan, Awol, & Penche, 2008).

It is located in the extreme south of the country on the border with Uganda, next to Nimule Town in Eastern Equatoria (SSWS, 2014). It is adjacent to Mount Kei Forest Reserve and Mount Otzi Forest Reserve, which are two important bird areas in Uganda. The Kayu River flows through the park from the Ugandan border to the White Nile, which forms the Park's eastern border. The topography of the Nimule National Park is hilly and is mostly covered with savannah woodland of *Acacia spp., Balanitesa egyptiaca* and *Combretum aculeatum.* The permanent and seasonal watercourses are bordered by riverine woodland composed of *Acacia sieberiana* (Mahgoub & Riak, n.d.). The Park is inhabited by at least twenty mammal species, including elephants *(Loxodonta africana),* hippopotamus *(Hippopotamus amphibius)* and kob *(Kobus kob)* (SSWS, 2014). Poaching has reduced its formerly large elephant population and locally exterminated the white rhinoceros *(Ceratotherium simum).* Other species of global conservation concern include *K. kob, Kobusellipsiprymnus* and *T. spekii,* and *Reduncaredunca* (Mahgoub & Riak, n.d.).

Shambe National Park

The Shambe National Park is dominated by savannah woodland and the Shambe River, which provide habitat for a variety of flora and fauna (Junubian, 2015).

Species of particular importance in the Shambe area due to their limited range and threatened conservation status include: the near-endemic Nile lechwe *(Kobus megaceros)* (WCS, 2010). Species present include elephant, hippo, tiang, Uganda kob, and lion, with the most common species being the Bohor reedbuck.

In the Shambe zone the most important habitat and wildlife areas were found along the Nile River. This is an important dry season feeding area along the Nile River and a refuge from human persecution in the swamps (Grossmann, Elkan, Tiba, & Awol, 2011).

Southern National Park

The Southern National Park is located in the southwest, on the Ironstone Plateau. The Ibba River bisects it from north to south, the Sue River forms its western boundary and the Maridi River forms its eastern perimeter. It is mostly covered by savannah woodland growing in ranges of gently undulating hills, separated by three parallel northward flowing rivers. Large mammals in Southern National Park include: Derby's eland (pop. est. 4,168), Lewelhartebeest (1,029), roan antelope, Defassa waterbuck, Ugandan kob, bushbuck, Bohor reedbuck, olive baboon (Grossmann, Elkan, Tiba, & Awol, 2011).

The National Parks and Game Reserves of South Sudan are governed by the 2015 Wildlife Conservation and Protected Areas Bill and are under the control of the Ministry of Tourism and Wildlife Conservation (Table 5).

In addition to protecting habitat, under South Sudanese law hunting is illegal. Therefore, all species are/should be protected.

TABLE 5. PROTECTED AREAS UNDER THE MINISTRY OF WILDLIFE CONSERVATION AND TOURISM (WILDLIFE CONSERVATION AND PROTECTED AREAS BILL 2015)

National Parks	Game Reserves	Others and proposed protected areas
Badingilo National Park (1986)	Ashana Game Reserve (1939)	The Sudd (Ramsar Site 2006)
Boma National Park (1986)	Bangangai Game Reserve (1939)	Imatong Mountains National Conservation Area (NCA)
Lantonto National Park (1986)	Bire Kpatous Game Reserve (1939)	Lake Ambadi (NCA)
Nimule National Park (1952)	Boro Game Reserve	Lake No (NCA)
Shambe National Park (1985)	Chelkou Game Reserve (1939)	Forest Reserves
Southern National Park (1939)	Fanyikang Game Reserve (1939)	
	Juba Game Reserve (1939)	
	Kidepo Game Reserve (1975)	
	Mbarizunga Game Reserve (1939)	
	Mushra Game Reserve.	
	Numatina Game Reserve(1939)	
	Zeraf Game Reserve (1939)	

Source: (MOE, 2015)

International goals and agreements

Many other political and legal means are specifically oriented to protecting South Sudan's biodiversity or include provisions related to sustainable habitat and/or species and genes conservation. At the international level, the country joined the United Nations Convention on Biological Diversity in 2014. In addition, the Sudd wetlands have been declared a wetland of international importance under the Ramsar Convention on Wetlands, which entered into force in South Sudan on 10 October 2013. The Ramsar Convention stipulates *"the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world"* (Ramsar, 1971).

South Sudan is also party to the United Nations Framework Convention on Climate Change and submitted its Intended Nationally Determined Contributions to the Convention, showing how it intends to mitigate its emissions that contribute to global warming and the actions it will undertake to adapt to its impacts. Box 4 shows its Intended Nationally Determined Contributions related to biodiversity and ecosystems.

BOX 4: INTENDED NATIONALLY DETERMINED CONTRIBUTIONS OF SOUTH SUDAN

"Mitigation: To maintain a clean and green environment, South Sudan will encourage payment for ecosystem services, access to resources and benefit sharing to avoid depletion of important natural resources. This would contribute towards the sustainability and viability of initiatives to reduce emissions from deforestation and forest degradation.

Adaptation: In South Sudan, there is a large diversity of ecosystems that provide society with a wide range of environmental services such as carbon sequestration, provision and maintenance of water resources, flood mitigation, provision of food and NTFPs, and the formation and maintenance of soils. These ecosystem services are seriously threatened by human activities and by the effects of climate change.

South Sudan is home to the largest designated Ramsar wetland 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. The Sudd acts as a barrier to the southward encroachment of the Sahara Desert and its preservation and management is consequently expected to be South Sudan's most significant contribution toward buffering against the impacts of climate change at the regional level.

Ecosystem-based adaptation consists of the conservation of biodiversity and ecosystem services as part of an integrated adaptation strategy to assist human communities to adapt to the adverse effects of climate change. 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.

Adaptation actions related to biodiversity:

- Establish conservancies and protected areas to buffer local communities and biodiversity against climate change impacts.
- Establish water points for wildlife in protected areas to reduce the negative effects of droughts on animal populations.
- Increase awareness of local communities on climate change and environmental protection.
- Introduce fire management plans to prevent the spread of wildfires during periods of drought.
- Introduce an integrated natural resource management approach".

Source:(RSS, 2016)

National policies and legislation to protect biodiversity

Currently, the following policy documents and legislation provide the framework for biodiversity protection in South Sudan, as shown in Table 6.

TABLE 6. LEGAL AND POLICY FRAMEWORK FOR BIODIVERSITY MANAGEMENT IN SOUTH SUDAN

Legislation or Policy	Content	Status
	National Biodiversity Legislation	
Environmental Protection Bill 2013	• Empowers the Ministry of Environment and Forestry to supervise and co-ordinate all matters relating to the environment and to be the principal instrument of government in the implementation of all policies relating to the environment including biodiversity. • Provides for the preparation of a National Environmental Action Plan; and 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 Agreements (MEAs). • Provides for freedom to access environmental information and this will facilitate education and public awareness on biodiversity (section 66). • Addresses pollution prevention, control and waste management currently a major source of biodiversity loss and ecosystem degradation particularly by the oil and extractive industries.	Pending
Wildlife Conservation and Protected Areas Bill 2015	• Covers all matters concerned with Wildlife Conservation, the establishment and management of protected areas (PAs) and the sustainable management and conservation of South Sudan's natural heritage and wildlife for the benefit of its citizens. • Allows local communities around PAs to manage wildlife in collaboration with the South Sudan Wildlife Service (SSWS) and permits other organisations to manage any PA on behalf of the government. • Grants SSWS Officers similar enforcement and prosecutorial powers as police officers under the Code of Criminal Procedure Act 2008 – arrest, inspection, seizure and forfeiture. • Increases the number of wildlife offences as well as explicitly providing for the crime of wildlife trafficking. These include illegal hunting, capture and trafficking of protected animals. • Provides for the protection of wetlands, which could potentially be in conflict with the Ministry of Environment and Forestry's role (section 60).	Pending
Forests Bill 2009	• Operationalise the Forestry Policy covering all matters concerned with all forests and woodlands and all forest reserves in the country. The Forests Bill provides for a governance structure for all the forests in the country, national sustainable forest management standards, certification systems and schemes, and private and voluntary standards; procedures and decision-making processes; and complaint and appeal mechanisms. • Establishes the South Sudan Forest Commission (SSFC) to function as a semi-autonomous body, which is business oriented. • Establishes a National Forest Fund (NFF) to be managed semi-autonomously to support forestry research, education and protection of forest biodiversity and heritage.	Established
Timber Utilization and Management Act 2003	• Regulates the harvesting of forest produce by establishing a licensing and compliance regime.	Established
Water Bill 2013	• Provides for the protection of water sources from pollution, erosion or any other adverse effects by creating Protected Zones within a catchment draining to, or above any water facility forming part of a water supply or any catchment, lake, reservoir, aquifer, wetland, spring, or any other source of water (section 34).	Pending
Petroleum Act of 2012	• Provides that a Social and Environmental Impact Assessment (SEIA) be undertaken by the oil contractor or licensee in compliance with international standards to determine any present environmental and social damage; establish the costs of repair and compensation and determine any other areas of concern.	Established

Legislation or Policy	Content	Status
	National Biodiversity Policies	
Draft National Environment Policy 2013	• Ensures the protection, conservation and sustainable use of the natural resources of South Sudan without compromising the tenets of inter-generational equity. This includes maintaining the balance between the environment and development needs through sustainable use of the natural resource base; creating public awareness of the importance of protecting the environment; and providing the basis for formulation of biodiversity and ecosystem protection and management policies, laws and guidelines. • Calls for the development and implementation of a National Strategy and Biodiversity Action Plan for South Sudan. It also urges for: – Promoting coordination, cooperation and participation of all relevant stakeholders in conservation and sustainable use of biodiversity across all sectors of the economy; – Encouraging a Green economy initiative to enhance low carbon and resource efficient economy as well as promoting carbon sequestration; – Promoting national integrated approaches for conservation and sustainable use of biodiversity and protection of aquatic ecosystems and life; – Implementing the Multilateral Environmental Agreements (MEAs) related to biodiversity; – Supporting communication, education and public awareness programmes on the importance and benefits of conserving biodiversity for citizens and their livelihoods; – Sharing the benefits of biodiversity conservation and sustainable use with local communities and stakeholders; – Discouraging introduction of invasive and alien species and where such species are present, manage and control properly to avoid adverse impacts on local environment; – Promoting *ex-situ* conservation of biodiversity; and – Encouraging conservation and cultivation of herbal, medicinal and economic plants. • Provides for the establishment of an autonomous South Sudan National Environmental Management Authority (NEMA) to act as the watchdog on all public institutions, private companies and individuals defaulting against the stipulated environmental laws and regulations. • Calls for developing a national strategy and mechanisms for climate change adaptation and mitigation; and formulating a climate change policy for South Sudan.	Draft
	Sectoral Biodiversity Policies	
South Sudan Wildlife Conservation and Protected Area Policy (Draft of June 2012)	• Guides the sustainable management and utilisation of natural resources, including land, water, fauna and flora for the benefit and enjoyment of the people of South Sudan. It provides for the formulation of legal frameworks for rationalising the protected area system and wildlife utilisation and benefit sharing. It also recognises and addresses security and landscape management.	Draft
Harmonized Forest Policy 2015	• Lays down a clear institutional and governance framework for forests at all levels across the country. It recognises the importance of forests for commerce, communities, and conservation, and sets forth a series of implementation and institutional measures. It introduces strict measures to protect the permanent forest estate and to prevent changes in forest boundaries without legislative approval. • Provides for the establishment of the South Sudan Forest Corporation (SSFC) whose primary role will be to provide regulation and operational standards for a vibrant forest sector, as well as administration and implementation of NFRs; the Ministry will provide oversight. • Develops institutional mechanisms for local communities to formalise tenure and management rights over forests on community lands. • Strengthens provisions and guiding principles on forest product regulation, utilisation, and marketing.	Approved by Council of Ministers

Legislation or Policy	Content	Status
Agriculture Sector Policy Framework for 2012-2017	• Enhances measures to mitigate the adverse effects and impacts from climate change in the medium and long-term. • Provides for the protection of plants, seed management, and development of plant genetic resources conservation programme and a biosafety framework. • Recommends a well-managed Genetically Modified Organisms (GMOs) policy to ensure stability and diversity of South Sudan's indigenous genetic resources for enhancing agricultural development. • Recommends formulation of a law to regulate importation and use of GMOs in South Sudan. • Develops a sustainable programme for the conservation and judicious utilisation of plant genetic resources to enhance agricultural development. • Enhances the institutional framework for promotion of sustainable crop pest and disease management and ensuring accessibility of organic and inorganic pesticides by farmers.	Approved by Council of Ministers
Ministry of Animal Resources and Fisheries (MARF) Policy Framework and Strategic Plan 2012 -2016	• Promotes best animal husbandry practices to reduce environmental degradation and promotes sustainable management of rangelands and pastures through integrated range management practices.	Approved by Council of Ministers
Fisheries Policy for South Sudan 2012-2016	• Provides a framework to manage fisheries resources of the country so as to maximise production and avoid over fishing and to prevent destruction of wetlands and promote their conservation.	Approved by Council of Ministers
South Sudan Tourism Policy 2012	• Recognises that tourism developments in national parks and game reserves shall adhere to the provisions of General Management Plans developed according to the Wildlife Conservation and Protected Area Policy and related legislation, regulations and guidelines.	Approved by Council of Ministers in 2012

Source: (MOE, 2015)

TABLE 7. **INSTITUTIONAL FRAMEWORK FOR BIODIVERSITY CONSERVATION AND MANAGEMENT IN SOUTH SUDAN**

Framework	Responsibilities as they relate to biodiversity	
Transitional Constitution	Provides that every person shall have the obligation to protect the environment and 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 biodiversity.	
Ministry of Environment and Forestry	Develops a policy and regulatory framework for wetlands and biodiversity management, capacity building and strengthening of partnership with stakeholders particularly for the justice and legislative institutions that contribute to delay legal and policy reviews, acceding to and implementing MEAs and environmental audit and assessment.	
	Directorate of Wetlands and Biodiversity	Ensures that wetlands, biodiversity and any natural features in South Sudan are protected and ensure their sustainable use.
	Directorate of Climate Change and Meteorology	Develops and implements programmes to address issues of climate change and coordinates the implementation of South Sudan's obligations under the United Nations Framework Convention on Climate Change (UNFCCC).

Framework	Responsibilities as they relate to biodiversity	
Ministry of Wildlife Conservation and Tourism	Protects, conserves and manages wildlife resources in South Sudan through the Wildlife Service. All protected areas and the wild animals therein remain the property of government on behalf of the people. The Wildlife Department is well established in the country with offices in each state and localities where protected areas are located. The Wildlife Forces Act 2003 established a decentralised system with the following organisational structures of the wildlife forces (section 5).	
	Director-General of Wildlife Forces	
	Wildlife Service	• Coordinate and cooperate with the local communities on the protection and management of wildlife within their areas; • Manage wildlife outside protected areas; • Conserve, manage and administer national parks, wildlife reserves or other protected areas according to law and in a manner consistent with the agricultural and pastoral activities of nearby settled communities; • Develop, in collaboration with other competent authorities, tourism based on wildlife, which contributes to the social and economic welfare of South Sudan and the communities proximate to the National parks or game reserves; • Combat illegal hunting, trade in protected animals and trophies, by detecting, apprehending and causing to be prosecuted illegal hunters, poachers or illicit traders in animal trophies; • Conduct research and monitor wildlife resources with a view to their optimisation, preservation, conservation, management, and protection; • Promote education and the dissemination of information about wildlife resources in Southern Sudan; • Undertake any administrative and technical tasks to ensure that the Wildlife Service is sustainably managed in Southern Sudan; and • Perform any other function or duty assigned to it under this Act or any other law.
Ministry of Agriculture, Forestry and Rural Development	• Responsible for increasing agricultural productivity to improve food security and contribute to economic growth, environmental sustainability and to facilitate and encourage equitable and sustainable development towards improved livelihood through sensitisation, mobilisation, capacity building and direct involvement of rural communities in their own development.	
	• Develops and implements policies, objectives and strategies for development of agricultural sector in the area of Forestry in South Sudan.	
	• Establishes sanctuaries for forestry biodiversity and a system for delineation of various types of natural woody vegetation as required for conservation of biodiversity be set up as prescribed by the Forest Policy 2014.	
	Directorate of Agriculture	• Observes that the genetic diversity has been maintained in South Sudan through the long tradition of conserving seeds; and • Responsible for water hyacinth control (and other invasive plant species).
	Directorate of Forestry	• Manages Forest Reserves.
Ministry for Irrigation and Water Resources	Manages water resources according to the following principles: • Water is commonly owned by all riparian people; • Water is an economic and social good. The criteria for optimal allocation shall include social equity, economic efficiency, system reliability, and environmental sustainability; • Water resources planning and development shall be undertaken at the lowest appropriate administrative level with the active participation of water users and stakeholders.	
Ministry of Animal Resources and Fisheries	Promote the criminalisation of cattle rustling and sensitise and train communities on issues related to risks of cattle rustling.	
	Directorate of Animal Resources	Implement the Ministry of Animal Resources and Fisheries (MARF) Policy Framework and Strategic Plan 2012 -2016 by the Department of Range Management in collaboration with relevant agencies in range and livestock research, wildlife activities and water development for livestock use.
	Directorate of Fisheries	Provide for a framework to manage the fisheries resources of the country.

Source: (MOE, 2015)

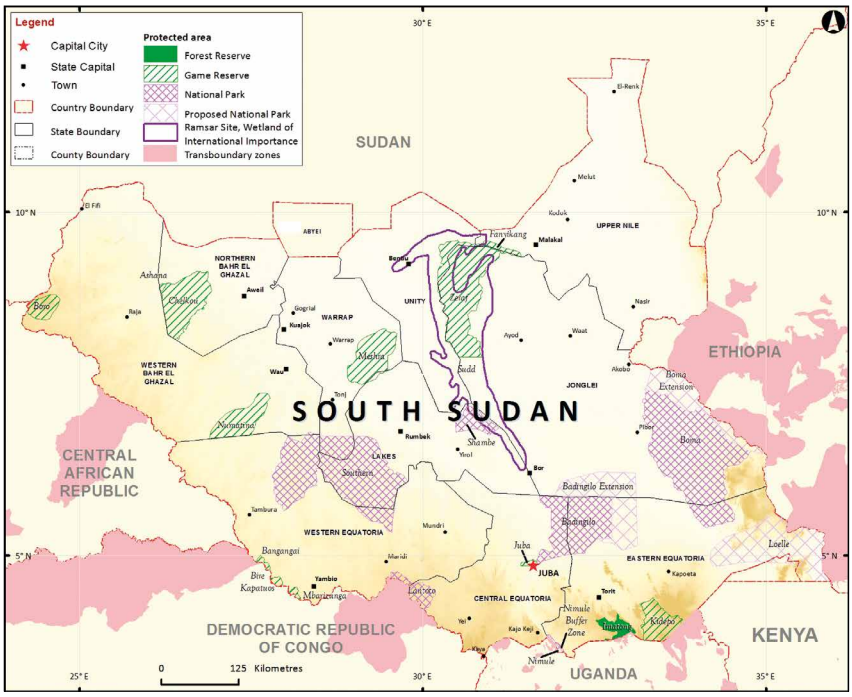
Transboundary wildlife and biodiversity management

Wildlife habitats and species do not respect political boundaries, so transboundary species and other aspects of biodiversity need to be protected by all countries that share them. For example, part of the kob migration route extends into Ethiopia and it has been proposed that the transboundary migration corridor be managed by the transboundary and conservation agreement between Ethiopian Wildlife Conservation Authority and South Sudan Wildlife Services (Rolkier, 2015).

Several more of South Sudan's protected areas are located along borders with neighbouring countries. South Sudan and Uganda have signed a memorandum of understanding to manage four transboundary protected areas or "peace parks" and there are plans to reach similar agreements with Ethiopia, Kenya, the Central African Republic and the Democratic Republic of the Congo (Figure 6) (MOE, 2015).

In February 2014, Tanzania, Gabon, Botswana and Ethiopia launched the Elephant Protection Initiative, an African-led, results-oriented partnership to stop the illegal ivory trade and secure a future for elephants across the continent. On the 15th of December 2016, the Republic of South Sudan joined the Elephant Protection Initiative, becoming the 15th African country to sign up to the Initiative (WCS, 2015).

FIGURE 6: **PROTECTED AREAS AND TRANSBOUNDARY ZONES OF SOUTH SUDAN**



Source: Redrawn map from WCS

Research and monitoring

Since 2007, the Wildlife Conservation Society in cooperation with the South Sudan Wildlife Service have been conducting regular aerial surveys in order to provide a comprehensive assessment of the status of wildlife resources, protected areas, and land-use in South Sudan. Surveys have been conducted in both the wet and the dry seasons. The purpose of this time series is to improve our understanding of the migratory processes, seasonal changes and monitor changes in human activity, in particular pastoralism. These surveys also provide an important monitoring tool of oil development, and other extractive industry activities in the area. Post survey data analysis is also targeted at informing key processes related to land-use planning and management. In line with this, research and monitoring efforts have highlighted key areas of conservation importance currently outside South Sudan's protected area network, leading to the proposal of new protected areas.

Recommendations

Observers and researchers have suggested a number of recommendations to address the pressures and impacts on biodiversity, as shown in Box 5.

BOX 5: RECOMMENDATIONS FOR BIODIVERSITY CONSERVATION

- Proper management of protected areas at the ends of the migration ranges and the corridors linking them (Boma and Badingilo National Parks);
- The legal gazetting of further protected areas to secure the migration's long-term conservation;
- Frequent surveys to effectively monitor kob population trends;
- An efficient anti-poaching programme and law enforcement;
- Inclusion of the conservation interests of the kob migration in future land-use plans in the Boma-Jonglei Landscape;
- The implementation of proper environmental impact assessments for all development projects (such as roads, oil concessions, agriculture, etc.) to determine the most effective conservation measures for migrating ungulates and all other wildlife and their habitat;
- The development of a conservation strategy and national action plan for the kob migration, including community-based conservation programmes;
- The translation of wildlife conservation policy documents into indigenous languages and their dissemination to communities that live and interact with the kob migration, as well as with other wildlife species;
- The development of an environmentally sustainable ecotourism industry as an effective mechanism to promote wildlife conservation among decision-makers and society in general, and to finance the conservation of the protected area network; and
- The final resolution of the root causes of social and political grievances that have led to conflicts, so that wildlife conservation can be implemented and play its role in the country's economic development.

Sources: (Marjan, 2014); (Harris, et al., 2009); (MWCT, 2012); (MOE, 2014); (RSS, 2012).

6.5 Conclusions

South Sudan's remarkable biodiversity is of global significance – the Sudd swamp is one of the world's largest tropical wetlands and the country is home to one of the planet's greatest circular wildlife migrations. Biodiversity is also of extreme national importance, since the country's ecosystem goods and services are the foundation of South Sudan's socioeconomic development.

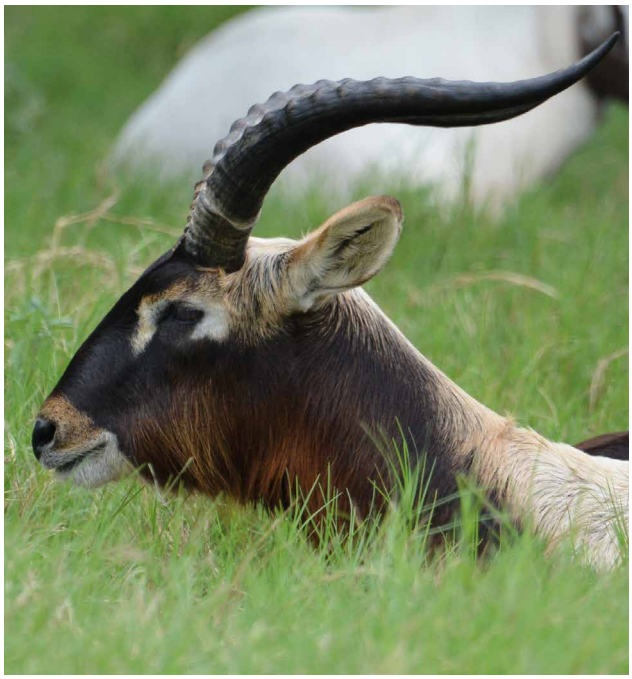
Of its six major ecosystem types, this chapter highlighted two that are the most extensive and significant: wetlands and grassland savannahs. Wetlands cover 14.7 per cent of the country's land area. Their important functions include filtering and storing water, and regulating the flow of the White Nile. The Sudd wetland has been designated a Ramsar Wetland of International Importance. It is essential habitat for millions of migrating birds and more than a million people depend almost entirely on this wetland for their livelihoods.

South Sudan's grasslands are part of the Sudanian Savannahs, which are deemed to be in a critical or endangered state. The country's grasslands cover about 15 per cent of the national land area. They include the Boma-Jonglei Landscape, the largest expanse of substantially intact, wild habitat in East Africa, covering 3 per cent of the country's land area. The Boma-Jonglei Landscape hosts the 900 km seasonal migration of white-eared kob, which represents Africa's longest antelope migration; some 2 million people of 17 different ethnic groups; a rich biodiversity of flora and other fauna; valuable oil reserves and mineral deposits. Ten mining concessions have been granted within the Boma-Jonglei Landscape. Of these, two lay partially within a protected area, and one is entirely within Boma National Park. Outside of the Boma-Jonglei Landscape, one concession lies partially within a protected area.

The country harbours an immense diversity of wildlife species, many of which face threats from human activities, including wildlife poaching and trafficking; deforestation; settlements, cropland and livestock expansion; road building; mining and oil development; and climate change impacts. Threatened species include the critically endangered Forest elephant; the tiang, which is in the category of "lower risk/near threatened", four critically endangered species, and 11 endangered species. In terms of species abundance, migratory antelope populations of white-eared kob, tiang, and Mongalla gazelle estimated to be some 1.5 million, have also been heavily poached during the recent years of armed conflict.

Elephant population estimates for these areas have declined from 20,000 to less than 2,500. A country wide survey in the 1970s actually estimated some 80,000 elephants. In 1982, in Boma National Park, there were an estimated 20,000 zebra, but by 2007 none were observed.

About 28 per cent of the country's land area is set aside as protected areas to help conserve its biodiversity and the migration phenomenon. This includes 26 national-level protected areas as well as one internationally protected area, the Sudd wetland. Many other political and legal means are specifically oriented to protecting South Sudan's biodiversity or include provisions related to sustainable habitat conservation, including national biodiversity legislation, policies and institutional frameworks and agreements, as well as projects for transboundary wildlife management where South Sudan's protected areas are contiguous with those of adjacent countries. Although the seasonal ranges of migrating species are within these protected areas, there is a dearth of patrols and law enforcement to afford them real protection from the many growing pressures, potentially squandering the future of a lucrative ecotourism sector. Unless conservation efforts are strengthened and enforced, the ecosystem goods and services, and potential economic value of South Sudan's biodiversity will deteriorate.



Nile lechwe. *Photo credit: regexman/Flickr.com/CC BY 2.0*

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Village on bank of River Nile, near Malakal.
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CHAPTER 7
WATER RESOURCES

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7.1 Introduction

South Sudan's water resources are unevenly distributed both spatially across the country, and temporally, since water quantities vary substantially between years depending on periodic major flood and drought events. The Nile River hydrological basin covers most of the country. Water is held in perennial rivers, lakes and wetland areas, in seasonal pools, ponds, rivers, streams and extensive floodplains. Water demand is still low given the country's relatively small population, density and the lack of industrial development, but it is expected to increase rapidly in the future with projected population growth and economic development. In 2007, the Ministry of Water Resources and Irrigation reported that the impact of human activities on the availability and quality of water resources was already evident and a growing concern.There is increased pollution, reduced river flows, declining water tables in urban areas and both surface and ground waters are becoming contaminated (MWRI, 2007).

Sunset on the Nile just north of Juba. *Photo credit: Quade Hermann/Flickr.com/CC BY 2.0*

7.2 Status and Trends

Hydrological basins

South Sudan's major water resources derive from two main hydrological basins: the Nile Basin and the Rift Valley Basin. A hydrological basin refers to the drainage system in which surface water from precipitation is channelled into rivers and streams and flows downstream towards another water body, such as a larger river, a lake, the sea or ocean, a wetland, or in the case of a closed hydrological basin, into a sink like a salt pan or underground reservoir. Hydrological basins can be comprised of smaller hydrological sub-basins; they are separated from each other by a "drainage divide" or "watershed". Figure 1 shows the 15 sub-basins of the Nile Basin as defined by the Nile Basin Initiative.

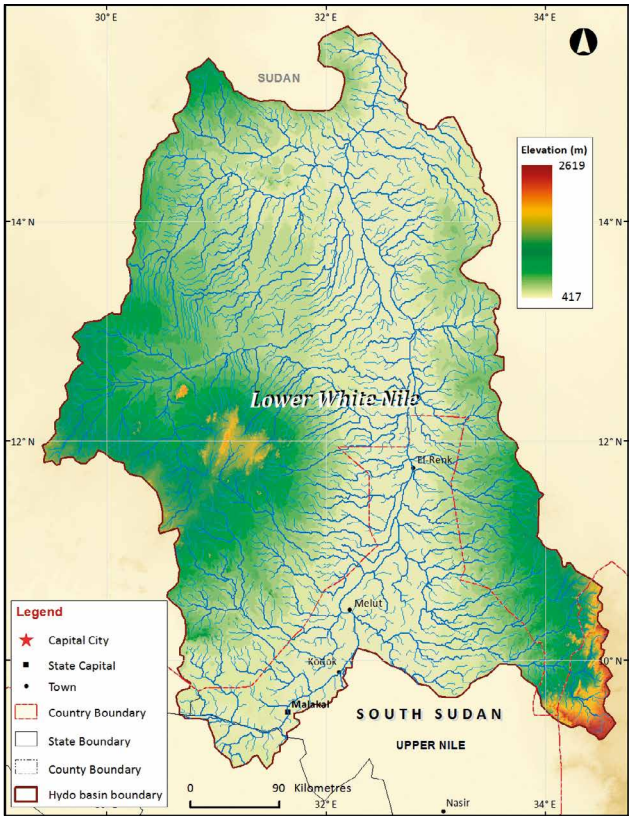
FIGURE 1: LOCATION OF SUB-BASINS OF THE NILE RIVER SYSTEM (WITHIN SOUTH SUDAN) DELINEATED BY THE NILE BASIN INITIATIVE

Source: (Bastiaanssen, et al., 2014)

About 20 per cent of the Nile Basin lies within South Sudan. The Nile River hydrological basin within South Sudan is formed from the White Nile, its tributaries and aquifers, which occupy 97.5 per cent of the country's land area (627,890 km²). Within South Sudan, the White Nile system is comprised of the sub-basin upstream of the Sobat River, which originates on the Great Lakes Plateau at the confluence of Bahr el Jebel River and Baro-Akobo-Sobat River above Malakal (Figure 2); the Baro/Sobat River system originating in the Ethiopian highlands (Figure 3); and the Bahr el Jebel and Bahr el Ghazal basins (Figures 4 and 5), in the west of South Sudan and extending northward into Sudan. Unlike the Nile, which is a permanent river, the Sobat and Bahr el Ghazal Rivers flow seasonally (FAO, 2011); (RSS, 2015). The Rift Valley Basin, in the south-east, on the border with Ethiopia and Kenya, covers the remaining 2.5 per cent of the country (16,440 km²) (FAO, 2011).

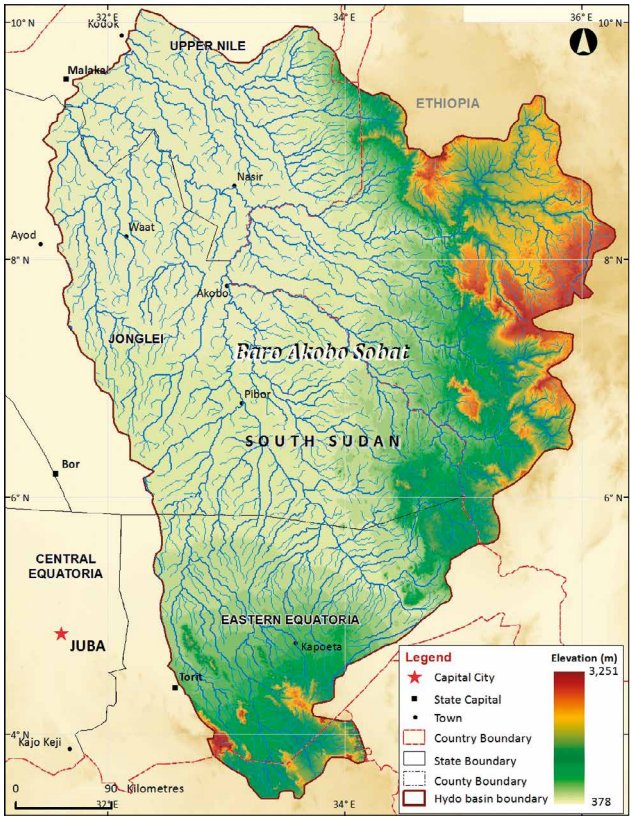
The White Nile sub-basin is shared by South Sudan, Ethiopia and Sudan (Figure 2). Inflows from tributaries are small and sporadic, and because water is stored in the floodplain, outflows are delayed, resulting in increased loss to evaporation. The average annual rainfall in the sub-basin is 754 mm and the average annual potential evapotranspiration is 1,983 mm. The Sudd wetland provides the base flow component and the Baro-Akobo-Sobat sub-basin contributes the seasonal component (NBI, 2016).

FIGURE 2: THE WHITE NILE SUB BASIN



Source: (NBI, 2016)

FIGURE 3: BARO-AKOBO-SOBAT SUB-BASIN



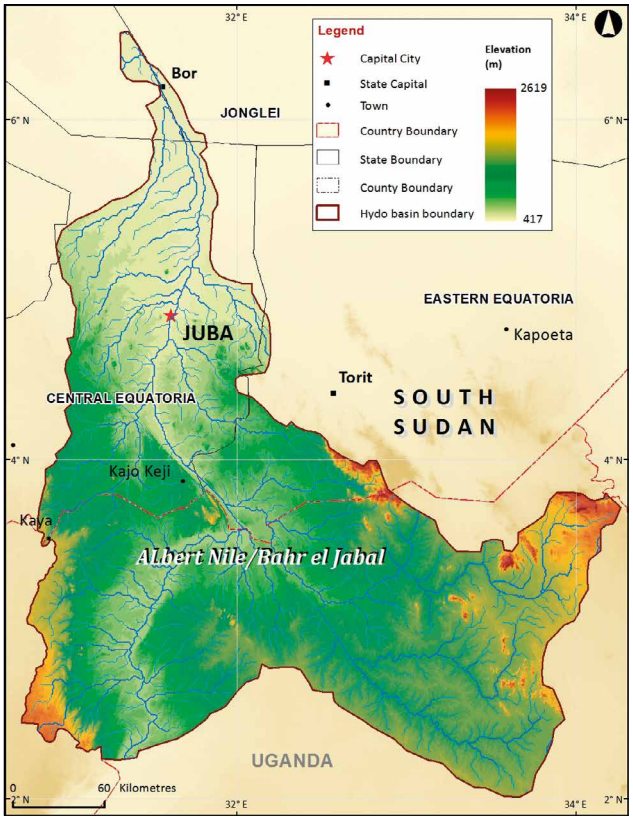
Source: (NBI, 2016)

To date, the Baro-Akobo-Sobat sub-basin (Figure 3) has not been well monitored. Its hydrology is very complex, with a distinct high-flow season between July and October. One of its most significant features is the high interconnectivity between floodplains and the river network, characterised by braided and bifurcating streams (NBI, 2016). The Sobat River, formed by the confluence of the Baro and Pibor Rivers, discharges about 14 billion m^3 per year into the White Nile (FAO, 2011).

The Baro River in the Ethiopian Highlands and the Pibor River in southern Sudan and northern Uganda feed into the Baro-Akobo-Sobat River. Some of the water from the Baro River flows through a series of channels downstream of Gambella station to the large Machar Marshes, which are in the White Nile sub-basin. The Pibor River drains a large river plain but its contribution is only significant when rainfall is high. The average annual precipitation over the entire sub-basin is 1,338 mm and the average annual potential evapotranspiration is 1,592 mm (NBI, 2016).

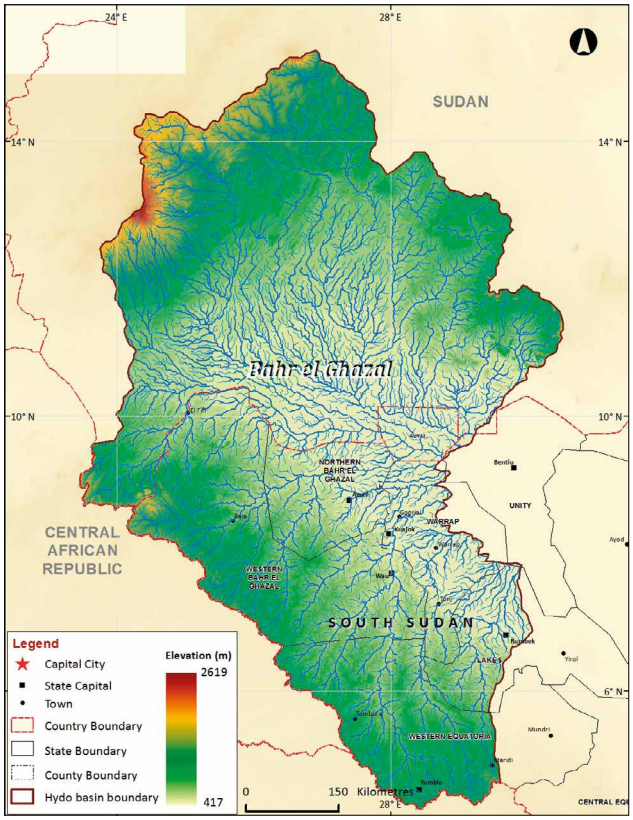
Sobat River during the rainy season. *Photo credit: Wikimedia Commons/CC BY-SA 3.0*

FIGURE 4: THE BAHR EL JEBEL SUB-BASIN



Source: (NBI, 2016)

FIGURE 3: THE BAHR EL GHAZAL SUB-BASIN



Source: (NBI, 2016)

Major rivers and water bodies

Figure 6 and Table 1 name the major rivers that flow within the hydrological basins of South Sudan. About 30 per cent (28 billion m^3) of the Nile River's water flow passes through South Sudan on its way to Egypt (FAO, 2011). The White Nile begins in Lake No, located just north of the Sudd swamp, at the confluence of the Bahr el Jebel and Bahr el Ghazal Rivers, and about 1,156 km downstream of Uganda's Lake Albert. Lake No is a large shallow lagoon marking the transition between the Bahr el Jebel and the White Nile (Baker, 1997); (NBI, 2016). The long-term average annual flow of the White Nile measured at Malakal is approximately 31 billion m^3 (NBI, 2016).

Village on bank of River Nile, near Malakal.
Photo credit: BBC World Service/Flickr.com/CC BY-NC 2.0

FIGURE 6: MAJOR RIVERS IN SOUTH SUDAN

Source: (AfDB, 2013)

TABLE 1: MAJOR RIVERS IN SOUTH SUDAN

River	Length (km)	Length (miles)	Drainage area (km²)	Outflow	Countries in the drainage basin	South Sudan states in the drainage basin
White Nile	3,700	2299	1,800,000	Confluence with Nile River	South Sudan, Democratic Republic of the Congo, Sudan, Tanzania, Rwanda, Uganda	Eastern Equatoria, Central Equatoria
Ghazāl	716	445	851,459	Joins White Nile	South Sudan, Central African Republic	Warrap, Northern Bahr el Ghazal, Western Bahr el Ghazal, Lakes
Sobat	354	220	225,000	White Nile	South Sudan	Upper Nile
Baro	306	190	41,400	Pibor River	Ethiopia, South Sudan	Jonglei
Pibor	320	200	10,000	Sobat River	South Sudan	Jonglei
Akobo	434	270	75,912	Pibor River	South Sudan, Ethiopia	Jonglei
Bahr el Arab	800	500	60,800	Bahr al-Ghazāl River	Sudan, Central African Republic, South Sudan	Bahr el Ghazal
Jur River/Sue	485	301	NA	Bahr al-Ghazāl River	South Sudan	Equatoria regions, Bahr el Ghazal

Source: (Maps of World, 2016)

Wetlands

About 7 per cent of South Sudan is covered by vast expanses of tropical freshwater wetlands that occur at the confluence of the White Nile's main tributaries. They have a significant influence on the Nile's hydrologic regime, storing and releasing water, retaining suspended solids, decreasing dissolved oxygen concentrations, increasing acidity and dissolved carbon dioxide concentrations, reducing sulphate concentrations, increasing total dissolved solids concentrations and losing water to evapotranspiration (NBI, 2012).

The Sudd, an inland delta of the White Nile, is the country's largest wetland, covering about 5 per cent of the country's land area. It is made up of lakes, swamps, marshes and extensive flood plains. It includes the Bahr el Jebel swamps, the Bahr el Ghazal swamps, the wetlands at the Baro-Pibor-Akobo confluence and the Machar marshes (NBI, 2012). Figure 7 shows the location of the country's extensive wetland systems.

FIGURE 7: **LOCATION OF SURFACE WATER RESOURCES (WETLANDS) OF SOUTH SUDAN**

Source: (AfDB, 2013)

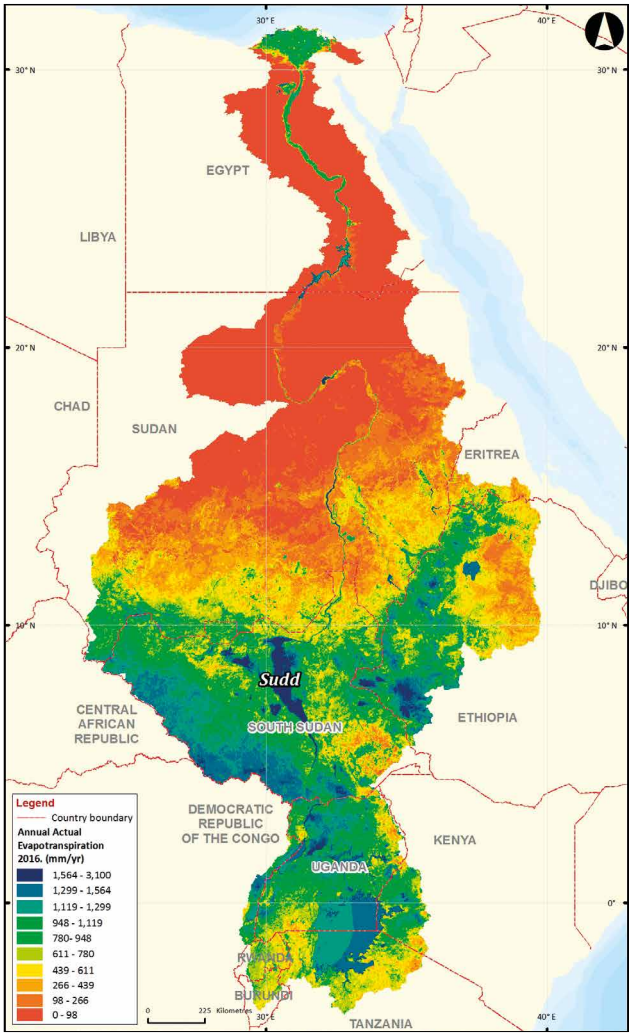
The Sudd is an extremely important water source for local people and their livestock; it also has significant fish and other aquatic resources. Complete scientific understanding of the hydrology and sustainability of the Sudd ecosystem is lacking, however, which makes it difficult to assess the impacts of the various planned hydrological interventions upstream of the Sudd wetland, as well as oil drilling developments that aim to increase food security and boost the economy. These are likely to affect the wetland's seasonal flows and modify the ecosystem's hydrology. Likewise, this dearth of knowledge hampers an understanding of the current and potential impacts of climate change on the wetlands and their ecosystem goods and services (Senay, Velpur, Bohma, Demissie, & Gebremkhael, 2014).

Evaporation and transpiration

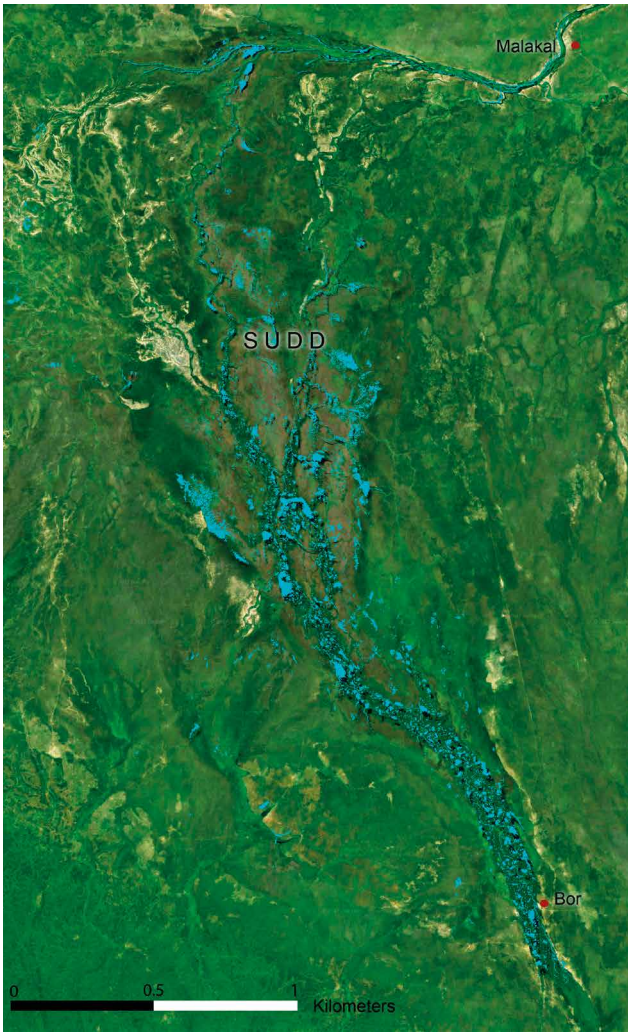
The vast wetlands in Southern Sudan are characterised by huge evaporation rates from the Sudd, Bahr el Ghazal and the Sobat sub-basins (Mohamed, Bastiaanssen, & Savenije, 2004). About half of the flow into the White Nile is lost mainly to evaporation and transpiration in the wetlands of South Sudan (FAO, 2011) and approximately half of the Bahr el Jebel flow is lost to evaporation (NBI, 2016). In total, long-term evaporation is thought to account for water losses as high as 85 per cent of the total inflows into the Sudd wetlands (Senay, Velpur, Bohma, Demissie, & Gebremkhael, 2014). Analysis of the rate of water loss to evapotranspiration in the Sudd wetlands found that the central part of the Sudd (not counting the seasonally flooded pastures surrounding the wetlands) has evapotranspiration rates between 1,500 and 2,000 mm/yr (Figure 8) (Bastiaanssen, *et al.*, 2014).

The average evaporation over the Sudd wetland is around 1,800 mm and due to uneven rainfall distribution, evaporation is lower in the northern part (600-700 mm/year) as well as in the south-eastern corner (RSS, 2015). However, due to uncertainty surrounding these numbers, this subject need further in-depth scientific investigation.

FIGURE 8: DISTRIBUTION OF THE ANNUALLY ACCUMULATED ACTUAL EVAPOTRANSPIRATION ACROSS THE NILE BASIN AVERAGED FOR THE PERIOD 2005-2010



Source: (Bastiaanssen, et al., 2014)



Sudd wetlands as seen from space *(Data Source: Landsat, United States Geological Survey)*

Groundwater

It is thought that large areas of South Sudan are underlain by rich aquifers that are recharged by seasonal rainfall and river flooding, with some of these underground water reservoirs extending across international boundaries (Table 2). There is little information on the distribution and hydrology of these underground waters, or about the rates of water extraction and the impacts of human activities, such as potential over-abstraction and pollution (MWRI, 2007).

The Upper Nile artesian aquifer lies in the extreme southern part of the plains of the Bahr el Ghazal, White Nile and Sobat Rivers. The plains collect water and recharge the aquifer internally, while the surrounding mountains act as an external recharge area. Rocks of the Nubian series underlay the Basin's northern parts where the water depth is between 25 to 100 metres, while the water depth in areas of Precambrian rock is between from 3 and 60 metres. The waters in the external recharge area occur at depths of 6 to 10 metres (NBI, 2012).

South Sudan shares three transboundary aquifers with neighbouring countries (Figure 9 and Table 2); to date, there is no sharing agreement between the countries.

FIGURE 9: **AQUIFERS IN SOUTH SUDAN**

Source: (NBI, 2016)

TABLE 2: **TRANSBOUNDARY AQUIFERS**

Aquifer name	Total aquifer area (km^2)	Sharing countries
Baggara Basin	239,411	Central African Republic
Sudd	331,661	Ethiopia, Kenya
Karoo-Carbonate	924,127	Central African Republic, Democratic Republic of the Congo

Source: (IGRAC, 2015)

Rainfall patterns

The rainfall regimes vary significantly across the Nile Basin's different sub-basins. For example, the area downstream of the Blue Nile sub-basin receives considerably lower rainfall, and water access in those basins depends entirely on the rainfall surplus from upstream basins (Bastiaanssen, *et al.*, 2014).

The relatively significant rainfall of South Sudan supplies most of its surface water, groundwater and other water sources. Based on rainfall contour maps, the national Irrigation Development Master Plan calculated that the country receives about 1 billion m^3 of rain annually (RSS, 2015) ranging between 700 mm a year in the lowlands areas of Eastern Equatoria, Jonglei, Upper Nile and Bahr el Ghazal, and between 1,200 and 2,200 mm a year in the north Western Equatoria and the highland areas of Eastern Equatoria (FAO, 2016b). Table 3 lists the Irrigation Development Master Plan'scharacteristics of South Sudan's different rainfall zones.

TABLE 3: **RAINFALL ZONES CLASSIFIED BY RAINFALL AND MOISTURE REGIMES**

Zone	Annual rainfall (mm)	Characteristics
High rainfall zone	> 1,500	The southwestern part of the country, far southeast and Kapoeta Hills, known as the Green Belt. Although rainfall is significant, it only occurs for a limited period (7-8 months) of the year and is highly variable.
Pastoralist zone	< 1,000	Most areas of the country in the central, eastern and western parts.
Moisture deficit zone	< 500	The northeastern part of the country. Rainfall is highly variable.

Source: (RSS, 2015)

7.3 Pressures and impacts

Water withdrawals and balances

Water availability in upstream and downstream areas of trans-boundary river basins is an extremely sensitive issue (Bastiaanssen, *et al.*, 2014). Because South Sudan is located in the "middle" of the Nile Basin, between the upstream Nile Equatorial Countries (Burundi, Democratic Republic of Congo, Kenya, Rwanda, Tanzania and Uganda) and the downstream Eastern Nile Countries (Egypt, Ethiopia and Sudan), natural water retention, water withdrawals and development activities in countries upstream of South Sudan affect its water quantity and quality (Fernando & Garvey, 2013). Lateral water transport flows from positive to negative areas and via floods and groundwater flow. Each individual country and water-use sector in the transboundary Nile Basin monitors water data, such as withdrawals, stocks, wastewater return flows and groundwater-well yields, making it difficult to assess the state of the entire basin's water flows. Earth observation data at the ecosystem scale helps to understand the Nile River Basin's major water flows and fluxes (Bastiaanssen, *et al.*, 2014).

Internal renewable surface water resources

The FAO estimates internal renewable surface water resources to be 26,000 million m³/year and internal renewable groundwater resources to be 4,000 million m³/year. These waters feed the base flow of the country's river systems (Table 4) (FAO, 2016b).

TABLE 4: LONG-TERM ANNUAL RENEWABLE WATER RESOURCES IN SOUTH SUDAN

Renewable Water Resources (RWR)	km³/year, average
Internal Renewable Water Resources	
Precipitation (mm/year)	900
Precipitation (km³/year)	579.9
Surface water: produced internally	26
Groundwater: produced internally	4
Overlap between surface water and groundwater	4
Total Internal Renewable Water Resources	**26**
External Renewable Water Resources	
Surface water entering the country	50
Surface water leaving the country	34
Total External RWR	**23.5**
Total Renewable Water Resources	
Surface water	49.5
Groundwater	4
Overlap between surface water and groundwater	4
Total Renewable Water Resources	**49.5**
Dependency ratio (%)	65.879

Source: (FAO, 2016b).

Water uses

Water uses in the Nile Basin as a whole threaten its capacity to meet the region's future water demand, including the water needs of South Sudan (Box 1).

BOX 1: THE EXTREME VULNERABILITY OF THE NILE BASIN'S WATER SUPPLIES

"Together, the countries of the Nile basin use almost 90 per cent of the region's renewable water resources. Egypt and Sudan, which need water from outside their borders, account for the largest water withdrawals at 57 and 31 per cent of the total renewable water withdrawals, respectively. The per capita withdrawals for these two countries are almost 10 to 15 times the amounts withdrawn by other countries in the basin. By far, the largest consumptive use is for irrigation, which has been estimated at 82 billion m³ per year with over 96 per cent of this occurring in Egypt and Sudan. Water demand for municipal and industrial use, estimated at 12.9 billion m³ per year is rapidly increasing from the present estimates of roughly 400 m3/s. Forecasts for 2030 are expecting a five-fold increase and the Nile Basin population seen as a whole, will become unable to meet the water demand".

Source: (FAO, 2016b)

Throughout the Nile Basin, irrigated agriculture accounts for more than 80 per cent of water withdrawals (NBI, 2016). Compared to other countries in the Nile Basin, South Sudan's water withdrawal is very low. According to the Food and Agriculture Organization of the United Nations, total water withdrawal in pre-2011 Sudan was about 27,590 million m^3 for the year 2005. The largest water user by far was agriculture, with 26,150 million m^3. Municipalities and industry accounted for withdrawals of 1,140 million m^3 and 300 million m^3, respectively. To arrive at an estimate for water use in South Sudan after 2011, Food and Agriculture Organization calculations were based on the figures for pre-2011 Sudan, with the following assumptions: the same total for South Sudan and Sudan together; no essential changes had taken place; almost all irrigation is located in Sudan; the population of South Sudan is 17 per cent of the total population of pre-2011 Sudan; and most (75 per cent) of the industries are located in South Sudan (specifically in the petrol sector) (FAO, 2016b). After 2011, it is estimated that surface and groundwater withdrawal (primary and secondary) is about 658 million m^3/year, representing about 1.3 per cent of the total renewable water resource, with agriculture using the most water and a per capita annual withdrawal of about 60 m^3 (FAO, 2016b). By comparison, annual per capita water withdrawal in Ethiopia is 106 m^3, in Egypt it is 911 m^3 and in Sudan, it is 714 m^3 (Table 5).

TABLE 5: WATER WITHDRAWAL DATA SHOWING COUNTRY COMPARISONS FOR YEARS 2008-2012 UNLESS OTHERWISE NOTED

Attribute	Country			
	Egypt	Ethiopia	South Sudan	Sudan
Total renewable water resources (10^9 m^3/year) (2006-2017)	58.3	122	49.5	37.8
Total water withdrawal (10^9 m^3/year)	78	10.55 (2013-2017)	0.658	26.93
Agricultural water withdrawal as % of total water withdrawal (%)	85.9	91.82 (2013-2017)	36.47	96.21
Industrial water withdrawal as % of total water withdrawal (%)	2.564		34.19	0.2785
Municipal water withdrawal as % of total withdrawal (%)	11.54		29.33	3.528
Total water withdrawal per capita (m^3/inhab/year)	910.6	106.1 (2013-2017)	59.92	714.1

Source: (FAO, 2016b)

Rural water consumption

On average, water consumption in rural areas is around 6 litres per person per day (MWRI, 2011). The World Health Organization suggests that a minimum of 7.5 litres per person per day will meet the requirements of most people under most conditions (Box 2). Only 20 per cent of the population operates and maintains their water supplies and existing data suggest that between 30 and 50 per cent of water points in the country are non-operational at any one time. There are no data on the precise number of boreholes yielding potable water in South Sudan (MWRI, 2011).

Girls collecting water and washing in rural area of South Sudan.
Photo credit: ArsenieCoseac/Flickr.com/ CC BY-ND 2.0

BOX 2: WATER REQUIREMENTS AS SUGGESTED BY THE WORLD HEALTH ORGANIZATION

"Based on estimates of requirements of lactating women who engage in moderate physical activity in above-average temperatures, a minimum of 7.5 litres per capita per day will meet the requirements of most people under most conditions. This water needs to be of a quality that represents a tolerable level of risk. However, in an emergency situation, a minimum of 15 litres is required. A higher quantity of about 20 litres per capita per day should be assured to take care of basic hygiene needs and basic food hygiene. Laundry/bathing might require higher amounts unless carried out at source".

Source: (WHO, 2017)

Children drinking water from a newly constructed borehole in Bentiu. *Photo credit: Steve Evans/Flickr.com/CC BY-SA 2.0*

Urban water consumption

In 2011, piped water supply systems that had standard Urban Water System technologies only existed in some parts of Juba and a few regional capitals. Most of the urban population relies on very rudimentary water supply systems typical of rural areas, such as water yards, motorised community and private hand-pumps, and basic unprotected wells (MWRI, 2011). Table 6 shows the trend in water consumption from 2010, projected to 2020, illustrating the threefold growth in demand for improved water between 2015 and 2020.

According to South Sudan's 2012 report on progress towards the 2015 Millennium Development Goals, the proportion of the country's population with sustainable access to an improved water source increased from 55 per cent in 2009 to 68.7 per cent in 2010. The proportions for access to improved sanitation were 20 per cent in 2009 and 36.9 per cent in 2010 (NBS, 2013).

Solar-powered mini wateryard facility in Gormoyok Village in Juba County, Central Equatoria State. *Photo credit: UN Photo/JC McIlwaine*

TABLE 6: ESTIMATED HOUSEHOLD DEMAND FOR WATER (BILLION LITRES PER YEAR), 2010-2020

Indicator	Year						
	2010	2011	2012	2013	2014	2015	2020
CONSUMPTION OF IMPROVED WATER							
Urban population	1.9	3.1	4.6	6.5	8.8	12.6	74.7
Rural population	19.3	22.9	26.9	31.3	36.1	41.3	74.2
Total	21.2	26.0	31.5	37.9	44.9	53.9	148.9
CONSUMPTION OF UNIMPROVED WATER							
Urban population	5.4	6.6	7.9	9.1	10.3	11.1	8.0
Rural population	18.7	18.6	18.3	18.1	17.7	17.2	13.3
Total	24.1	25.2	26.2	27.2	28.0	28.3	21.3
TOTAL CONSUMPTION							
Urban population	7.3	9.7	12.5	15.7	19.1	23.7	82.7
Rural population	37.9	41.4	45.2	49.4	53.8	58.5	87.5
TOTAL	**45.2**	**51.1**	**57.7**	**65.1**	**72.9**	**82.2**	**170.2**

Source: (AfDB, 2013)

Water quantity

In 2016, South Sudan's Ministry of Environment and Forestry reported that over the past two decades, water flow in a number of previously perennial rivers along the border with the Central African Republic had become seasonal. One of the main ecological impacts of decreased water flow is river siltation. A large part of the sediment created in the White Nile headwaters becomes confined in the Equatorial Lakes, held in the Sudd marshes or deposited along the river course downstream of the Sudd; thus, over its low-gradient course, the Nile's flow is very sluggish (NBI, 2012). Other impacts include the congestion of irrigation channels, water-table declines, receding wetland areas and the loss of vegetation due to the lack of water. In turn, the loss of ecosystem goods and services is having adverse effects on the livelihoods of people who depend on wetlands within South Sudan (MOE, 2016).

Water quality

The Nile Basin Initiative's 2012 State of the River Nile Basin report noted that over the previous several decades, population growth, agricultural intensification and industrial development throughout the Basin has led to accelerating soil erosion and generally deteriorating water quality. Data on the state of South Sudan's water quality and quantity are lacking, but given that it is more sparsely populated than other Nile Basin countries, it is likely that water quality still corresponds to standards set by the riparian countries and those of the World Health Organization (NBI, 2012).

People rely on the Nile waters to bath and wash their belongings.
Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0

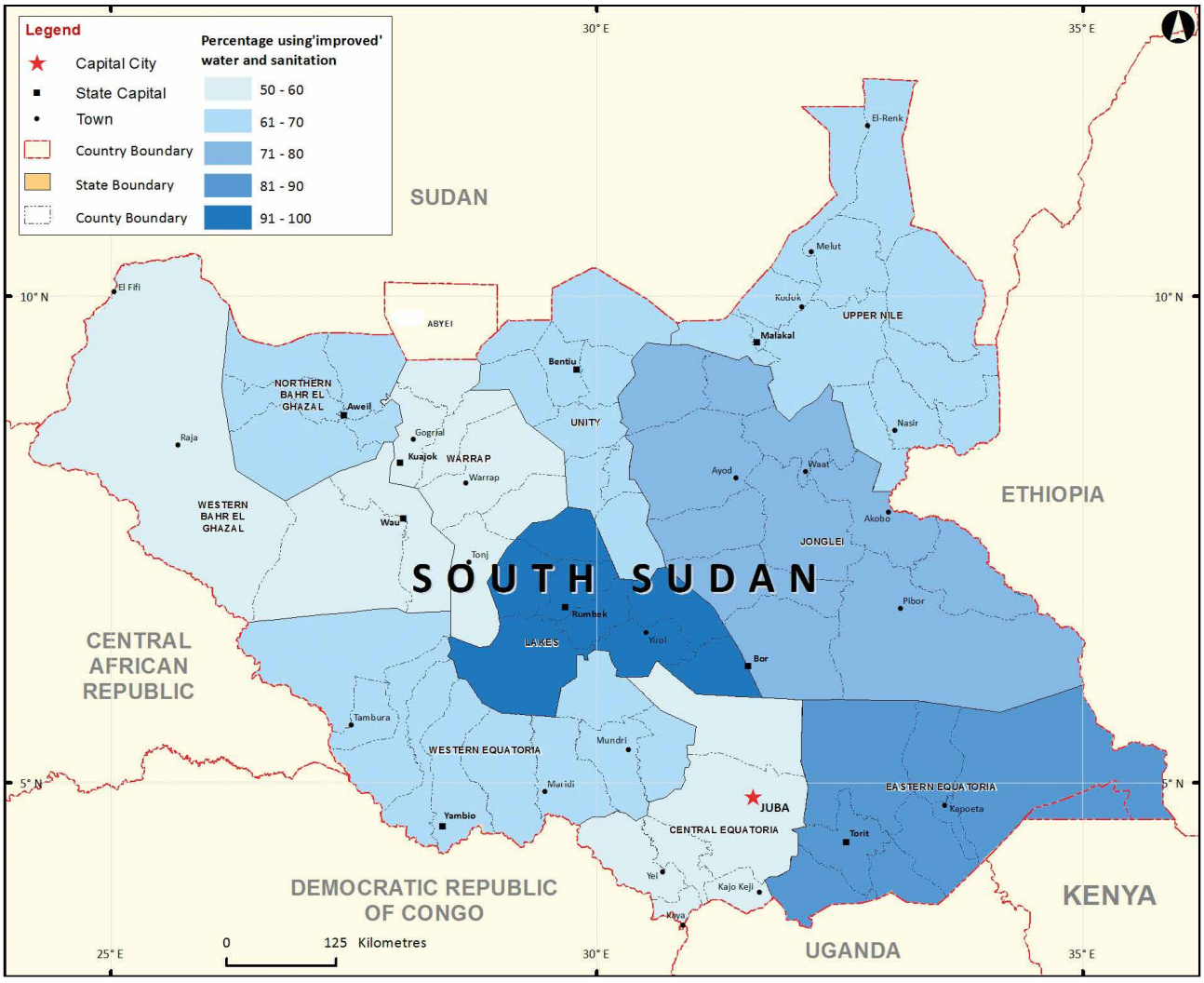
At local levels in South Sudan, however, rising urbanisation is associated with municipal wastewater, sewage and industrial effluents running straight into water sources, since most towns have no wastewater treatment facilities, and lack adequate sanitation and sewage management systems (MOE, 2014). According to the 2010 South Sudan Health and Household Survey, access to sanitation was 14.6 per cent (Figure 10), while hygiene awareness was one of the lowest in the world (UNICEF, 2016). More recently, 80 per cent of South Sudanese still had no access to any toilet facility (World Bank, 2016).

Irresponsible oil companies causing major environmental degradation and health hazards.
Photo credit: folkehjelp via Foter.com / CC BY

The single most critical environmental issue related to the pollution of local water supplies is the recurring incidence of gastrointestinal diseases, due mainly to the consumption of contaminated water (MOE, 2014).

Water sources are also subject to the runoff of agro-chemical fertilisers and pesticides, which adversely affect water quality. In addition, pollution from the development of the oil industry, particularly in the Unity and Upper Nile States, poses serious threats to wetlands and fisheries (MOE, 2016). For example, spillage during oil exploration and the overuse of agro-chemicals threaten the Sudd wetlands with pollution and eutrophication (MOE, 2014).

FIGURE 10: **WATER AND SANITATION IN SOUTH SUDAN**



Source: (Namah, 2013)

Dams and impoundments

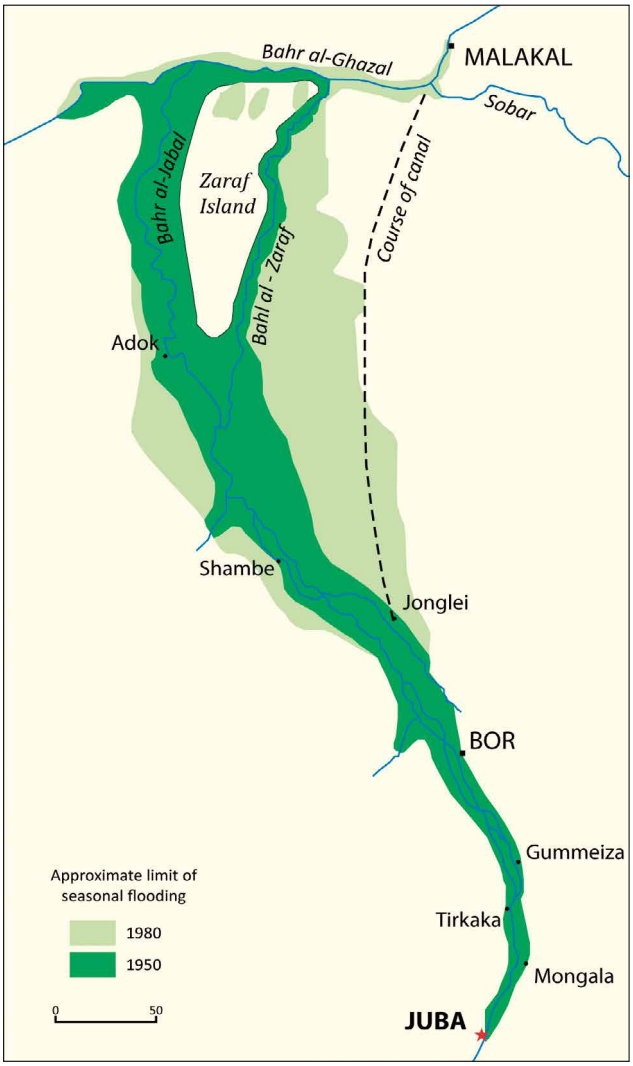
Dams, impoundments and other water infrastructure are increasingly being developed in the Nile Basin to meet the growing water needs of riparian states; the environmental impacts could be substantial (NBI, 2016). The Ministry of Environment and Forestry of South Sudan considers the construction of large hydroelectric dams and other related development schemes within the Nile Basin to be the most significant environmental threats to South Sudan's surface and sub-surface water resources. Schemes such as the construction of the Jonglei Canal (Box 3) or dykes along the River Nile, as well as plans to build a number of dams upstream of the Sudd would divert water and change the water-flow regime, which could irreversibly or partially destroy downstream ecosystems. The pollutants discharged from development schemes, such as wastewater and oil spills, risk contaminating rivers and groundwater resources (MOE, 2014).

BOX 3: THE JONGLEI CANAL PROJECT

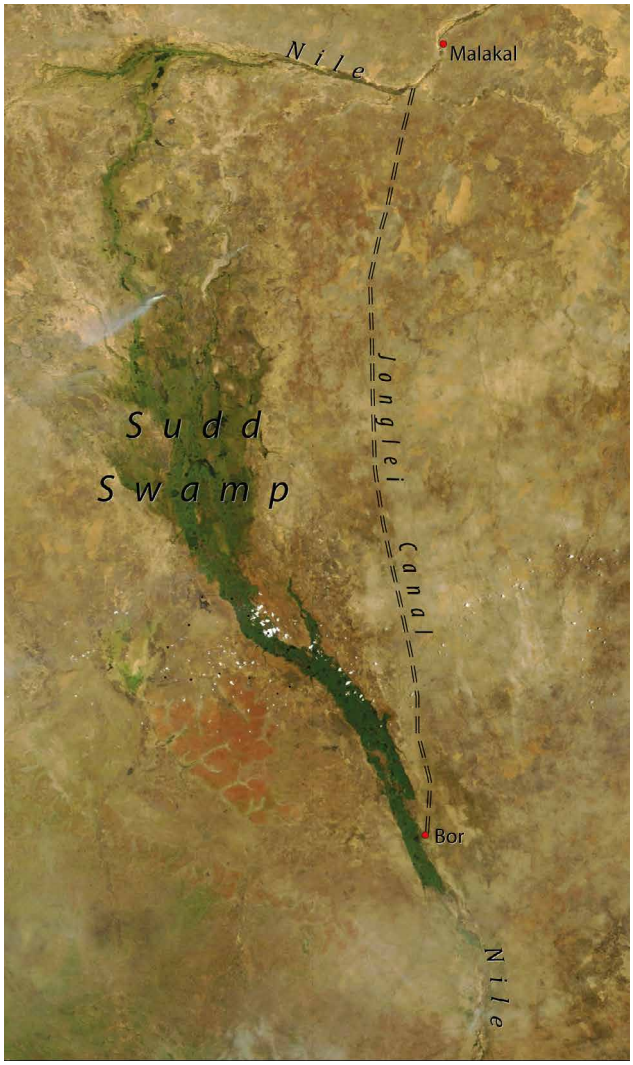
In the 1980s, the construction of the Jonglei Canal had been planned to divert water from the Sudd wetlands to minimise water loss due to evapotranspiration and make more water available for irrigation and other uses downstream to the rapidly expanding populations in northern Sudan and Egypt. The Jonglei Canal plan was to dig a 360 km canal to divert 4.7 billion m^3 of irrigation water a year to Egypt and Sudan. The civil war halted the project in 1984 after 260 km had been completed and the infrastructure was bombed, but should the project be revived, it would have untold environmental and social impacts for South Sudan, including the loss of fish habitat and important grazing areas.

During the planning stages, the Jonglei Investigation Team expected the project would have major impacts on the livelihoods of local communities, especially pastoralist groups such as the Nuer, Dinka and Shilluk. The drainage of the fragile wetlands ecosystem would result in the loss of biodiversity, less water for grazing land and the massive resettlement of pastoralist and agriculturalist populations. In addition, the canal would act as a divide between the east and west banks of the Nile that would jeopardise the movement of people, livestock and wildlife in South Sudan.

FIGURE 11: COURSE OF THE JONGLEI CANAL



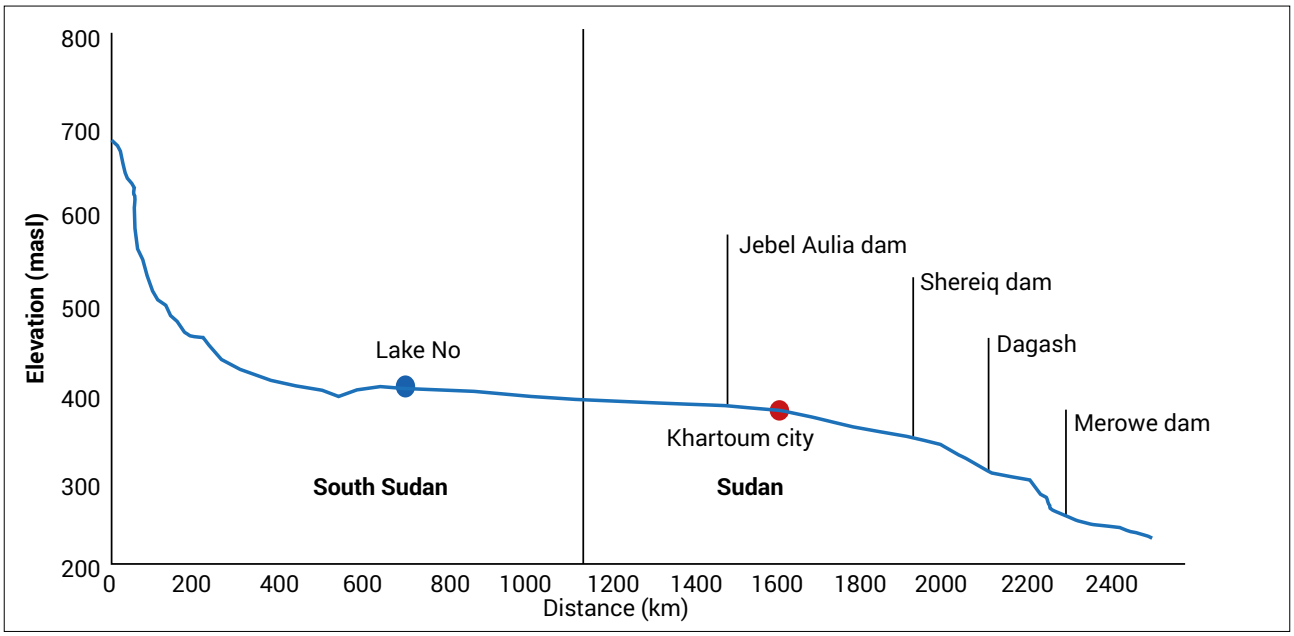
Sources: (CGIAR, 2013); (Rebelo, Senay, & McCartney, 2012); (Gowdy & Lang, 2015); (Mohamed, Bastiaanssen, & Savenije, 2004); (Cascão, 2013)



A Satellite image of Jonglei Canal
(Source: Landsat Data from United States Geological Survey)

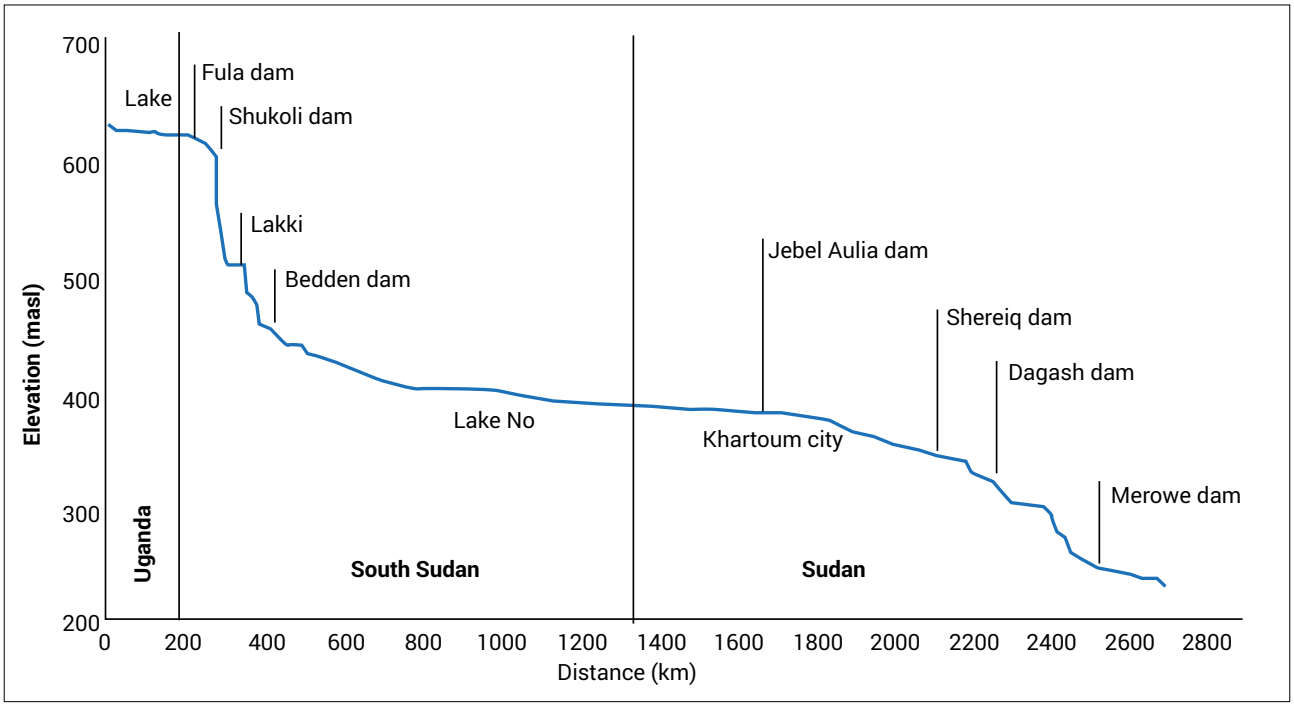
Within South Sudan, dam capacity is currently limited. In 2010, the Maridi dam, also called Kazana, was improved for public water supply and irrigation uses. In 2008, feasibility studies were conducted for three medium-sized dams that would help satisfy South Sudan's needs for electricity and clean water: the Sawa dam in Wau (Western Bahr el Ghazal), the Baraj dam in Juba (Central Equatoria) and the Kenti dam in Torit (Eastern Equatoria). In addition, five projects (in Fula, Bedden, Shukoli, Lekki and Juba) have been proposed as part of the Bahr el Jebel hydropower cascade, which would yield an estimated 2,590 MW compared to the current 22 MW available (for a demand of around 45 MW) (FAO, 2016a).

FIGURE 12: **BAHR EL GHAZAL RIVER PROFILE (ORIGINATING IN THE LOL RIVER)**



Source: (NBI, 2016)

FIGURE 13: **BAHR EL JEBEL RIVER PROFILE AND DOWNSTREAM PART OF MAIN NILE**



Source: (NBI, 2016)

From the outlet of Lake Albert to the inlet of Lake No, the Bahr el Jebel River runs for about 1,000 km, dropping some 250 m; several potential hydropower sites have been identified along the way, such as Fula I, Shukoli, Lakki and Bedden (Figure 13) (NBI, 2016).

Micro-dams across small water-courses or dykes have traditionally been constructed to supply livestock with water. Other customary water infrastructure includes haffirs, which are manmade underground reservoirs located outside of human settlements and livestock pasture areas, to store rainwater carried by streams, as well as open wells and expanded or deepened seasonal river beds (FAO, 2016a). These traditional water management approaches are cultural adaptations to the natural cycles of flooding and drought in South Sudan. Box 4 explains that limited access to water resources can trigger conflict and that water infrastructure is urgently needed to harness water resources in the country's floodplains.

BOX 4: WATER-RELATED NATURAL DISASTERS IN SOUTH SUDAN AND THE NEED FOR WATER INFRASTRUCTURE

"Competition for grazing lands and water, especially during the dry season, is a regular source of conflict in South Sudan. The extensive floodplains (toich) of South Sudan are subject to periodic water logging and intensive drying. In drought years, most water-holding features in the floodplains dry up. Given the small number of boreholes and lack of water-storage facilities in the area, a large number of people, livestock, and wildlife are left to depend on a few perennial rivers, lakes, pools, and marshes. Fierce tribal fights frequently erupt over the limited water resources and the rights to fishing grounds, essential to the livelihoods of the floodplains communities. These conflicts lead occasionally to loss of life and internal displacement of people.

Apart from the problem of frequent droughts, the floodplains experience occasional flooding that result in widespread crop failure, livestock deaths, loss of cropland, and loss of pasture. Thus, even in the absence of conflicts, communities in the floodplain are periodically displaced and forced to migrate beyond their territories, including into neighbouring countries, by natural disasters. Water infrastructure is urgently needed in the floodplains area for harnessing the water resources and facilitating their use for socio-economic activities. The needed infrastructure includes boreholes, valley tanks, small dams, river training works, and a variety of water-harvesting structures such as haffirs (open reservoirs) and dykes".

Source: (NBI, 2012)

Flooded Pibor. *Photo credit: ОлегСокол/ Via Wikimedia Commons/ CC BY-SA 3.0*

7.4 Response

International cooperation

Since the withdrawal of water in one sub-basin of the larger Nile Basin affects the amount of water available in others, the riparian nations need a high degree of trust and cooperation to share the water and its benefits among them (NBI, 2016). Given its central geographical position in the Nile Basin, and the fact that its water resources are governed by the natural hydrological characteristics of the Nile Basin and impacted by water developments both within and outside the country, South Sudan needs to engage in transboundary and international agreements to help manage the benefits of the Nile Basin's shared water resources.

The Nile Basin Initiative is the key agreement. It was launched in 1999 as a partnership among the nine Nile Riparian states at the time, that shared the river's resources. South Sudan was admitted into the Initiative in 2012 and is the 10th member (since Eritrea has observer status). The Nile Basin Initiative "seeks to develop the river in a cooperative manner, share substantial socioeconomic benefits, and promote regional peace and security" (AfDB, 2013). Its implementation is hindered by the historical agreements signed between Britain and Egypt in 1929 and between Egypt and the then Sudan in 1959.

The estimated average annual yield of the Nile as measured at Aswan was 84 billion cubic metres (bcm) and out of this the 1929 agreement allocated Egypt 48 bcm and Sudan 4 bcm (Kamau, 2015). Egypt was also given veto power over any projects that might interfere with the volumes of water reaching the Mediterranean. The 1959 agreement increased the allocations given to the two countries to 55.5 bcm and 18.5 bcm respectively (Matara, 2015);(Katz, 2013).

The Cooperative Framework Agreement, developed in 2010 under the auspices of the Nile Basin Initiative, was meant to be a permanent legal and institutional framework to govern the Nile River Basin. It introduced the concepts of equitable water allocation and water security into discussions about governing the Nile's waters. Egypt and Sudan declined to sign the agreement, however, since it failed to protect their "acquired rights" to the waters of the Nile River (Kimenyi & Mbaku, 2015).

The issue of establishing a legal framework to assign water rights among riparian countries also became more complicated with South Sudan's independence. Currently, there is no clarity on how the water rights will be allocated (AfDB, 2013).

The World Bank, the African Development Bank and other donors support a substantial programme among member states to build capacity and invest in developing and managing water resources in the following sectors: power generation, transmission and interconnection; irrigated agriculture; navigation; and fisheries, as well as in land management, watershed protection and environmental conservation. South Sudan does not generally benefit from these programmes, but it collaborates with the Nile Basin Initiative in the following activities (AfDB, 2013):

- The Applied Training Programme component of the shared vision programme has trained technical staff from the Ministry of Water Resources and Irrigation of South Sudan;
- The Lau and Aswa integrated watershed management projects are being implemented; and
- The Baro-Akobo-Sobat multipurpose water resources study project is being prepared (AfDB, 2013).

Vision 2040

South Sudan's national policies and institutional framework include provisions for managing its water resources. Vision 2040 stipulates the "sustainable harnessing and accountable management of water resources that respond to water related public-health needs, livelihoods and development aspirations of the people of South Sudan in an equitable manner" (MWRI, 2011)

Institutional framework

The Ministry of Water Resources and Irrigation has overall leadership in the water sector. In the water resources sub-sector, the Ministry has responsibility for the following:

- Drafting and overseeing the implementation of policies, guidelines, master plans and regulations for water resources development, conservation and management in South Sudan;
- Encouraging scientific research into the development of water resources in South Sudan;
- Overseeing the design, construction and management of dams and other surface storage infrastructure for irrigation, human and animal consumption, and hydroelectricity generation;
- Setting tariffs for water use;
- Creating policy on rural and urban water resource development and management;
- Initiating irrigation development and management schemes;
- Protecting the Sudd and other wetlands from pollution; and
- Advising and supporting the states and local governments in building their capacity to assume all functions vested by the Constitution and government policy.

The three key directorates responsible for the water resources sub-sector are Water Resources Management, Irrigation and Drainage, and Hydrology and Survey (AfDB, 2013).

Policy framework

In 2007, the Ministry of Water Resources and Irrigation adopted a water policy for southern Sudan, and at independence in 2011, it adopted a strategic framework. The overall goal of the water policy is to promote effective management of the quantity, quality and reliability of available water resources to maximise social and economic benefits while ensuring long-term environmental sustainability. The key guiding principles for water resources management are as follows:

- Water is a shared resource and appropriate legal frameworks shall be established to govern all aspects of water use; and
- Water resources planning shall involve all relevant stakeholders and will be undertaken on the basis of natural hydrologic boundaries.

The policy discusses aspects of water use in fisheries, navigation, livestock, forestry, industries, environment, and wildlife and tourism development, but postpones developing policies on irrigated agriculture to a later date, depending on progress made developing and using water for irrigation (AfDB, 2013).

The water sector strategic framework of 2011 recommends the formation of a Water Council as the water sector's main multi-stakeholder advisory body and the establishment of a Water Resources Management Authority to enforce regulatory functions in the management and use of water resources (AfDB, 2013).

In August 2011, established the now Ministry of Energy and Dams. Details on its duties, functions and interlinkages with the Ministry of Water Resources and Irrigation have not yet been clarified. The Ministries of Electricity and Dams, Agriculture and Forestry, Animal Resources and Fisheries, and local government play major roles in developing and managing the country's water resources activities. In addition, due to the transboundary nature of water resources and anticipated negotiations with other riparian states, the Ministry of Foreign Affairs and International Cooperation will also be a key party in water-related decisions (AfDB, 2013).

At the state level, water resources management departments are coordinated under the water and sanitation directorates. They are accountable to both their respective state ministries and the Ministry of Water Resources and Irrigation. The directorates lack clear mandates, regulatory frameworks, required funding, and the essential human resources and capacity to operate effectively. So far, South Sudan has not developed a Water Act.

In addition to the 2007 Water Policy, the relevant policy documents related to water governance include the 2013 Water Bill and the 2011 Water, Sanitation and Hygiene Sector Strategic Framework. The latter outlines equitable and sustainable water allocation measures. The strategies include monitoring the social and environmental impacts of water resources management, and generating and adapting complementary knowledge (MOE, 2015).

Water Resources Management (WRM)

The Water Resources Management Strategy of South Sudan aims to improve knowledge and capacity in water resource mapping, assessment and monitoring; strengthen the water information system; and promote conflict prevention and sustainable management of water resources (Table 7) (UNESCO, 2016).

TABLE 7: **WATER RESOURCES MANAGEMENT STRATEGY OF SOUTH SUDAN**

WRM Strategy Component	High Priority Actions and Programs
Assessment and monitoring	► Collect and analyse historic and recent data, information, and knowledge ► Identify and map potential pollution spots ► Improve capacity of the WASH information management system
Planning and development	► Plan water resources management at the lowest appropriately identified and demarcated hydrologic unit (catchment) ► Plan focused flood risk analysis and disaster prevention measures with capacity building at all levels ► Develop conflict prevention and mediation capacity
Regulation, allocation, and use	► Adopt legislation, by-laws and enforcement mechanisms that address priority access to water for domestic use, with clear allocation criteria for other uses ► Establish water allocation and reallocation tracking and monitoring systems through water extraction licenses to safeguard against over-extraction or depletion of groundwater and surface water ► Designate areas with localised pollution problems (for example, near oil extraction facilities) and high competition for scarce water sources
Research and innovation	► Identify and encourage collaborative national, regional and international research to address crucial WRM challenges ► Promote a culture of learning, documentation and sharing interdisciplinary knowledge for WRM
Setting up WRM institutions	► Establish a WRM regulatory authority at the national level to regulate water allocation and use, and enforce all water-related legislation
Transboundary water issues	► Address transboundary water issues in partnership with the riparian countries
Financing WRM	► Introduce annual water abstraction permits, taxes and tariffs for agricultural and industrial bulk water users ► Allocate a prescribed proportion of these tariffs to support WRM initiatives

Source: (Fernando & Garvey, 2013).

In its 2016 National Adaptation Programme of Actions to climate change report, the government listed the key ways water management policies and institutions might address the need to adapt to changes in water resources as a result of climate change:

- Undertake assessments to identify areas prone to shortages under climate change and inform integrated water resources management.
- Promote the development of water harvesting structures, including dykes, water reservoirs and canals, to increase water availability.
- Improve water and sanitation infrastructure in urban areas to improve water supply and quality.
- Develop supplementary irrigation systems in rural areas to improve agricultural production and increase food security.
- Establish a regulatory framework for the monitoring of water quality, including penalties for pollution of water sources.
- Develop a solid waste management plan to ensure water quality is maintained (MOE, 2016).

Although the government is gradually instituting water management policies and regulations, the state of conflict, low population densities and widely scattered villages and towns present formidable challenges to providing water facilities, services and infrastructure in a cost-effective way.

Pit toilet with super structure built in metal sheets.
Photo Credit: Rahul Ingle, May 2012 via SuSanA Secretariat/ Flickr.com/ CC BY 2.0

7.5 Conclusions

South Sudan is located in the "middle" of the Nile Basin, which occupies almost 98 per cent of the country's land area. About 7 per cent of South Sudan is covered by vast expanses of tropical freshwater wetlands that occur at the confluence of the White Nile's main tributaries; the Sudd alone covers 5 per cent of the country. These wetlands have a significant influence on the Nile's hydrologic regime. About 30 per cent of the Nile River's water flow passes through South Sudan on its way to Egypt. But as much as 85 per cent of the total water that flows into the Sudd wetlands is lost to long-term evapotranspiration.

Together, the countries of the Nile Basin use almost 90 per cent of the region's renewable water resources, with Egypt and Sudan, which need water from outside their borders, accounting for the largest water withdrawals, mainly for agriculture. South Sudan's water withdrawal is very low. Annual per capita withdrawal is about 60 m^3 compared to Ethiopia at 106 m^3, Egypt at 911 m^3 and Sudan at 714 m^3. On average, water consumption in rural areas of South Sudan is around 6 litres per person per day, compared to requirements of a minimum of 7.5 litres per person per day for most people under most conditions. Limited access to water resources can trigger conflict. To date, there is no clarity on water sharing in the Nile Basin and no formal decision on South Sudan's share of the Nile's waters. South Sudan needs to support the establishment of a legal framework to assign water rights among riparian countries.

Water quantity and quality in South Sudan have declined in the past two decades. In a number of previously perennial rivers, for example, water flow has become seasonal. Lower water flows can lead to siltation. Large quantities of sediment are held in the Sudd marshes or deposited along the river course downstream of the Sudd. With municipal wastewater, sewage and industrial effluents running straight into water sources due to a lack of wastewater and sanitation management, water quality is declining in urban areas and contaminated water is responsible for recurring incidences of gastrointestinal diseases. Other significant threats to water resources include the construction of large hydroelectric dams and other related development schemes within the Nile Basin, the overuse of agrochemicals and spillage during oil exploration, which risk polluting the Sudd wetlands.

The Ministry of Water Resources and Irrigation has overall leadership in the water sector and state level directorates are accountable to it, but there is a lack of clear mandates, regulatory frameworks, required funding, and the essential human resources and capacity to operate effectively.

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Camp for the displaced in Wau.
Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0

CHAPTER 8
URBAN ENVIRONMENT

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8.1 Introduction

In 2016, an estimated 54.5 per cent of the world's population lived in urban settlements. More than half of Africa's population still lived in rural areas in 2016, but the share of those living in urban areas is rising. The urbanised population in Africa is projected to grow from 36 per cent in 2010 to 50 per cent by 2030, and to 56 per cent by 2050 (UNDESA, 2014); (World Bank, 2015). Between 2016 and 2030, the number of cities with 500,000 inhabitants or more on the continent is expected to grow by 80 per cent. Africa's urbanisation rate is the highest in the world (UNDESA, 2016).

TABLE 1: URBAN AND RURAL POPULATION STATISTICS (IN THOUSANDS), 1990-2050

Region	Urban			Rural			Proportion urban (per cent)			Average annual rate of change (per cent)
	1990	2014	2050	1990	2014	2050	1990	2014	2050	2010-2015
South Sudan	**765**	**2,182**	**8,403**	**4,999**	**9,556**	**16,357**	**13**	**19**	**34**	**1.0**
Africa	196,923	455,345	1,338,566	433,064	682,885	1,054,609	31	40	56	1.1
World	2,285,031	3,880,128	6,338,611	3,035,786	3,363,656	3,212,333	43	54	66	0.9

Source: (UNDESA, 2014)

BOX 1: DEFINITION OF CITIES AND URBAN AREAS

The Population Division of the United Nations explains that "So far, no standardized international criteria exist for determining the boundaries of a city and often multiple different boundary definitions are available for any given city. One type of definition, sometimes referred to as the "city proper", describes a city according to an administrative boundary. A second approach, termed the "urban agglomeration", considers the extent of the contiguous urban area, or built-up area, to delineate the city's boundaries. A third concept of the city, the "metropolitan area", defines its boundaries according to the degree of economic and social interconnectedness of nearby areas, identified by interlinked commerce or commuting patterns, for example" (UNDESA, 2016).

BOX 2: INFORMAL SETTLEMENTS

The United Nations Conference on Housing and Sustainable Urban Development (UN Habitat) define informal settlements as "residential areas where 1) inhabitants have no security of tenure vis-à-vis the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing, 2) the neighbourhoods usually lack, or are cut off from, basic services and city infrastructure and 3) the housing may not comply with current planning and building regulations, and is often situated in geographically and environmentally hazardous areas. Slums are the most deprived and excluded form of informal settlements characterized by poverty and large agglomerations of dilapidated housing often located in the most hazardous urban land. In addition to tenure insecurity, slum dwellers lack formal supply of basic infrastructure and services, public space and green areas, and are constantly exposed to eviction, disease and violence".

Source: (UN Habitat, 2016)

8.2 Urbanisation in South Sudan: Status and Trends

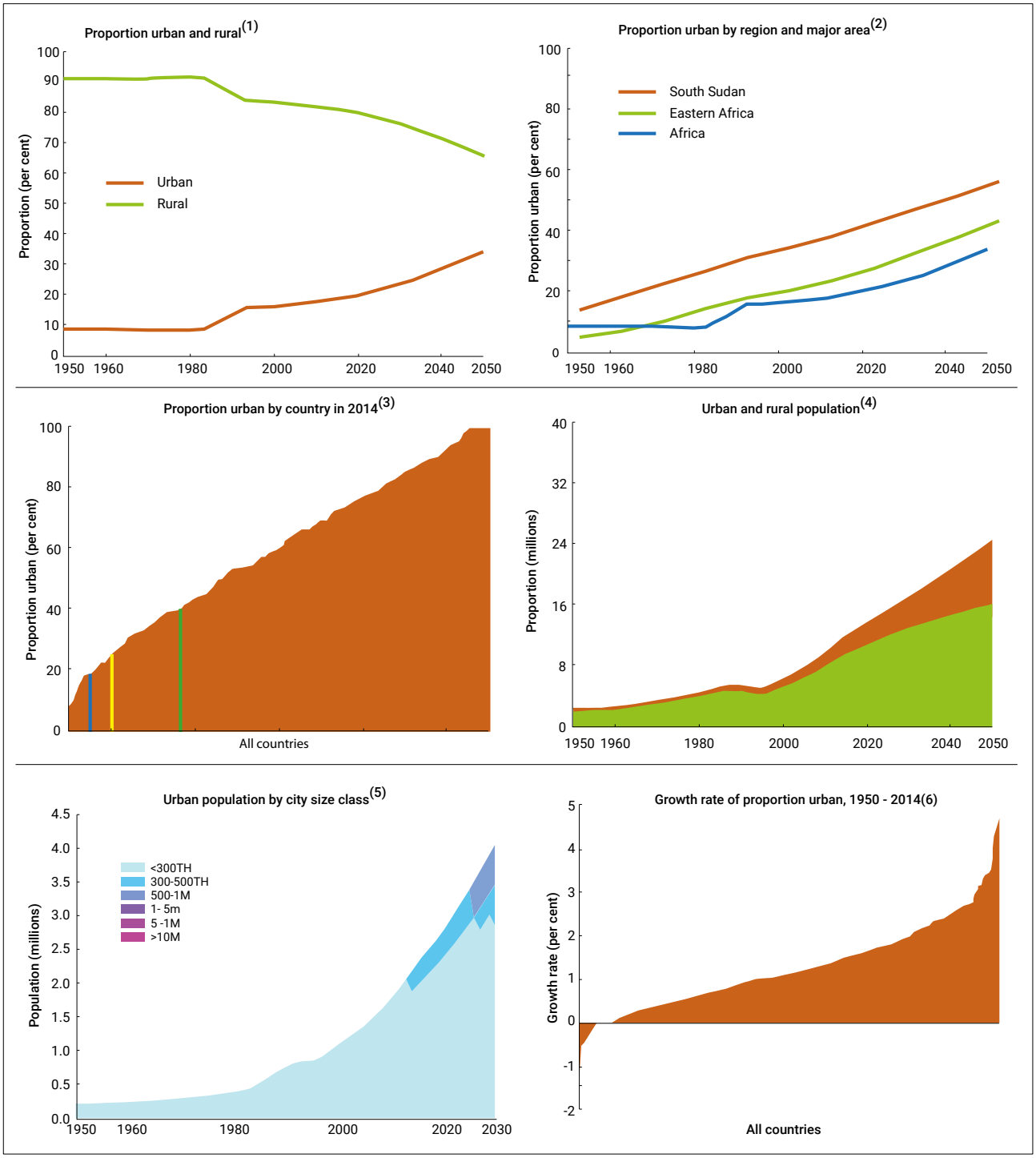
Urban growth

In South Sudan, the extent of urbanisation is currently much smaller than the African average. Of South Sudan's population of 12.3 million, less than 20 per cent live in urban areas. In 2009, 11 counties were more than a third urbanised (World Bank, 2011). The urban population is growing rapidly, however, due to high birth rates and the return of Internally Displaced People as well as the migration of returnees and newcomers from neighbouring countries (MOE, 2014). The ongoing conflict has uprooted more than 2.3 million people, nearly 1.7 million have been displaced internally and some 650,000 refugees live in neighbouring countries (D'Adamo, 2017). Many migrants are attracted to cities and towns where socioeconomic and livelihood opportunities are considered to be better than in the countryside (MOE, 2014). South Sudan's urban population is expected to grow fourfold from 2014 to 2050, by which time 8.4 million people will be housed in urban areas (UNDESA, 2014) (Table 1). Between 2010 and 2015, the rate of urbanisation in the country was 5.05 per cent annually (CIA, 2016).

New school being built in Moliandru Village. *Photo credit: BBC World Service/Flickr.com/ CC BY-NC 2.0*

Malakal. *Photo credit: UNMISS*

FIGURE 1: SOUTH SUDAN URBAN PROFILES, 1950-2050



Source: (UNDESA, 2014)

Notes:

1. Proportions of urban and rural population in South Sudan as a percentage of the total population, 1950 to 2050.
2. Proportions of urban population in South Sudan as compared to Eastern Africa and Africa as a whole. The proportion is expressed in per cent of the population between 1950 and 2050.
3. Proportion of urban population in South Sudan (blue line), Eastern Africa (red line) and Africa (green line) as compared to the ranked urban proportions of all countries of the world (grey area). The figure illustrates the level of urbanisation South has compared to its major area and region, as well as compared to all other countries of the world.
4. Urban and rural population in South Sudan.
5. Urban population of South Sudan by size class of its urban agglomerations in 2014. The light blue area is a residual category, which includes all cities and urban agglomerations with a population of less than 300,000 inhabitants. The size classes correspond to the legend.
6. Average annual growth rate of the urban population of South Sudan between 1950 and 2014 (blue line), as compared with the average annual growth rates of the urban population of all countries of the world (grey area). The figure illustrates that urban growth rates between 1950 and 2014 were positive in the great majority of the countries of the world. Only a few countries had negative urban growth rates - indicating that their urban proportion was declining between 1950 and 2014. Due to limitations of space, official country names had to be abbreviated in the figure legends.

Table 2 names the ten largest cities in South Sudan and provides their estimated population numbers. It shows that Juba is by far the largest city in the country, and that Malakal, the second-largest city, is just over half the size of Juba. Juba, Malakal and Wau have populations of over 100,000; the seven next-largest cities have populations of around, or below 50,000.

The three fastest growing cities are Juba, Wau and Malakal. The 2008 census data show the trend in the growth rate of these cities (Table 3).

Although migration is an important factor in urban growth in South Sudan, the most significant driver is the natural increase in the population (births less deaths) due to the high fertility rate, which in 2012, was an average of 5 births per woman.

TABLE 2: SOUTH SUDAN'S LARGEST CITIES

Rank	Name	Population
1	**Juba,** Central Equatoria	300,000
2	**Malakal,** Upper Nile	160,765
3	**Wau,** Western Bahr el Ghazal	127,384
4	**Torit,** Eastern Equatoria	49,000
5	**Yei,** Central Equatoria	40,382
6	**Yambio,** Western Equatoria	40,382
7	**Aweil,** Northern Bahr el Ghazal	38,745
8	**Gogrial,** Warrap	38,572
9	**Rumbek,** Lakes	32,083
10	**Bor,** Jonglei	26,782

Source: (GeoNames, n.d.)

TABLE 3: POPULATION GROWTH IN THE THREE LARGEST CITIES, 2008

City	Population from Census				Intercensal Growth Rates (%)		
	1973	1983	1993	2008	1973-1983	1983-1993	1993-2008
Juba	56,737	84,377	125,000	372,413	4.0	3.9	10.9
Wau	52,750	58,008	84,000	151,320	1.0	3.7	5.9
Malakal	34,894	33,737	72,000	126,483	-0.3	7.6	5.6

Source: (GeoNames, n.d.)

Transportation network

The country's road, rail and river networks link its major settlements and rural hinterlands within the country and connect it to neighbouring nations (Figure 2). Most river ports are located along the Nile River. Although there is no functioning railway, the railway track from Sudan to Wau in Western Bahr el Ghazal State still exists (MOE, 2014).

Malakal Port loading dock. *Photo credit: BBC World Service/Flickr.com/ CC BY-NC 2.0*

FIGURE 2: SOUTH SUDAN'S ROAD NETWORK, 2011

Source: redrawn by EPI from a map by World Food Programme

Juba, the capital city

Juba, the capital city of South Sudan, is a river port on the west bank of the Nile River (Bahr el Jabal). The city is also the capital of Central Equatoria State and is made up of three of the 16 payams of Juba County: Juba, Kator and Munuki (RSS, 2015). It is a commercial hub for most of the country's internal and external trade, as it is the southern terminus for river traffic in the country, and has roads extending to South Sudan's other urban areas and into Uganda, Kenya, and the Democratic Republic of the Congo (Figure 2) (Encyclopædia Britannica, 2011).

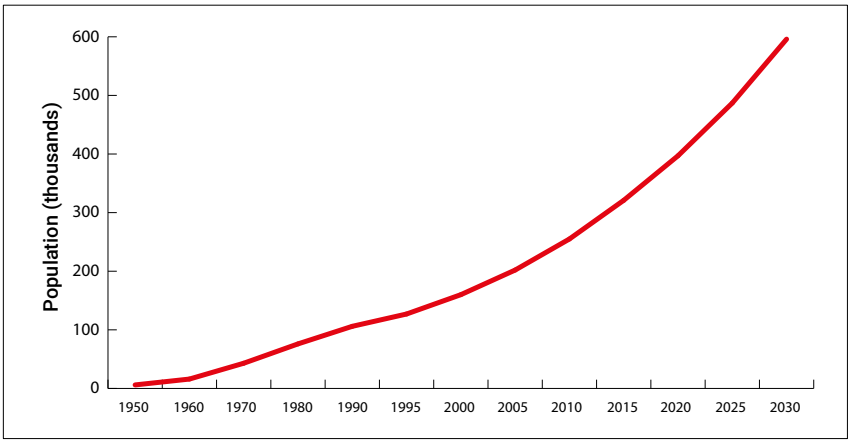
Juba Airport. *Photo credit: United to End Genocide/Flickr.com/CC BY-NC-ND 2.0*

Juba is one of the world's fastest growing cities. Its population is about 350,000-400,000, which is double the number of people inhabiting the city in 2005 when the Comprehensive Peace Agreement ended the civil war with Sudan (CIA, 2016) (Figure 3). Immigrants and people returning home after the conflict contributed to swelling the population as the city was considered to be the only safe settlement in Equatoria State during the civil war (RSS, 2015). Economic and job opportunities also attract newcomers to Juba, including people from neighbouring countries, and movement to the city has been facilitated by regional roads opening such as the Juba-Nimule road (RSS, 2015). The annual average rate of urban growth in Juba in 2010-2015 was 4.63 per cent (Figure 4).

Figure 5 is a map showing the city's rapidly expanding boundary in 2002, 2007 and 2012, during which the city grew into the surrounding rural payams of Northern Bari and Rajaf. In that time, the urban area increased five-fold (UNHCR, n.d.). Without proper urban planning, however, informal and squatter settlements lacking water, sanitation and other services, grew up around the city core. Juba is also a hub for humanitarian aid organisations in the country, and the city centre is surrounded by army camps.

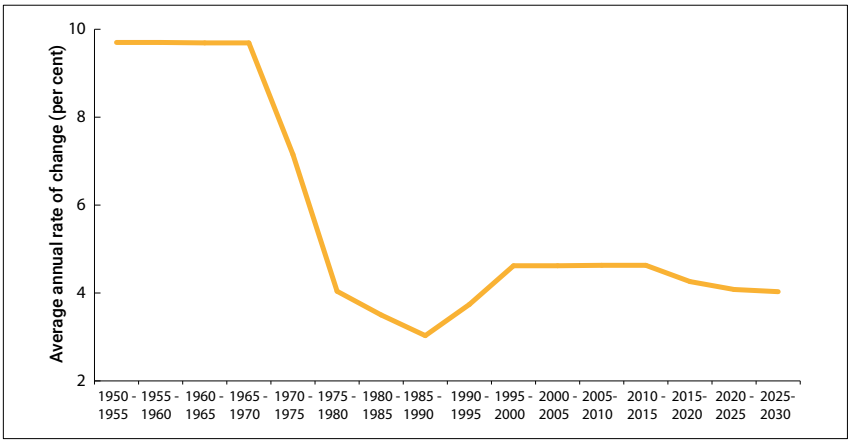
Another of the city's main features is the expansion of human settlements towards Juba Game Reserve, a protected area of savannah and woodland that is the habitat for some important bird species.

FIGURE 3: POPULATION OF JUBA, 1950-2030



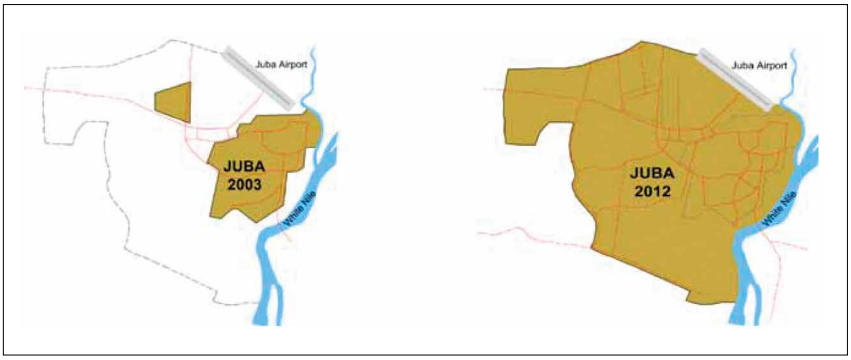
Source: (UNDESA, 2014)

FIGURE 4: AVERAGE ANNUAL RATE OF CHANGE IN JUBA 1950-2030



Source: (UNDESA, 2014)

FIGURE 5: EXPANSION OF JUBA CITY, 2002-2012



Source: (UNHCR, n.d.)

Significant densification of Juba between 2003 and 2016. The Republic of South Sudan became the newest nation in the world on July 9, 2011. Juba, a port city on the White Nile, is the capital of the new nation and is one of the fastest growing cities in the world. Juba's population is uncertain, but it is estimated to be roughly 350,000 to 400,000. The city has doubled in size since 2005. Both hopeful immigrants and returning residents have created the population surge. Green colour generally represents vegetation, brown: human settlements or fields, and dark blue: water.

Juba city near the Juba Game Reserve, 2003

Data Source: DigitalGlobe

Juba city expansion towards the Juba Game Reserve, 2016

Data Source: DigitalGlobe

In about 2015, the urbanised area of Juba (Greater Juba) was estimated to be approximately 52 km^2 (RSS, 2015). Juba's infrastructure and main transportation routes were severely damaged during the civil war with Sudan, but since independence, aid from a number of countries and international organisations has helped to rebuild the city's roads, railroads and airport. A bridge across the Nile River in Juba is planned. The housing sector has recently seen an expansion of quality buildings as the population increases and there has been a rise in solar energy use by many citizens as well as low emission lighting (RSS, 2016a).

Juba from above. *Photo credit: Amy the Nurse/Flickr.com/CC BY-NC-ND 2.0*

South Sudan's other cities

Malakal, the country's second-largest city, is located on the banks of the White Nile near the country's northern border with Sudan. Transportation by river from Malakal on the White Nile reaches as far north as Khartoum, the capital of Sudan, and as far south as Adok, in Lakes area. It is the capital of the oil-producing Upper Nile region and is served by the Malakal International Airport. Since 2013, it has seen intense fighting between South Sudan's rival forces.

South Sudan's internally displaced people (IDP) camps

South Sudan is in a state of conflict and instability and there are areas where malnutrition is critical. These circumstances force people to move within the country, often to cities and towns, or to IDP camps. In addition, migrants, asylum seekers and refugees from neighbouring countries migrate to South Sudan (RMMS, 2016). Statistics from early 2017 show there were 260,868 refugees in South Sudan (which includes asylum seekers, trafficked persons and smuggled economic migrants), the majority (92 per cent) of whom are from neighbouring Sudan (RMMS, 2017) (Tables 4 and 5). In addition, there are another 1.85 million IDPs. The United Nations High Commission for Refugees estimates that nearly one in four South Sudanese citizens are displaced within its borders or to neighbouring countries. In 2017, in Juba, Central Equatoria, a total of 46,600 IDPs were registered in three locations with food, water, and health as their major basic needs (UNHCR, 2017a).

In early 2017, the United Nations High Commission for Refugees reported that "South Sudan is now Africa's largest refugee crisis and the world's third after Syria and Afghanistan – with less attention and chronic levels of underfunding" (UNHCR, 2017a). Most refugees and many IDPs in South Sudan are living in camps. Some

TABLE 4: NUMBERS OF REFUGEES BY STATE, 2017

Area	Total Population	Households
Upper Nile	13,8193	31,889
Unity	95,857	22,485
Central Equatoria	15,807	5,876
Western Equatoria	8,526	2,792
Jonglei	2,485	668

Source: (RMMS, 2017)

TABLE 5: DATA ON REFUGEE NUMBERS IN SELECTED CAMPS, 2017

Refugee camp or settlement	Area	Number of refugees
Yida	Unity	54,496
Ajuong Thok	Unity	33,729
Doro	Upper Nile	52,756
Pamir		7,642

Source: (UNHCR, 2017b)

IDP camp in Bentui. *Photo credit: European Commission DG ECHO/Flickr.com/CC BY*

camps in South Sudan host many thousands of people in a densely settled area such that their needs in terms of water, sanitation and waste disposal, and their environmental impacts are similar to those of urban areas, although they do not fit the criteria of cities.

The United Nations Peacekeeping mission in the Republic of South Sudan, UNMISS, also provides shelter in Protection of Civilians sites. As of 16 February 2017, six of these sites located on UNMISS bases sheltered 223,926 civilians (Table 6) (UNMISS, 2017).

Aerial view of Bentiu Protection of Civilian site in Bentiu.
Photo credit:UNMISS/Flickr.com/CC BY-NC-ND 2.0

TABLE 6: NUMBER OF PEOPLE IN PROTECTION OF CIVILIANS (POC) SITES, 2017

Region	Location	Number of civilians seeking protection
Central Equatoria	UN House PoC I & III	38,942
Unity	Bentiu	120,011
Upper Nile	Malakal	33,191
	Melut	681
Jonglei	Bor	1,976
Western Bahr el Ghazal	Wau	200
	AA	28,925
Total		**223,926**

Source: (UNMISS, 2017)

Water and sanitation provision

Most South Sudanese lack access to safe drinking water and sanitary facilities. The dearth of sewerage systems means that liquid waste, grey water and sludge from kitchens, laundries, toilets and bathrooms generally flow untreated onto open ground or spaces, while there is also widespread defecation in open spaces, bushes and backyards (MOE, 2014). This makes urban populations and people in surrounding villages especially vulnerable to waterborne diseases and epidemics, such as cholera (RSS, 2016b). South Sudan's Ministry of Environment and Forestry deems the single most critical environmental issue related to unclean water supplies is the current incidence of gastrointestinal diseases caused mainly from drinking contaminated water (MOE, 2014).

In 2014, 66.7 per cent of people in urban areas had access to improved drinking water and 16.4 per cent had access to improved sanitation facilities (UN-OHRLLS, 2016) (Table 7). The areas with the highest provision of improved drinking water in 2009 were Lakes, Jonglei and Northern Bahr el Ghazal (Table 8).

Latrine slabs waiting to be installed, Jamam refugee camp.
Photo credit: Oxfam International/Flickr.com/CC BY-NC-ND 2.0

Pumping water. *Photo credit: UN Photo/Tim McKulka*

TABLE 7: PERCENTAGE OF THE POPULATION USING IMPROVED DRINKING WATER AND SANITATION FACILITIES, 2014

Aspect	Population		
	Rural	Urban	Total
Population using improved drinking water sources	56.9	66.7	58.7
Population using improved sanitation facilities	4.5	16.4	6.7

Source: (WHO, 2016)

TABLE 8: PERCENTAGE OF THE POPULATION WITH IMPROVED DRINKING WATER BY STATE, 2009

Locale	Improved source	Not improved source
Upper Nile	35	65
Jonglei	67	33
Unity	54	46
Warrap	52	48
Northern Bahr el Ghazal	66	34
Western Bahr el Ghazal	45	55
Lakes	71	29
Western Equatoria	40	60
Central Equatoria	51	49
Eastern Equatoria	63	37

Source: (NBS, 2012)

Even in the country's cities where socioeconomic levels are generally higher than in rural areas, only a relatively small percentage of the population has access to a filtered water system (Table 9).

TABLE 9: PERCENTAGE OF ALL HOUSEHOLDS USING VARIOUS SOURCES OF DRINKING WATER BY STATE, 2009

Locale	Per cent						
	Water filtering stations with common network/ standpipe (koshk)	Mechanical boreholes with common network/ standpipe (koshk)	Deep boreholes (donkey) without network	Deep boreholes (donkey) with network	Hand pumps	Sand filters with common network stand pipe (koshk)	Shallow wells (dug wells)
South Sudan	2	1	15	3	34	0	16
Urban	6	3	24	4	29	1	7
Rural	1	0	13	3	35	0	18
Upper Nile	9	2	8	3	14	0	1
Jonglei	0	0	27	0	42	0	3
Unity	3	4	5	2	40	1	5
Warrap	0	0	10	4	38	1	31
Northern Bahr el Ghazal	0	0	2	1	63	1	24
Western Bahr el Ghazal	2	0	10	1	29	2	38
Lakes	0	0	4	2	66	0	12
Western Equatoria	0	0	18	4	18	0	44
Central Equatoria	1	2	26	11	11	0	17
Eastern Equatoria	2	0	28	1	33	0	4

Source: (NBS, 2012)

(CONT.) TABLE 9: PERCENTAGE OF ALL HOUSEHOLDS USING VARIOUS SOURCES OF DRINKING WATER BY STATE, 2009

Locale	Per cent						
	Hafeer/Dam without filter (still open water)	Hafeer/Dam with filter (still open water)	Turdal/ fula/ river (still open water)	Running open water source (river, pond, tura'a)	Water vendor (tanker cart bearer) from deep boreholes	Water vendor from shallow wells pond/ river/ spring	Total
South Sudan	2	0	4	18	2	2	100
Urban	0	0	2	15	4	4	100
Rural	2	0	5	19	1	2	100
Upper Nile	2	0	11	43	6	2	100
Jonglei	0	1	11	17	0	0	100
Unity	3	1	6	25	4	2	100
Warrap	3	1	2	9	0	2	100
Northern Bahr el Ghazal	6	0	1	2	0	1	100
Western Bahr el Ghazal	0	0	1	7	7	2	100
Lakes	0	0	3	6	3	3	100
Western Equatoria	0	0	1	12	1	2	100
Central Equatoria	0	0	1	22	1	7	100
Eastern Equatoria	1	0	1	27	0	2	100

Source: (NBS, 2012)

Another environmental health problem in both rural and urban areas is the long distances people have to walk to obtain drinking water. In 2009, only 5% of the population had direct access to drinking water (i.e. 0 minutes), 14% of the population had to walk between 30 to 39 minutes and 19% of the population had to walk for an hour or more to fetch water (Table 10).

TABLE 10: THE TIME TAKEN BY A PERCENTAGE OF THE POPULATION TO WALK ONE WAY TO THE MAIN SOURCE OF DRINKING WATER BY STATE, 2009

Locale	Per cent								
	'0 minutes	1-9	10-19	20-29	30-39	40-49	50-59	60+	Total
South Sudan	5	25	23	8	14	3	2	19	100
Urban	14	28	26	5	14	2	2	10	100
Rural	3	25	22	9	14	4	2	20	100
Upper Nile	8	43	22	5	8	1	1	11	100
Jonglei	3	23	17	11	15	5	6	20	100
Unity	3	28	21	5	12	1	1	29	100
Warrap	7	20	21	9	12	3	1	27	100
Northern Bahr el Ghazal	2	24	34	9	13	4	1	13	100
Western Bahr el Ghazal	14	32	21	4	12		1	15	100
Lakes	1	29	19	9	16	4	2	21	100
Western Equatoria	1	10	23	9	27	7	1	21	100
Central Equatoria	9	21	24	5	20	4	1	18	100
Eastern Equatoria	2	27	27	15	10	4	1	14	100

Source: (NBS, 2012)

Solid waste dumping site in Juba. *Photo credit: Arshad Khan, UN Environment.*

The collection, transportation and final disposal of both solid and liquid waste are inefficient or non-existent in most of South Sudan, since urban planning and waste management have not kept pace with the influx of immigrants and have been hampered by the insecurity of conflict. Towns have also become congested with many people residing in poor and over-crowded shelters where they risk contracting communicable diseases such as tuberculosis (RSS, 2016b).

Table 11 shows that in 2009, half of urban residents had access to a private or shared pit latrine, only 3 per cent used a shared flush toilet and the rest (about 46 per cent) had no toilet facility at all.

TABLE 11: PERCENTAGE OF THE POPULATION BY MAIN TYPE OF TOILET FACILITY BY STATE, 2009

Locale	Pit latrine private	Shared pit latrine	Private flush toilet	Shared flush toilet	Bucket toilet	No toilet facility	Total
South Sudan	13	5	1	0	0	80	100
Urban	37	13	3	0	0	46	100
Rural	9	4	0	0	0	86	100
Upper Nile	8	3	1	1	0	87	100
Jonglei	2	6	0	0	1	91	100
Unity	7	5	0	0	0	89	100
Warrap	4	4	0	1	0	92	100
Northern Bahr el Ghazal	3	1	0	0	0	96	100
Western Bahr el Ghazal	20	8	1	0	0	72	100
Lakes	4	1	0	0	0	94	100
Western Equatoria	64	12	0	0	0	24	100
Central Equatoria	33	11	3	0	0	53	100
Eastern Equatoria	3	7	0	1	0	89	100

Source: (NBS, 2012)

South Sudan is beginning the process of building its municipal services, key amongst them sanitation. In 2009, it was estimated that urban sanitation coverage in South Sudan had increased to approximately 19 per cent, a very low figure, even by African standards. The challenge is even bigger in towns like Juba which are growing at a rapid rate. The exact population numbers for Juba remain contested, but the population was estimated to be 163,000 in 2005 and 500,000 in 2013 (Senkwe, 2014).

Provision of sanitation and other services, however, lags behind this population growth. For example, despite the low coverage numbers, only limited government or donor investments have been made in urban sanitation. In Juba, the only notable investment has been the construction of a wastewater lagoon for discharging septic exhauster trucks. The lagoon which was completed in 2010, was funded under the World Bank managed Multi-Donor Trust Fund (MDTF) and is managed by the Juba County Government. In the meantime, the use of septic tank exhauster trucks has grown significantly within the city of Juba, rising from having no exhauster trucks in the city in 2006 to 80 licensed exhausters in 2012. A sanitation mapping exercise undertaken by Sustainable Water and Sanitation in Africa (SUWASA) in 2013, suggests that over 90 per cent of households rely on onsite sanitation systems and at least 20 per cent of them had used the services of a septic tank exhauster in the preceding 12 months (Senkwe, 2014).

Household sanitation and hygiene practices in Juba

A survey, in 2013, shows that even though over 89 per cent of residents are using pit latrines, there is a small percentage (9.4 per cent) using flushing or pour-flush toilets. In addition, over 42 per cent of pit latrines are lined and can therefore be exhausted or emptied. The high level of emptying pit latrines and septic tanks is enhanced by the fact that the sewer network is almost non-existent (Table 12), with the little which is there being confined to government ministries and ministers' compounds (Senkwe, 2014).

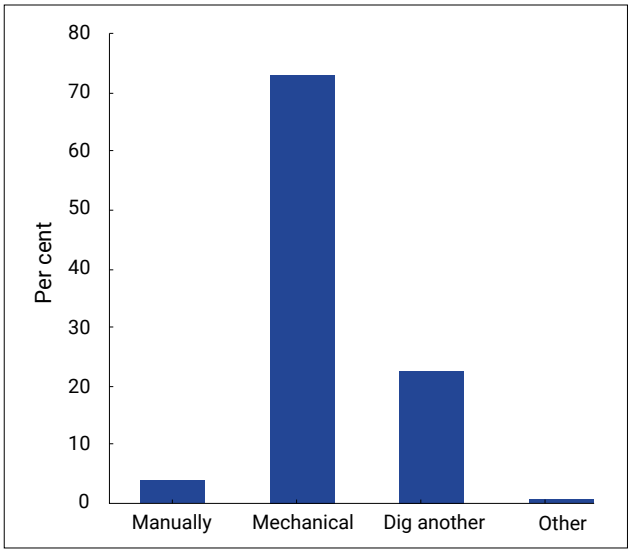
In addition, toilets tend to fill up quickly due to the large household sizes (9.36 people per household) and high level of sharing toilets (44.2 per cent of households share a toilet with 37 people using 1 toilet), and the Islamic influence which means that most people use water for cleansing. Mechanical exhausting is therefore widely practiced by those with septic tanks and lined pit latrines, and costs a reported average of 229 South Sudanese Pounds (approximately US$51). For instance, 20 per cent of the respondents had exhausted their toilets in the last 12 months (17.7 per cent of people with pit latrines, 25 per cent of those with composting toilets and 48.1 per cent of those with pour-flush toilets). It is actually worth noting that amongst

TABLE 12: SEPTAGE MANAGEMENT BY TOILET TYPE, 2013

Description	Frequency	Percent
Piped sewerage	4	0.5
Septic tank	22	2.7
Concrete or other lining	304	37.3
Pit latrine/unlined pit	477	58.5
Don't know	12	1.5
Total	**816**	**100**

Source: (Senkwe, 2014)

FIGURE 6: METHODS OF TOILET EXHAUSTION IN JUBA



Source: (Senkwe, 2014)

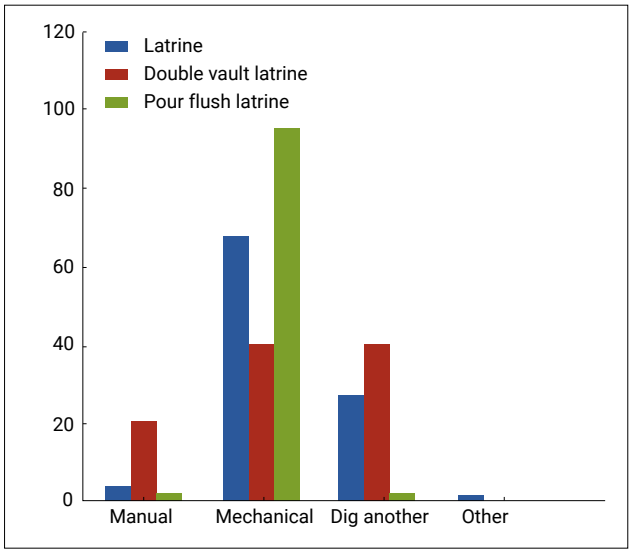
those who answered the question on exhausting the toilet, the majority (72.9 per cent) had used a mechanical exhauster, whilst only 3.75 per cent exhausted manually (Figure 6) (Senkwe, 2014).

Whilst this result is positive, it also points to the need for concerted effort to get households to construct their latrines properly so that they can be emptied. As would have been expected, the pour flush toilets had the highest level of use of mechanical exhausters (95.6 per cent) (see Figure 7) (Senkwe, 2014).

It is, however, worth noting that mechanical exhaustion among the pit latrines was relatively high at 68 per cent. The fact that over a quarter of respondents with pit latrines reported digging a new pit is also worth noting. Aside from the households, the potential for mechanical exhausting is enhanced by presence and growth in the number of commercial properties including hotels, shops, offices and government departments (Senkwe, 2014).

There are a number of challenges and ways forward on both the demand and supply side of Faecal Sludge Management in Juba and the key ones are summarised below (Senkwe, 2014).

FIGURE 7: METHOD OF EXHAUSTION BY TOILET TYPE



Source: (Senkwe, 2014)

TABLE 13: SEPTAGE MANAGEMENT BY TOILET TYPE, 2013

Challenges	
Demand side	**Supply side**
• Poorly constructed latrines • Large family sizes • Poor hygiene behaviors • High costs of private exhaustion services	• Multiple public agencies • Dominance of foreign owners • Apparent over-supply of tankers • Inadequate functionality of lagoon • Poor health and safety practices • Limited access to spare parts • Limited participation of women
Way forward	
Demand side	**Supply side**
• Increase capacity building for latrine construction • Increase hygiene promotion	• Support streamlining roles of public agencies • Increase analysis and improvement of technical functionality of lagoon • Increase capacity building for health and safety • Increase capacity building for private exhauster business • Increase spare parts supply chain • Encourage local and female participation

Source: (Senkwe, 2014)

8.3 Pressures and impacts

Conversion of land use

The United Nations observes that urbanisation "can lead to economic growth, transformation, and poverty reduction. Alternatively, it can lead to increased inequality, urban poverty, and the proliferation of slums" (UNDESA, 2016). In 2014, the Ministry of the Environment of South Sudan reported that "massive rural-urban migration and urbanization has been accompanied by major environmental damage, particularly in areas with fragile ecosystems. Irreversible impacts on the environment, e.g. deforestation, water pollution and poor sanitation, are related to large concentrations of people in the urban centres due to the creation of informal settlements" (MOE, 2014).

One of the impacts of rapid and un-managed urban growth is the loss of green spaces. Poor urban planning has meant that large areas in most towns and municipalities have been gazetted for predominantly residential purposes with little or no space protected as parks and public recreational spaces (MOE, 2014). This no doubt has also meant the loss of wildlife habitat and biodiversity and of the ecosystem services provided by vegetation cover, such as erosion control, water capture, air and water purification and urban air cooling.

Expansion of Torit

Torit Footprint, 2005

Torit Footprint, 2016

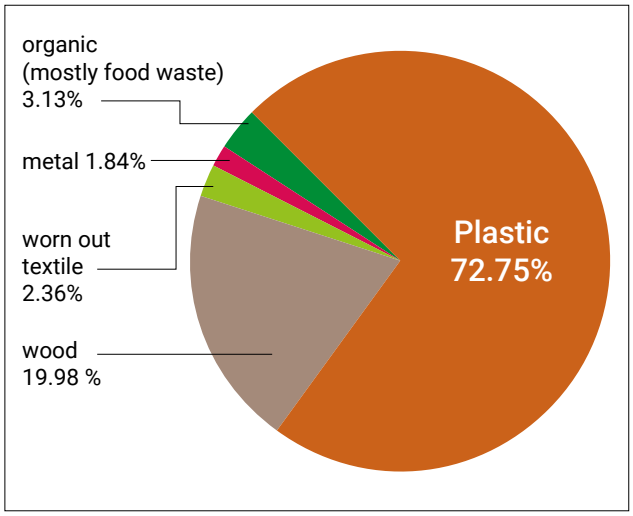
Significant expansion of the Torit urban footprint between 2005 to 2016. *(Source: Landsat data from United States Geological Survey)*
Green colour generally represents vegetation, brown: sparse vegetation, bare ground, fields or human settlementsand dark blue: water.

Solid waste generation and disposal

High population densities in urban centres, and the lack of policies and effective solid waste management infrastructures in South Sudan has led to municipal waste becoming a major environmental problem (MOE, 2014). Research published in 2014 on municipal solid waste in Juba reported that the city's population generated a total of about 667.5 tonnes/day of household municipal solid waste, which breaks down to a daily per capita amount of 0.38 kg (Loboka, Shihua, Jianxiong, Celestino, & Lukaw, 2014). Figure 8 shows that plastic dominates the waste stream.

The study found that Juba's waste management units and private companies picked up and disposed of only 22 per cent and 9 per cent of the waste, respectively; householders randomly disposed of 69 per cent of the waste themselves (Loboka, Shihua, Jianxiong, Celestino, & Lukaw, 2014). Government data from 2009 showed that 55 per cent of the urban population burned its waste (Table 14) (NBS, 2012). In addition to

FIGURE 8: SOURCES OF JUBA'S SOLID WASTE, PERCENTAGE, 2014



Source: (Loboka, Shihua, Jianxiong, Celestino, & Lukaw, 2014)

Waste dumping along a canal in Juba Town.
Photo credit: Ministry of Environment and Forestry

the low collection rates, limitations in managing solid waste in South Sudan include the lack of waste categorisation and segregation systems for non-degradable and biodegradable or organic waste, and incompetent and unqualified personnel (MOE, 2014).

The 2014 study found that much of the waste was illegally dumped along river banks or in stream beds, especially at night, or was burned in the open air on roadsides and in other vacant spaces (Loboka, Shihua, Jianxiong, Celestino, & Lukaw, 2014). The Ministry of Environment and Forestry of South Sudan reports that "littering, mainly of plastic shopping bags and water bottles, is a pervasive and unaesthetic environmental problem across most towns of South Sudan" (MOE, 2014).

In addition to improper household waste disposal, commercial centres and markets usually leave most of their biodegradable or organic waste to decompose onsite, creating a stench and causing a serious health risk to local residents, and to those scavenging for food and other reusable materials. As well, public hospitals and private health clinics in urban centres like Juba do not manage the disposal of septic and pharmaceutical wastes (MOE, 2014).

Unsegregated and untreated solid waste in the environment has dangerous impacts for human and ecosystem health, since it contaminates the water people use for household purposes, promotes the proliferation of pathogens, vectors (such as flies and rodents) and foul odours, and pollutes the soil and wildlife habitat, while smoke from burning waste causes air pollution that results in respiratory illnesses among the population (MOE, 2014); (Loboka, Shihua, Jianxiong, Celestino, & Lukaw, 2014).

TABLE 14: PERCENTAGE OF THE POPULATION USING VARIOUS MEANS OF SOLID WASTE DISPOSAL BY STATE, 2009

Locale	Skip bin open	Skip bin closed	Pit	Heap	Burning	Other	Total
South Sudan	4	1	7	17	46	25	100
Urban	3	2	12	17	55	11	100
Rural	4	0	6	17	45	28	100
Upper Nile	1	2	0	8	55	33	100
Jonglei	3	0	4	6	64	23	100
Unity	0	0	2	15	65	18	100
Warrap	6	1	1	5	42	45	100
Northern Bahr el Ghazal	12	0	4	19	13	52	100
Western Bahr el Ghazal	10	0	1	16	58	14	100
Lakes	4	0	7	30	58	1	100
Western Equatoria	2	2	26	52	12	7	100
Central Equatoria	1	0	19	19	47	13	100
Eastern Equatoria	4	0	7	17	50	22	100

Source: (NBS, 2012)

Environmental impacts of refugee camps

Refugee camps are often developed rapidly to address immediate, short-term crises. However, the average length of displacement is now close to twenty years (Yossinger, n.d.). The long-term presence of such camps in arid and semi-arid environments pose significant environmental threats to camp residents, their hosts and to ecosystem services, including deforestation, soil erosion, and the depletion and pollution of water resources (UNHCR, 2001).

Deforestation affects both refugees and resident communities in the vicinity. As wood supplies gathered from the area are gradually depleted, women (and children) from refugee camps are forced to walk further afield, making them vulnerable to physical assault. Likewise, materials from the local environment for building homes and making fires that are normally available to the host community become increasingly depleted, which creates shortages and increases costs, often causing tension between the two communities (Shepherd, 1995). The loss of vegetation leads to habitat and biodiversity loss and can cause soil erosion that may lead to land degradation and eventually to desertification. These impacts increase the risk of wet-season flooding and decrease dry-season water availability, further straining already stressed water supplies (Yossinger, n.d.). In camps with high population densities, poor hygiene and sanitation, and the lack of proper management of animal, medical and human waste affects water quality and heightens the risk that infectious diseases will multiply rapidly (Shepherd, 1995).

Some aid agencies attempt to prevent these environmental impacts. For example, in 2017, the United Nations High Commissioner for Refugees and partners distributed seeds and agricultural tools to some 5,000 refugee families in the Ajuong Thok camp and provided them and their host communities with 5,360 tree seedlings. In addition, in January of that year, it distributed a total of 1,857 Fuel Efficient Stoves, which reduce the frequency of firewood collection and its associated environmental degradation, as well as improving indoor air quality (UNHCR, 2017a); (UNHCR, 2017b).

Camp for the displaced in Wau.
Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0

Air pollution

According to WHO (2016), in 2012, household air pollution from cooking with unclean fuels or inefficient technologies caused 4.3 million deaths globally. Ambient (or outdoor) air pollution from traffic, industrial sources, waste burning or residential fuel combustion, caused 3.0 million deaths during the same year. Together, air pollution caused an estimated 6.5 million deaths, or 11.6 per cent of all global deaths in 2012, making it the largest single environmental health risk.

In the urban areas of South Sudan, there is relatively little air pollution because vehicle numbers are still low and there is no heavy industry that emits polluting fumes. The most significant environmental impact of transportation is likely to be unregulated vehicle emissions that can cause respiratory illnesses in humans. There are currently no data on these emissions. Other threats include oil and petrol leaks, and runoff from parking lots and roads that enter water courses.

Almost all households in both urban and rural areas in South Sudan use solid fuels for cooking, however, and the smoke from these indoor fires contains tiny particulates. Women and children are exposed to these airborne pollutants and risk contracting pneumonia (Abd-Elfarag & Langoya, 2016). According to a WHO analysis, the mortality rate due to environmental pollution in South Sudan is higher than in the rest of Africa (Table 15) (WHO, 2016).

Cooking with charcoal in Juba. *Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0*

TABLE 15: SOUTH SUDAN MORTALITY RATES FROM ENVIRONMENTAL POLLUTION, 2012

Region	Mortality rate attributed to exposure to unsafe WASH services (per 100 000 population)	Mortality rate from unintentional poisoning (per 100 000 population)	Both Sexes	
			Mortality rate attributed to household and ambient air pollution (per 100 000 population)	Age-standardized mortality rate attributed to household and ambient air pollution (per 100 000 population)
South Sudan	50	6.9	95.1	132.5
Africa	43.1	3.8	80.1	127.1
Global	12.4	2.7	92.4	110.1

Note: WASH = Water, Sanitation and Hygiene. *Source: (WHO, 2016)*

The environmental impacts of conflict in urban areas

Conflict in South Sudan's urban areas has exerted numerous pressures on the local natural environment. For example, toward the end of 2013 and the beginning of 2014, there was widespread fighting and violence in the town of Mayom in the former Upper Nile State (IRNA, 2014). The majority of the town had been destroyed primarily by fire. A total of 1,801 burned or otherwise destroyed structures were identified throughout the town centre as well as in outlying areas surrounding Mayom (UNOSAT, 2014).

As a result, water provision ceased and people were forced to drink river water with its threat of contamination from corpses on the riverbank. A Rapid Needs Assessment concluded that "In the current context of food insecurity, lack of access to safe drinking water, and decreased hygiene and sanitation, the likelihood of disease outbreak has increased exponentially" (IRNA, 2014).

Another example is the use of deforestation as a war strategy, a tactic that has been observed around former army garrison towns to remove vegetation that obstructs the ability to see the opposing forces from a safe distance (RSS, 2016b).

8.4 Response

The draft Vision 2040 document (RSS, 2016b) recognises the major environmental challenges facing urban areas in the country. Its goal is to "ensure balanced, integrated, equitable and sustainable rural development by taking towns to the people and to avert the urban-biased development". It identifies the following actions to achieve the goal:

- Develop urban physical plans in all States
- Facilitate development of decent and affordable homes
- Establish recreational facilities to enhance the well-being of the citizens
- Provide access to safe drinking water
- Improve sanitation and hygiene.

The government has introduced policy responses in the form of land and housing policies in the urban sector, an electricity policy in the energy sector and a housing policy in the infrastructure sector (RSS, 2016a).

To address the challenges of rapid urban growth in Juba City and the environmental impacts described above, the municipal government prepared a Juba City Sanitation Reform and Investment Plan, which lays out an integrated strategic approach for dealing with sanitation issues. It describes the challenges related to containing, transporting, treating and disposing of faecal waste in Juba and discusses the related institutional and financial challenges. The plan describes interventions for the short, medium and long term (2015-2020; 2021-2025; 2026-2030) aimed at increasing sanitation access to 85 percent of the city's population by 2030. It also aims to introduce effective management and regulation of private exhauster tankers, complete the Roton Wastewater Lagoon, improve operations and maintenance, and gradually introduce a sewer system in the city (JCC, 2015).

8.5 Conclusion

South Sudan is less urbanised than most other African countries. Less than 20 per cent of its population lives in urban areas, compared to the African average of 50 per cent. Urban areas are growing rapidly however, due to both natural increase (South Sudan has a high fertility rate of 5 births per woman) and the influx of refugees, IDPs, immigrants and returnees to urban settlements. Between 2010 and 2015, the rate of urbanisation was 5.05 per cent annually. By 2050, about 8.4 million people will be housed in the country's urban areas.

Juba is by far the largest city in the country and one of the world's fastest growing cities. Between 2002 and 2012, its urban footprint grew five-fold. Malakal, the second-largest city, is just over half the size of Juba.

In addition to cities and towns, large and dense populations live in refugee camps. In early 2017, there were 260,868 refugees in South Sudan and the country was the site of Africa's largest refugee crisis.

One of the main urban environmental issues in the country is the low level of access to improved drinking water and sanitation. In 2014, 66.7 per cent of people in urban areas had access to improved drinking water and only 16.4 per cent had access to improved sanitation facilities. The lack of proper sewage systems and water treatment means human waste contaminates the water people use for household purposes, leading to the risk of water-borne illnesses such as cholera. In addition, because of poor or absent municipal waste collection, households dispose of their waste, much of which is composed of plastics, in unsightly informal dumps on roadsides and in other public spaces. At least half of the urban waste is burned, resulting in the proliferation of pathogens, vectors (flies, rodents), foul odours, soil pollution, the destruction of wildlife habitat, and air pollution that results in respiratory illnesses among the population. The lands around refugee camps are often subject to deforestation, soil erosion, and the depletion and pollution of water resources. The mortality rate due to environmental pollution in South Sudan is higher than in the rest of Africa.

Unplanned urban expansion, as well as an increasing rural-urban migration and lack of investments in infrastructure building are some of the most pressing issues in South Sudan. There is a dire need for urban planning and the management of water, sanitation and municipal waste. Large investments are needed to strengthen the human and operational capacities of government ministries and municipal-level departments to implement the actions stipulated in the draft Vision 2040.

Organised efficiently, urban areas can be engines of economic growth. But poorly-planned urbanisation can have serious long-term consequences, including water shortages, air pollution, traffic congestion and disease outbreaks. In the coming years, South Sudan would do well to invoke the concept of Smart Cities, which enhance liveability, workability and sustainability. Furthermore, citizens need to be involved in the city design, so that policies address real needs and are socially inclusive.

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Charcoal and firewood sale on roadside near Torit.
Photo credit: Arshad Khan, UN Environment.

CHAPTER 9
ENERGY

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9.1 Introduction

Energy is one of the most important sectors of any country's economy, providing power to support economic development and human wellbeing. Since independence in 2011, the Government of South Sudan has taken steps to prepare for sustained economic growth. As a very young country, there are massive opportunities for growth in all sectors, especially in industry and public infrastructure services, such as education, health and water. Developments in these areas all require an affordable and reliable electricity supply.

South Sudan has abundant energy resources, many of them unexploited except for oil, which accounts for almost all of its exports and for around 80 per cent of the Gross Domestic Product (GDP); this makes South Sudan the most oil dependent country in the world. Oil revenues provided 98 per cent of the country's national budget in 2011. Prior to independence, South Sudan produced nearly 80 per cent of the whole Sudanese (Republic of Sudan and South Sudan) oil output (Risk Watchdog, 2011). The literature forecasts that South Sudan's oil reserves will decrease because of the natural decline in mature fields. If new production comes on-stream, there is no guarantee that the volumes will be large enough to offset declines. Current reserves are projected to last only until 2035 (World Bank, 2017b); (Harding, 2012). Given this scenario, the government of South Sudan needs to strategically consider other primary energy sources with which to generate electricity.

Although South Sudan is known for its oil reserves, numerous renewable energy sources are available, including solar, wind, hydro and geothermal. Renewable sources of energy can easily be regenerated through natural, physical or chemical processes. Oil takes millions of years for the earth's processes to create, and because it can be depleted, it is a non-renewable energy source.

Population growth and aspirations for economic growth and development are the chief drivers of energy demand. Given the country's low level of development, however, biomass is the chief source of fuel for domestic purposes with 96 per cent of the population using some form of biomass for cooking (NBS, 2012). This over dependence on biomass for fuel places enormous pressure on the country's forest and woodland resources. Wood can be considered renewable since woody vegetation can regenerate within a human life span, but to be sustainable, stocks need to be constantly replenished by replanting.

In South Sudan, electricity, a secondary energy source, is primarily generated from thermal sources. Electricity is a much more efficient and cleaner form of energy than oil, which is the primary energy source currently utilised. Electricity use is extremely low; in 2015, final consumption of electricity was 16 ktoe and total electricity generated was 28 tonnes of oil equivalent (ktoe). Of this, about 94 per cent (26 ktoe) was generated from fossil fuels while 2 ktoe was generated from hydro sources (AFREC, 2015).

9.2 Status and Trends

Key energy indicators

Energy statistics for South Sudan basically start in 2012 (Table 1), since before independence in 2011, all data was integrated with that of the current Republic of Sudan. In 2014, the total primary energy supply amounted to 700 ktoe and was dominated by oil (72.2 per cent), with 194 ktoe from biofuels and waste, and 15 ktoe from crude oil (IEA, Various). South Sudan is a net exporter of energy. Total petroleum exports amounted to 7,900 ktoe in 2014; imports of oil products were only 530 ktoe. All the country's needed oil products are currently imported as there are no working refineries. However, two oil refineries – one in Bentiu in Unity with a refining capability of 3,000 barrels of oil per day, and the other in Thiangrial in Upper Nile – are planned and should make the country less reliant on imported oil products.

TABLE 1: KEY ENERGY STATISTICS, 2012-2014

Year	Population (million)	GDP (billion 2005 US$)	Energy production (ktoe)	Net imports (ktoe)	TPES (ktoe)	TPES/GDP (toe/thousand 2010 US$)	Electricity consumption (TWh)	CO_2 emissions Mt of CO_2	Electricity consumption/ pop (MWh/ capita)
2012	10.98	5.20	1,770	-1,090	640	0.12	0.42	1.44	0.04
2013	11.30	10.95	5,230	-4,510	680	0.12	0.45	1.47	0.04
2014	11.91	6.08	8,110	-7,370	700	0.12	0.46	1.52	0.04

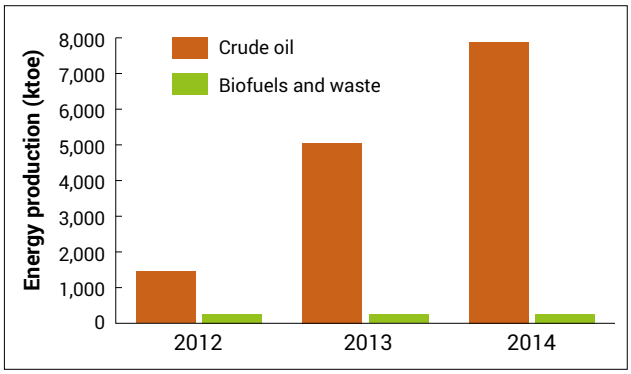
Source: (IEA, Various)

Energy production and consumption

The total primary energy supply of South Sudan in 2014 was 700 ktoe, up from 644 and 677 ktoe in 2012 and 2013, respectively. Figure 1 shows the share of primary energy. Most of the energy in South Sudan is produced from oil and its dependence on oil for energy has been increasing. In 2012, total energy from crude oil was 1,578 ktoe, with 193 ktoe from biofuels and waste, increasing to 5,043 in 2013 and 7,915 in 2014 (IEA, Various).

The total final consumption or end use energy has been fluctuating over the last three years. It was 542 ktoe in 2012, decreasing to 526 ktoe in 2013. In 2014, total final consumption was 543 ktoe, with 345 ktoe from oil products, 162 from biofuels and waste, and 37 ktoe from electricity. In 2014, a total of 488 GWh of electricity was produced. Of this, 486 GWh was produced from oil and 2 GWh from solar energy. It is expected that electricity will continue to be the single largest use of energy in South Sudan for years to come.

FIGURE 1: ENERGY PRODUCTION IN SOUTH SUDAN, 2012-2014



Source: (IEA, Various)

TABLE 2: TOTAL ENERGY STATISTICS (KTOE), 2011-2015

- Data not applicable, 0 Data not available, (P) Projected

Category	2011	2012	2013	2014 (P)	2015 (P)
Production of coking coal	-	-	-	-	-
Production of charcoal	7	8	8	8	8
Production of crude oil, NLG and additives	16,343	0	12,234	11,011	11,378
Production of natural gas	-	-	-	-	-
Production of electricity from biofuels and waste	-	-	-	-	-
Production of electricity from fossil fuels	14	15	21	24	26
Production of nuclear electricity	-	-	-	-	-
Production of hydro electricity	1	2	2	2	2
Production of geothermal electricity	-	-	-	-	-
Production of electricity from solar, wind, Etc.	-	-	-	-	-
Total production of electricity	15	17	23	26	28
Refinery output of oil products	-	-	-	-	-
Final Consumption of coking coal	-	-	-	-	-
Final consumption of oil	329	364	355	353	355
Final consumption of natural gas	-	-	-	-	-
Final consumption of electricity	15	17	16	16	16
Consumption of oil in industry	0	6	0	0	0
Consumption of natural gas in industry	-	-	-	-	-
Consumption of electricity in industry	-	-	-	-	-
Consumption of coking coal in industry	-	-	-	-	-
Consumption of oil in transport	313	336	336	326	328
Consumption of electricity in transport	-	-	-	-	-
Net imports of coking coal	-	-	-	-	-
Net imports of crude oil, NGL, Etc.	-16,315	0	-3,255	0	0
Net imports of oil product	419	466	493	453	456
Net imports of natural gas	-	-	-	-	-
Net imports of electricity	-	-	-	-	-

Current and potential energy sources

This section provides information on the status and trends in the country's primary available energy resources.

Biomass

There are huge biomass resources in the country, including forests, animal wastes, agricultural residues and sugar cane, with a total energy content of about 32 million GJ, as shown in Table 3. Biomass is used by the majority of South Sudanese for their energy needs. Virtually everyone (99 per cent of the population) uses biomass for cooking, in the form of firewood, charcoal and grass (NBS, 2012). Biomass also provides energy for household lighting needs, with 50 per cent of the population using some form of biomass to light their homes — 35 per cent using firewood and 15 per cent using grass.

According to the 2009 National Baseline Survey (NBS, 2012), 0.2 per cent of the population uses animal dung for cooking. Although biogas is not an important energy source, there are efforts to introduce it because of the huge availability of animal dung or waste. The country has the 6th largest livestock resources in Africa, with just over 36 million cattle, goats and sheep that produce about 4.5 million tonnes of animal waste or dung per year that can be used raw as a fuel (UNDP and MED, 2013). Pilot studies of dung use have been successful and there is much potential for scaling up. For example, the United Nations Children's Fund/ Operation Lifeline Sudan (UNICEF/OLS) supported a biogas pilot project that was installed at Rumbek Secondary School in 2001 (UNDP and MED, 2013).

TABLE 3: SOURCES OF BIOMASS ENERGY AVAILABLE IN SOUTH SUDAN

Stream	Quantity	Unit	Energy content (GJ)
Forestry resources	1,332,953	M^3	17,137,967
Agricultural residues	1,464	Tonne	14,460
Animal waste	290,599	Tonne	4,649,584
Bagasse	197,875	Tonne	1,978,750
Urban waste	568,911	Tonne	9,102,586
Total	**-**	**-**	**32,883,527**

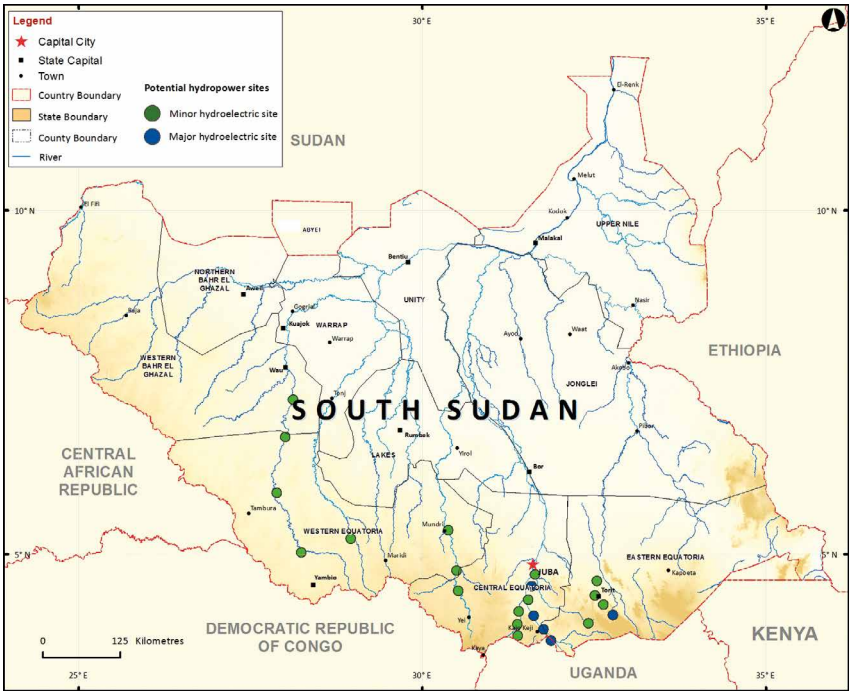
Source: (Whiting, Amogpai, & Carmona, 2015)

Hydropower

The future of the country's electricity generation could be dominated by hydropower, since it has the capacity for up to 5,583 MW. Around 28 per cent of the Nile's water flows through South Sudan. Figure 2 shows where most of the country's hydropower potential is located (Liu, Masera, & Esser, 2013).

Some of the greatest potential is located along the Bahr el Jebel, the section of the Nile River between Nimule and Malakal, including at the following sites: Fula (1,080 MW), Bedden (720 MW), Lekki (420 MW), Shukoli (250 MW) and Juba barrage (120 MW) (Figure 3). These barrage sites have all passed the feasibility study and Environment Impact Assessment

FIGURE 2: LOCATION OF POTENTIAL HYDROPOWER SITES IN SOUTH SUDAN



Source: (AfDB, 2013)

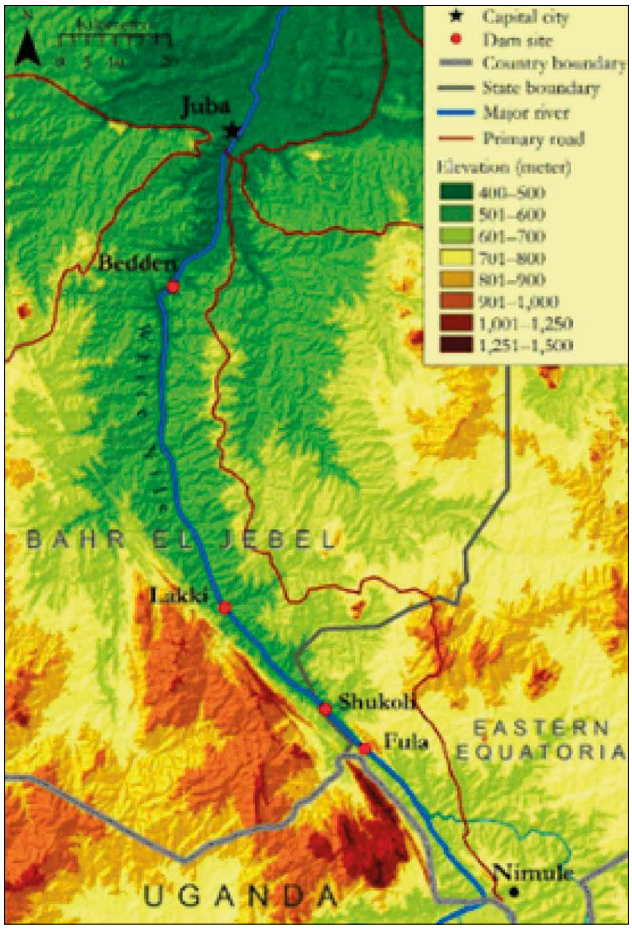
(EIA) stages of development planning. There are also 18 minor hydropower plant sites with the potential for generating between 2 and 40 MW per plant; some of these have been identified for development in the short-term (ROSS, 2013b). The Fula small hydropower plant, designed to supply Juba, will generate between 40 and 60 MW once it is completed (AfDB, 2013). Others include Sue (12-15 MW) in Western Bahr el Ghazal and Kinyeti (5 MW) in Eastern Equatoria (Liu, Masera, & Esser, 2013).

Oil and natural gas

South Sudan has the third largest oil reserves in Africa, estimated at 472 million tonnes after Nigeria (5,002.7 Mt) and Angola (1,709.4 Mt) (WEC, 2017). In 2014, the proven oil reserves were estimated at 3.5 billion barrels with an annual production of about 220,000 BBL/day (WEC, 2017). South Sudan's oil industry is constrained by the fact that the refining capacity, oil pipeline and export infrastructure are in the north, far from the reserves themselves. The oil pipelines extend from the oil fields to Port Sudan.

Most of the oil producing blocks are located in Unity and Upper Nile areas and include Blocks 3 and 7 (Dar blend); to a lesser extent, Block 6 (Fula crude) and block 5A (Thar Jath crude). Blocks 1, 2 and 4 (Nile blend) are split between South Sudan and Sudan as they cover part of the border and the disputed Abyei region, as shown in Figure 4 (AfDB, 2013).

FIGURE 3: LOCATION OF SOME OF THE LARGER HYDROPOWER DAM SITES ON THE BAHR EL JEBEL

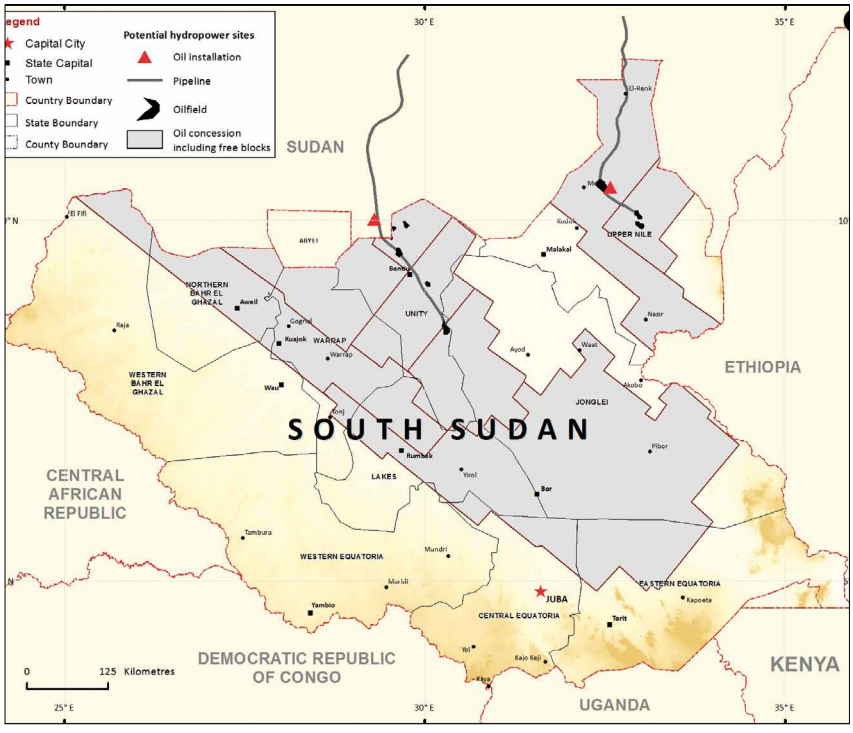


Source: (AfDB, 2013)

The natural gas industry is underdeveloped. Any that is produced along with the oil is flared or re-injected (WEC, 2017), even though the Petroleum Act 2012 in Article 35(2) does not allow flaring or venting of gas.

Oil plays a major role in the economy, representing 98 per cent of its total revenues and 60 per cent of GDP (WEC, 2017). In early 2012, South Sudan lost around 95 per cent of government revenue due to the shutdown of oil production because of a dispute with Sudan over transhipment fees. This had a negative impact on GDP, which declined by 55 per cent in 2012. Oil production resumed in March 2013, but only to an output level of between 150,000 - 200,000 barrels per day compared to earlier production figures of 350,000 barrels a day.

FIGURE 4: KEY OIL INFRASTRUCTURE OF SOUTH SUDAN, INCLUDING THE DISPUTED ABYEI REGION



Source: (James, 2015)

Wind
Wind power density ranges between 285 and 380 W/m^2. Wind power generation is not developed but it is a key growth industry and already some private investors are using wind for rural electrification (REEEP, 2013). The government plans to invest in exploiting wind potential to provide clean energy.

Geothermal
The geographical location of South Sudan in the East African rift region indicates the possibility of geothermal energy resources. A thorough assessment is required to ascertain the availability and viability of the geothermal resource, if any. South Sudan is collaborating with the Geothermal Development Company of Kenya to undertake this assessment (REEEP, 2013).

Solar
According to the International Energy Agency, solar power provides about 2 ktoe of energy (IEA, Various). Located on the tropics, there are at least 8 hours of sunshine per day and the country's potential is estimated at 436 W/m^2/year. This could be used in facilitating a rural electrification programme, especially at the domestic level, for lighting, charging mobile phones and powering radios. Already 45,000 households use some form of solar-derived energy service (REEEP, 2013).

There are plans to increase the use of the country's high potential for solar energy to meet energy demand. For instance, with support from the United Nations Development Programme, the local government in Aweil (north-western South Sudan) is using solar energy to power local government offices.

Electricity supply

The electricity network is made up of three decentralised generation plants, each with a localised distribution network, serving Juba (Equatoria region) and the regional capitals of Malakal (Greater Upper Nile region) and Wau (Bahr el Ghazal region).

Electric power capacity versus demand
The formal energy sector is limited to only the South Sudan Electricity Corporation, which is in charge of generation, transmission and sale of electricity to distributors. The South Sudan Electricity Corporation currently operates in Juba, Malakal, Wau and Renk, and has eight diesel generators with a capacity of 1.5 MW each (Liu, Masera, & Esser, 2013). Some 15,000 consumers had access to an electricity network in 2010. Of these, 10,000 consumers (66.7 per cent) are located in Juba (World Bank, 2014); (AfDB, 2013).

In 2010, the total installed operational electric power generation capacity was estimated at 23.8 MW and in 2012, it was 26.8 MW. Demand for electricity greatly outstrips supply, however, with the total electric power required by South Sudan estimated at 450 MW. Since independence in 2011, the demand for electricity has been on a steady upward trajectory in tandem with increasing economic opportunities and population growth (Liu, Masera, & Esser, 2013). Electric power is divided amongst six towns: in 2010, Juba received 12 MW but had an average demand of 32 MW, rising to at least 80 MW in 2012; in 2010, Malakal had a total installed capacity of 4.8 MW while demand was estimated at 15 MW, which rose to about 30 MW by 2012. In 2010, capacity in Wau was 4 MW, and it was 2 MW in Bor, Rumbek and Yambio (AfDB, 2013); (Liu, Masera, & Esser, 2013). Renk Town is supplied through an interconnection agreement with neighbouring Sudan to import up to 32 MW, although only 3 MW is imported due to inadequate demand (AfDB, 2013). In the coming decades, a growing population and industrial development will increase the demand for electricity, which is expected to rise to over 1,400 MW by 2030 (Liu, Masera, & Esser, 2013); (ROSS, 2013b).

Electricity consumption

The undeveloped state of energy infrastructure in South Sudan means that the country has the lowest electricity consumption per capita in sub-Saharan Africa. In 2012 electricity consumption was 38.2 kWh per capita compared to the sub-Saharan average of 496.4 kWh per capita, as shown in Table 4 (World Bank, 2016). By 2012, only 12.3 per cent of urban areas in South Sudan were electrified and only 3.5 per cent of rural areas had electricity.

Meeting this demand will require expanding the installed generation capacity significantly and making extensive expansions and upgrades to the power grid. The Infrastructure Action Plan envisages an electrification rate of 20 per cent by 2025, up from the current 5 per cent in 2011 (AfDB, 2013). However, at this rate, 11.33 million people are still expected to be without access to electricity by 2025.This will result in a complex and persistent electricity gap, which refers to both the supply-demand mismatch in grid-connected regions and the lack of access in off-grid regions. Closing this electricity gap is a challenge with important implications for how to frame the country's energy problem as a whole. There are opportunities to fill the electricity gap using renewable energy options based on wind, geothermal, hydropower and solar technologies and to use responsive and efficient demand management strategies.

TABLE 4: A COMPARISON OF ELECTRIFICATION STATISTICS FOR SOUTH SUDAN AND NEIGHBOURING COUNTRIES

Country	Access to electricity (% of population)			Electric power consumption (kWh per capita)	
	National	Urban	Rural	2012	2013
Central African Republic	10.8	14.9	8.2	-	-
Sudan	32.6	62.1	17.8	156.9	158.7
Uganda	18.2	71.2	8.1	-	-
Kenya	23.0	58.2	6.7	156.8	167.7
Democratic Republic of Congo	16.4	36.3	5.8	104.8	110.0
Ethiopia	26.6	100.0	7.6	57.5	64.6
South Sudan	**5.1**	**12.3**	**3.5**	**38.2**	**38.9**
Sub-Saharan Africa (excluding high income countries)	35.3	71.6	15.3	496.4	488.1

Source: (World Bank, 2016)

Challenges facing the electricity sector

The long running civil war, and internal conflict and continuing instability since 2013, as well as poor infrastructure and a lack of technical, financial and human resources capacity, especially at the South Sudan Electricity Corporation, have been major factors limiting the country's electrification and hindering achievements of some health, education and other social development goals. Current electricity demand cannot be met through the country's existing power generation and distribution system (World Bank, 2014).

South Sudan is a large country with most (83 per cent) of the population living in rural areas, scattered in communities separated by hundreds of kilometres, with a resulting low population density of about 20.8 people/km2 in 2016 (UNSD, 2017). Scattered populations present challenges for infrastructure design and service provision, which is more costly to deliver over large distances to small numbers of people.

The facilities for transporting electrical energy are highly inadequate. Without expanding the current transmission system, it will be impossible to address the current energy supply constraints. The infrastructure is also aging, there is a lack of spare parts and facilities are inadequately maintained. As a result, many of the generation plants are out of order and the existing infrastructure is unreliable, leading to high transmission losses, with estimates up to 25 per cent. However, there are plans to reduce this to 12 per cent by 2025 (AfDB, 2013).

The electricity distribution networks have supply constraints, and blackouts and load shedding is common. For instance, Juba International Airport is only operational 10 hours a day (8:00-18:00) due to erratic power supply, among other causes. As a result of outages, households and businesses that need and can afford electricity commonly use costly and noisy

generators. In 2014, it was estimated that business establishments experienced an average of 1.5 power outages in a typical month, which translated into sale losses of 13.6 per cent (World Bank, 2016).

The country's dependence on thermal electricity also creates problems of supply and price variability, resulting in economic losses for consumers, especially during times of high insecurity or global price fluctuations when prices may be pushed up. The disparities between cost of generation (US$0.70/kWh), system losses, tariff costs (US$0.25) and low bill collection rates (40-50 per cent) pose a heavy burden. Each kWh of electricity is subsidised by US$0.54, which translates into an electricity subsidy that is 4 per cent of the government budget (World Bank, 2013). Table 5 shows recent data on electricity tariffs within the region (World Bank, 2017a).

It is difficult for local companies to invest in this sector due to the huge investments and long gestation times required to recoup their capital. The government needs to systematically plan for and invest in the power sector. Without this, the industrialisation and modernisation they require to build a strong economy will be impossible. There is a need for legal, policy and institutional reforms, capacity building, off-grid expansion and improvements in energy efficiency, all of which are core to improving the financial viability and general sustainability of the sector.

TABLE 5: **COST OF ELECTRICITY IN SOUTH SUDAN AND ITS NEIGHBOURS**

Country	Cost (US cents/kWh)	Name of utility
South Sudan	**38.8**	**South Sudan Electricity Corporation**
Kenya	17.6	Kenya Power and Lighting Co. Ltd
Central African Republic	11.0	Enerca
Ethiopia	4.4	Ethiopian Electric Utility
Uganda	22.7	Umeme
DRC	11.5	Société Nationale d'Electricité (SNEL)
Sudan	5.1	Sudanese Electricity Distribution Company (SEDC)

Source: (World Bank, 2017a)

9.3 Pressures and Impacts

The development of energy is a major source of environmental pollution, through emissions to the atmosphere and habitat destruction to build infrastructure, all leading to the loss of livelihoods and settlements, and associated health and safety concerns.

Emissions from the energy sector

Emissions occur mainly from electricity generation, the combustion of traditional fuels and the transport sector. Although South Sudan's total greenhouse gas emissions are relatively low, they still present a challenge. Global data indicate that all of South Sudan's emissions are from the combustion of liquid fuels. Total carbon dioxide (CO_2) emissions in 2012 were 1,331 kt, increasing to 1,448.5 kt in 2013 (World Bank, 2016). Since South Sudan strives to be an industrialised, middle-income country by 2040, this development pathway is likely to result in increased emissions from the energy sector.

Emissions of CO_2 from total primary energy supply in 2014 were 2.17 t CO_2/toe, which is higher than the average for Africa (1.43 t CO_2/toe), as shown in Table 6. This is consistent with the fact that fossil fuels are currently the dominant source of primary energy in South Sudan, unlike in some of the other countries where renewables form a good proportion of the primary energy mix.

TABLE 6: REGIONAL COMPARISON OF CO_2 EMISSIONS, 2014

Country	CO_2 / TPES (t CO_2 / toe)	CO_2 / Population (t CO_2 / capita)	CO_2 / GDP (kg CO_2 / 2010 GDP)	CO_2 / GDP PPP (kg CO_2 / 2010 GDP)
South Sudan	**2.17**	**0.13**	**0.25**	**0.07**
Kenya	0.52	0.28	0.25	0.10
Ethiopia	0.19	0.09	0.21	0.07
Eritrea	0.69	0.11	0.22	0.08
Egypt	2.32	1.93	0.73	0.20
Sudan	0.89	0.34	0.20	0.09
Africa	1.43	0.96	0.50	0.22

Source: (IEA, Various)

Emissions from electricity generation

Burning fossil fuels produces CO_2, one of the leading gases contributing to global warming. Data from the World Bank indicate that power generation contributed 30.6 per cent of the country's CO_2 emissions in 2013, as shown in Table 7 (World Bank, 2016). South Sudan's electricity sector is based on thermal generation, including fuelling personal diesel generators. Juba has between 5,000 and 10,000 generators of varying sizes and according to national data, they contribute between 20 and 80 tonnes of CO_2 per year (MOE, 2014).

TABLE 7: CARBON DIOXIDE EMISSIONS BY SECTORS IN SOUTH SUDAN (% OF TOTAL FUEL CONSUMPTION), 2012-2013

Sector	2012	2013
Power generation	26.4	30.6
Manufacturing industries and construction	1.4	0.7
Residential buildings, commercial and public services	0.7	0.7
Transport	67.4	65.3
Other sectors	4.2	3.4

Source: (World Bank, 2016)

Emissions from traditional fuels

Worldwide, the use of traditional biomass energy for cooking is thought to be responsible for about 18 per cent of global greenhouse gas emissions (SEI, 2008). Pollution from cooking with inefficient traditional fuels is responsible for 25 per cent of black carbon emissions that contribute to climate change (UN Foundation, n.d.).

In South Sudan, where about 99 per cent of households use biomass resources for cooking, emissions from solid fuels are certainly an issue, but there are no data on their contribution to local or global emissions (NBS, 2012). Charcoal production is also a source of greenhouse gas emissions. Research shows that traditional earth-mound charcoal making kilns in Kenya have a charcoal yield ranging between 21.6 to 34.2 per cent; the emission factors for CO_2 have been assessed at between 1,058 to 3,027 g/kg of charcoal (Pennise, *et al.*, 2001).

Emissions from the transport sector

The transport sector is the other significant contributor to greenhouse gas emissions, although data on emissions and trends are not currently available.

Carbon dioxide emissions from the transport sector as a percentage of total fuel combustion was 67.4 in 2012 decreased to 65.3 in 2013 (World Bank, 2016).

Impacts on forests

Many people are unable to access the modern energy services necessary for cooking food safely and sustainably. With 81.4 per cent of the population dependent on firewood as a cooking fuel and 14 per cent on charcoal (NBS, 2012), there is massive pressure on the country's forest and biomass resources. A study in 2007 estimated the national deforestation rate of South Sudan at 0.84 per cent per year (UNEP, 2007). It is driven principally by energy needs and agricultural clearance. Between 1990 and 2005, the country lost 11.6 per cent of its forest cover and it is estimated that if this continues, there might be a total loss of forest cover within 50 years (MOE, 2016); (ROSS, 2013a).

The loss of forests and woodlands jeopardises long-term food security. In areas with high population pressure, extracting wood for fuel accelerates deforestation and forest degradation, which increases the risk of drought, soil erosion and landslides. Overharvesting may lead to women and children having to walk longer distances to obtain fuelwood. To compensate for deficiencies in fuelwood availability, there is widespread use of animal dung, harvest surpluses or agricultural residues, which could be better used as fertilisers, enhancing crop production. These impacts affect food security and human wellbeing, and contribute to greenhouse gas emissions. Given that around 80 per cent of the food consumed by humans requires cooking, food insecurity is exacerbated when vulnerable populations have limited access to cooking fuel (Practical Action, 2014); (FAO, 2017).

Energy for displaced people

An emerging energy problem is providing fuelwood for people displaced internally due to conflict or to resettlement by huge development projects, and for returning refugees and refugees from neighbouring Sudan who flee conflict in that country. Woodfuel is even more important under situations of displacement, and since most cooking stoves burn wood inefficiently, greater quantities are required.

The sudden influx of a displaced population puts pressure on the natural resource leading to its degradation, and impacts on the health and livelihoods of the affected people. On average, about 85 per cent of Internally Displaced People source their fuel from nearby forests and about 49 per cent of them do so twice or three times a week. Evidence from Melijo Camp in the former Upper Nile State shows that rapid depletion of the woodfuel stock around the camp means that women and children have to travel longer distances to obtain supplies, increasing the risk of violence to themselves. For instance, 45 per cent of people at the camp take an average of 5 hours per collection trip and 54 per cent of them have to walk an average of 5-6 km. The majority (96 per cent) use the traditional three-stone stove (Wani, 2015).

Major development projects such as petroleum exploration and mining, or the construction of roads or hydroelectricity dams also cause displacement. Although these are usually planned, at times the facilities set up at the site of resettlement are inadequate, with impacts on the surrounding environment.

Charcoal making

Charcoal making has become an attractive economic activity and as more people become involved in it, deforestation is accelerated. Charcoal production is highly inefficient since as little as 10-20 per cent of the wood used in traditional charcoal making is actually marketable as charcoal, while the rest is often wasted in the process (Thulstrup & Henry, 2015). In crisis-affected parts, it is also the main source of income for displaced people.

Rapid urbanisation and demand from neighbouring countries, including Sudan, Uganda and the Middle East, also drives the market for charcoal (Thulstrup & Henry, 2015). For instance, forests in Central Equatoria region are being depleted to supply Juba with charcoal. Over 50 per cent of people in urban areas use charcoal for cooking. There are laws that regulate the use and production of charcoal, but they are difficult to enforce. As shown in Chapter 5 on Forests, a study in Northern Bahr el Ghazal revealed that about 1.5 trees are needed to make a bagful of charcoal and a family of five uses approximately one bag a week in that area (MOE and UNDP, 2012).

A literature review by Lawry *et al.* (2015) suggests that there is a risk that trees valued for their non-timber forest products, such as shea and Gum Arabic (see Chapter 5 on Forests), are being harvested to make charcoal. Given the limited market for shea nuts and oil at present and the preference for the shea species to make charcoal, it is likely that the harvesting of mature shea trees for charcoal has increased. Although the market for Gum Arabic is stronger, with long-held ties between producer cooperatives in Upper Nile in South Sudan and northern traders in Sudan, Lawry *et al.* report that "In recent years prices for charcoal have gone up while prices for gum have dropped… individuals can make more from selling *Acacia seyal* to charcoal makers than they can make by tapping them for gum" (Lawry, McLain, & Kassa, 2015).

A charcoal production site in Jabel Lado County.
Photo credit: Peter Gilruth, EPI

TABLE 8: PER CENT DISTRIBUTION OF POPULATION BY MAIN SOURCE OF ENERGY FOR COOKING BY LOCATION, 2009

Location	Firewood	Charcoal	Gas	Electricity	Paraffin	Cow dung	Grass	Biogas	No cooking	Total
South Sudan	**86**	**10**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**100**
Urban	**44**	**54**	**1**	**0**	**0**	**0**	**1**	**0**	**0**	**100**
Rural	**94**	**2**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**100**
Upper Nile	63	21	1	0	0	0	14	0	0	100
Jonglei	92	3	0	0	0	0	4	0	0	100
Unity	83	8	0	0	0	1	8	0	0	100
Warrap	97	2	0	0	0	0	1	0	0	100
Northern Bahr el Ghazal	93	4	0	0	0	1	1	0	1	100
Western Bahr el Ghazal	68	32	0	0	0	0	0	0	0	100
Lakes	93	5	0	0	0	0	1	0	1	100
Western Equatoria	96	4	0	0	0	0	0	0	0	100
Central Equatoria	72	25	1	0	0	0	2	0	0	100
Eastern Equatoria	94	6	0	0	0	0	0	0	0	100

Source: (NBS, 2012)

TABLE 9: PER CENT DISTRIBUTION OF POPULATION BY MAIN SOURCE OF ENERGY FOR LIGHTING BY LOCATION, 2009

Location	Public electricity	Private electricity (generator)	Gas	Paraffin lantern	Paraffin lamp	Firewood	Grass	Candle wax	Solar power	Biogas	No lighting	Total
South Sudan	**1**	**2**	**0**	**3**	**10**	**35**	**15**	**6**	**1**	**0**	**27**	**100**
Urban	**7**	**10**	**0**	**3**	**23**	**10**	**3**	**24**	**3**	**0**	**17**	**100**
Rural	**0**	**0**	**0**	**3**	**8**	**40**	**17**	**2**	**1**	**0**	**29**	**100**
Upper Nile	2	7	0	0	11	5	15	7	2	1	50	100
Jonglei	0	0	0	1	3	35	10	2	0	0	49	100
Unity	2	1	0	3	4	33	20	8	0	0	28	100
Warrap	0	1	0	0	1	85	11	0	0	0	2	100
Northern Bahr el Ghazal	0	2	1	0	1	32	26	8	1	0	30	100
Western Bahr el Ghazal	6	5	1	1	10	43	5	16	1	1	12	100
Lakes	1	2	0	1	4	38	14	4	3	0	34	100
Western Equatoria	0	0	0	2	30	34	8	3	0	0	22	100
Central Equatoria	3	2	1	12	30	11	22	12	1	0	5	100
Eastern Equatoria	1	0	0	5	9	37	12	5	1	1	29	100

Source: (NBS, 2012)

Impacts on agriculture

Although South Sudan is rich in agricultural land, only 4.5 per cent of arable land is under cultivation (UNDP and MED, 2013). The agricultural sector is co-related to energy issues, since it began to decline with the beginning of oil exports in 1999 and is thought to be symptomatic of the so-called "Dutch disease". Dutch disease describes a situation in which a country that receives huge revenues from one sector, for instance oil, overlooks other sectors, leading to their decline. These typically include manufacturing or agriculture.

Impacts on health

Energy is essential for human health: it allows the ability to cook food, facilitates transport, and heats and lights living spaces. It is also required to run health centres that provide services to ensure a healthy and productive populace.

The energy production chain (generation, distribution and consumption) can have different health outcomes on people depending on the types of energy used. Workers in the energy industry – oil workers, for example – may face work related health hazards from construction work, oil extraction, transport and waste disposal.

In urban areas, emissions from burning fuel leads to high levels of both indoor and outdoor air pollution. Burning fossil fuels also contributes to climate change that affects people's health through the impacts of drought and floods that may exacerbate the spread of disease vectors, or exacerbate food insecurity and displacement. Cholera and meningococcal meningitis are linked with changes in climate. Outbreaks of cholera are linked to floods associated with extreme rains and warm temperatures, while Meningococcal meningitis epidemics are frequent during hot, dry seasons, subsiding with the rains (WHO, 2017b). For example, although cholera is commonly present in South Sudan along the River Nile, heavy rains and floods in 2014 worsened the cholera outbreak especially around Bentiu in eight sub-counties (out of 15) in Juba County, with 586 cases reported (WHO, 2017a).

A woman making local beer from Sorghum by burning wood, and is exposed to the smoke from the fire. *Photo credit: Ron Savage - Savage Vistas Photography via Foter.com / CC BY-NC-SA.*

Public health impacts of energy use

Activities to generate, distribute and consume energy can have major public health impacts. They generate pollutants that contaminate the air, water and soil. The public health concerns associated with the oil industry include toxic pollutants that contaminate the air, water and soil, oil spills, food contamination and mental health impacts.

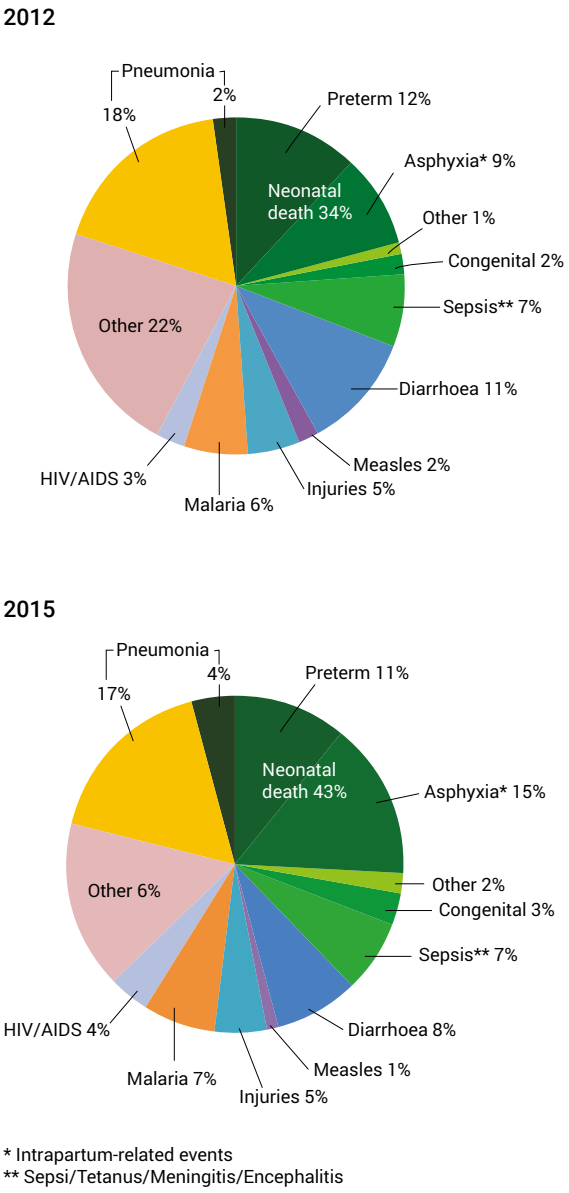
Impacts of indoor air pollution

As indicated in the section on Health and Public Health in Chapter 2, globally, exposure to indoor and outdoor air pollution has been linked to poor health outcomes with the statistics showing that children exposed to smoke from burning solid fuels such as charcoal, crop residue, wood and animal dung had twice the risk of pneumonia infections compared to children from households where clean fuels such as electricity or gas are used, or where children are not exposed to smoke (Abd-Elfaraga & Langoya, 2016).

In South Sudan, where almost all households use solid fuels, there is a high risk of pneumonia or other respiratory tract diseases. Pneumonia is the leading cause of deaths among children in South Sudan, accounting for 20 per cent of deaths in children under five in 2012, increasing slightly to 21 per cent in 2015 as shown in Figure 5 (WHO, 2015); (WHO, 2014).The number of deaths of under five-year-olds per 1,000 children is declining but is still higher than the global and sub-Saharan averages. For instance, as shown in Figure 6, there were 93 deaths per 1,000 children under five in 2015 (World Bank, 2016). South Sudan is one of the top 15 countries contributing to the global burden of child pneumonia and diarrheal deaths (IVAC, 2016).

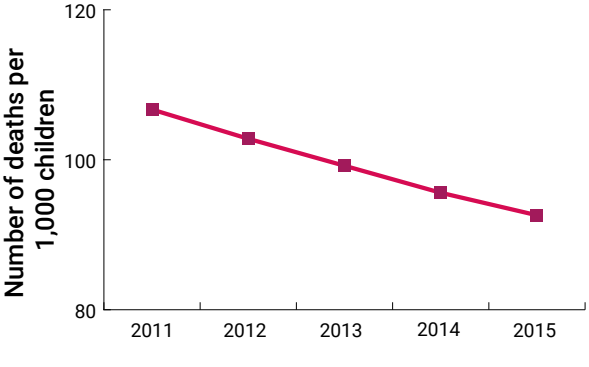
Oil leakages near Tharjath oilfield. *Photo credit: Ministry of Petroleum*

FIGURE 5: CAUSES OF UNDER-FIVE DEATHS IN 2012 AND 2015



Sources: (WHO, 2014) and (WHO, 2015)

FIGURE 6: TRENDS IN DEATHS IN CHILDREN UNDER-5 IN SOUTH SUDAN, 2011-2015



Source: (WHO, 2015)

Outdoor air pollution

Outdoor air pollution is worse in the urban areas due to the abundance of generators used at a household level to supplement lack of access to grid electricity (WHO, 2016). Apart from environmental pollution from the noxious fumes, generators produce considerable noise and odour pollution that can lead to mental and emotional stress as well as respiratory disorders (MOE, 2014).

Studies show that reducing household air pollution also reduces its health risks, such as pneumonia. Thus, the World Health Organization has recommended the use of cleaner fuels and/or technologies that offer significant health benefits, including the use of clean cooking stoves. This would greatly improve the health of all South Sudanese, since 99 per cent of people use solid fuels for cooking in both rural and urban areas. Some of the actions could include promoting the use of improved cook stoves that would reduce the risk of childhood pneumonia and pneumonia-related deaths in South Sudan. Examples of these energy saving cook stoves include the Uga Cooking Stove locally made in Uganda that uses charcoal and the Ecos Cooking Stove made in Kenya that uses charcoal or firewood. The Ecos Cooking Stove or multitasking stove is able to boil up to 7 litres of water at the same time as cooking food (Daily Nation, 2013).

Hydropower development on the River Nile

There are regional legal and institutional issues connected with the management and development of the Nile basin. South Sudan, as a sovereign nation and member of the Nile Basin Water Initiative, is now interested in utilising the Nile waters and is demanding a share in the Nile waters allocated to the Republic of Sudan under the 1959 Agreement. It is also necessary that the South Sudanese portion of the Nile basin be protected while being allowed to contribute to poverty alleviation through a good governance system which views the Nile, the resources, and people who live along its basin as shared resources (Katz, 2013); (Kamau, 2015). There is an urgent need, for instance, to produce hydroelectricity from the existing potential so as to reduce the current reliance on polluting generators and for irrigation projects to be developed in support of agriculture (AfDB, 2013).

As decision makers in South Sudan consider hydropower development, Fernando and Garvey (2013), urge that they bear in mind the following points:

- Nature and scale of transboundary water issues
- Future social, economic, and environmental benefits that might be foregone consequent to construction and operation of dams
- Impacts on the environment and hydrology of Sudd and wetlands
- Impacts on downstream communities and their livelihoods dependent on Nile water.

9.4 Responses

The government aims to expand the transmission and distribution grid to other state capitals and to allow interconnections with Ethiopia, Kenya and Uganda. By 2025, it intends to have 75 per cent of the urban population connected to electricity, up from the five per cent in 2012 (AfDB, 2013). The South Sudan Development Plan 2011-2013 includes plans to invest US$700 million into the energy sector. This investment is targeted at grid expansion, an increase in distribution networks and expansion of thermal generation capacity. It plans to reduce transmission losses to 12 per cent by 2025 (AfDB, 2013).

The institutional framework

The Energy sector is managed between the Ministry of Energy and Dams and the Ministry of Petroleum. The Ministry of Energy and Dams is in charge of electricity sector policy and strategy, and actively implements electricity development projects such as large hydropower or transmission line developments; institutional capacity, however, remains a challenge.

The energy regulator is the South Sudan Electricity Regulation Authority. The South Sudan Electricity Corporation is an autonomous parastatal legally in charge of generating, transmitting, and selling electricity to distributors. The South Sudan Electricity Corporation is one of the key institutions supporting economic growth and development, and has been earmarked for reform. South Sudan uses a federal governance system and

each state has a State Electric Distribution Company that manages electric power distribution services at the state level. At this level also, there is a dearth of capacity within these institutions.

South Sudan became the sixth member of the East African Community in August 2016, allowing it to participate in regional power trading through the Eastern African Power Pool. Furthermore, the East African Community Cross-Border Electrification Policy has operationalised a programme — the East African Community cross-border electrification programme — through which border towns in South Sudan can access electricity from the nearest gird-connected town in a more cost-effective way. For instance, there are arrangements for the Government of Uganda to supply electricity to the South Sudanese towns of Nimule and Kaya. The Cross-Border Electrification Policy also provides the opportunity for sharing electricity from renewable energy projects such as small hydropower plants.

The legal and policy framework

Sustainable energy policies that meet the basic needs of people lie at the heart of Section 41(4) of the Interim Constitution of South Sudan 2011. This sets the stage for all other legal provisions in the energy sector. Some of the relevant laws include:

- The National Electricity Bill 2015
- Petroleum Act 2012
- Draft South Sudan Petroleum Policy Paper 2010
- National Electricity Sector Policy 2007
- Environment Bill 2014

Environment Bill 2014
The Environment Bill 2014 addresses the issue of air pollution in various sections. Section 20(6) specifically talks about reducing carbon emissions into the air, water and soil, and promotes the use of high-performance, low-noise, low-fuel consuming electric generators. Further, in Section 80, it stipulates that the emissions from electric generators will need to follow strict air quality emissions standards that will be developed.

Section 75 directs the relevant Ministry to address the issue of air pollution by developing air quality standards, and to ensure their implementation and enforcement as required. Section 81 on ambient air standards clearly states that no enterprise or individual is allowed to pollute the air, and any emissions must adhere to the air standards.

The government also plans to encourage foreign investment by establishing an investor-friendly environment, including regulations for private sector involvement, feed-in tariffs and Power Purchase Agreements.

Addressing energy-related forestry issues

The National Environment Policy
The goal of the National Environment Policy 2015-2025 is to ensure the conservation and sustainable use of the country's natural resources, including forests. It aims to expand national forest cover from 34.2 to 50 per cent by 2020 and will promote forest conservation activities such as pollution control and protecting trees from uncontrolled logging and cutting for charcoal.

The Forest Bill 2009 and the Forest Policy 2013
The Forest Bill 2009 regulates the production, transportation and marketing of charcoal. It has put in place the requirement that those making charcoal on farmland, or in public or private forests will need to have a licence before doing so. The Forest Policy recognises the accelerating rate of deforestation and means to ensure that there are optimal benefits from forestry and agro-forestry activities for food security and to alleviate rural poverty.

The Paris Agreement

In line with the Paris Agreement on Climate Change, South Sudan articulated its Intended Nationally Determined Contributions (INDC) in 2015. One of the targets is to ensure more efficient use of biomass energy (especially charcoal and fuelwood) in the traditional energy sector. It also aims to increase the protection of its forest estate by declaring 20 per cent of its forests as reserve forests; as well, it addresses the issue of deforestation by planting 2 million trees per year for the next 10 years (ROSS, 2015).

The INDC document promises to address emissions in the transport sector by establishing vehicular emissions standards, establishing a testing regime to ensure that the standards are adhered to, and restricting the importation of motorcars that do not meet the emissions standards (ROSS, 2015).

Under the INDCs, the country also aims to develop more clean forms of energy such as hydroelectricity. This will reduce pressure on the country's forests while reducing emissions that contribute to climate change. In addition, energy efficiency interventions will be introduced into the formal energy sector. The INDCs related to energy are as follows:

- Increase the use of clean and carbon-neutral energy
- Construction of a hydroelectricity plant at Fulla rapids
- Increase the use of the country's high potential for solar and wind energy to meet energy demands
- Increase the efficiency of biomass use (particularly fuelwood and charcoal) in the traditional energy sector
- Increase efficiency of electricity usage in the formal energy sector and ensure the best use of hydropower by careful management of the water sector. Source: (ROSS, 2015).

Sustainable Energy for All (SE4ALL)

Only 5 per cent of people countrywide have access to electricity, with 3 per cent in rural areas and 12 per cent in urban areas. The Infrastructure Action Plan aims to expand generation capacity from the present 50 MW to about 580 MW by 2025 (AfDB, 2013). There is no information on energy efficiency indicators.

TABLE 11: SOUTH SUDAN'S PROGRESS TOWARDS ACHIEVING SDG7 - ENSURE ACCESS TO AFFORDABLE, RELIABLE, SUSTAINABLE AND MODERN ENERGY FOR ALL.

Target	Indicators	1990	2000	2010	2012
Ensure universal access to modern energy, including electricity and cooking	Access to electricity (% of population)	0	0	2	5
	% of population with primary reliance on non-solid fuels	2	2	2	2
Double the rate of improvement of energy efficiency	GDP per unit of energy use (constant 2011 PPP $ per kg of oil equivalent)	-	-	-	-
	Level of primary energy intensity (MJ/$ 2005 PPP)	-	-	-	-
Double the share of renewable energy in the global energy mix	% of total final consumption of energy from renewable sources	-	-	-	-

Sources: (World Bank, 2016)

9.5 Conclusion

The aspirations of South Sudan for economic and social development all require an affordable and reliable energy supply. Currently, oil accounts for almost all of its exports and for around 80 per cent of GDP. Most of its energy is produced from oil, and its oil-dependence has been increasing. Most of the country's needed oil products are imported, however, because as yet there are no working refineries and current reserves are projected to last only until 2035.

Almost all (94 per cent) of the electricity consumed in South Sudan comes from burning oil, including fuelling personal diesel generators, but electricity use is extremely low: only 12.3 per cent of urban areas and a mere 3.5 per cent of rural areas are electrified and the country has the lowest electricity consumption per capita in sub-Saharan Africa. Demand for electricity greatly exceeds supply and is expected to rise to over 1,400 MW by 2030.

There are opportunities to fill this electricity gap using renewable energy options. Presently, 99 per cent of the population uses biomass for fuel. If used sustainably, it could be a renewable resource, but currently the use of woodfuel and charcoal are causing deforestation and polluting emissions that are responsible for respiratory diseases. Other available renewable energy sources include solar, wind, hydro and geothermal. Currently, hydro and solar each provides only 2 ktoe of energy.

As electricity-generating capacity is being developed, the country should look keenly at reducing reliance on thermal power by developing untapped potentials in small hydro, wind, solar and geothermal energy. There is great potential for solar use in rural electrification. Implementing a strong rural electrification programme is important, since ensuring that a critical mass of rural households has access to electricity would lessen the pressure on the country's forests and woodlands, and reduce the rate of forest loss. In addition, the incidence of pneumonia and other respiratory tract infections associated with indoor air pollution from the use of traditional biomass fuels are likely to decline, improving the overall health of the population and reducing health expenditures.

Solar panel at Abiriu Haffir. *Photo credit: Arshad Khan, UN Environment*

Charcoal and firewood sale on roadside near Torit. *Photo credit: Arshad Khan, UN Environment.*

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Man panning for gold in Kapoeta Region.
Photo credit: Arshad Khan, UN Environment

CHAPTER 10
PETROLEUM, MINING AND INDUSTRY

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10.1 Introduction

The economy of South Sudan depends on revenues generated from the oil sector. South Sudan is the most oil-dependent country in the world, making it very vulnerable to fluctuations in global oil prices. Thus, the government has been making efforts to diversify its revenue sources, especially by developing its mining and industry sectors.

Industry can be defined as the production of goods or related services within an economy. Primary industries collect and directly use available natural resources. Secondary industries or manufacturing add value or transform the raw materials into other processed goods, and the tertiary industry provides services or intangible products, such as professional work, fast moving consumer goods or financial services, among others.

Generally speaking, all three industry sectors are grossly under-developed in South Sudan, with the only modern primary industrial sector being the oil industry, which is dominated by foreign, mainly Chinese, Malaysian and Indian, investors. All oil produced in the country is exported. Gold is the other main natural resource contributing to the primary sector, but it is mainly mined at an artisanal level. The secondary or manufacturing industry is virtually non-existent and almost all intermediate and consumer goods are imported. The most prominent service-based industries (tertiary sector) include construction and metal fabrication (Chaudhuri, 2010).

10.2 Status and Trends

Oil

Oil is currently the backbone of South Sudan's economy. Available data indicate that oil alone accounts for 98 per cent of the government budget and in the recent past, contributed between 60 and 80 per cent to GDP (NBS, 2012). In 2011, the petroleum sector accounted for 61.3 per cent of GDP, but that proportion declined to 7.4 per cent in 2012 and 14.7 per cent in 2013. The massive decrease in the share of petroleum in GDP in 2012 was due to the shutdown of oil production, which led to a decline in production in that year and a decline of about 47 per cent in GDP (NBS, 2012).

In June 2014, oil prices dipped from $112 to $30 per barrel. South Sudan currently produces 130,000 barrels of crude oil per day, down from 350,000 per day before the war (Houreld, 2017).

In the foreseeable future, oil will remain a strong driver of investments in the economy. However, it is not a renewable resource and already declining crude oil reserves point to an urgent need for government investment in other revenue earning sectors (World Bank, 2016a).

Gummry Oil Spill. *Photo credit: Mr. Hamoun, Ministry of Petroleum*

Agriculture

Agriculture (mainly subsistence) is estimated to account for about 15 per cent of GDP (World Bank, 2016a). An analysis of value added by major sector shows the very small share of GDP that market-based agriculture and manufacturing contribute compared to the oil sector (Table 1).

TABLE 1: **VALUE ADDED BY ECONOMIC ACTIVITY, PERCENTAGE DISTRIBUTION (SHARES OF GDP)**

Year	2008	2009	2010	2011	2012	2013	2014	2015
Agriculture, hunting, forestry, fishing	4	5	5	5	4	5	5	5
Mining, manufacturing, utilities	58	48	49	57	54	50	49	51
Manufacturing	2	3	2	3	3	2	2	2
Construction	4	4	6	5	6	7	7	7
Wholesale, retail trade, restaurants and hotels	5	8	8	6	8	7	8	8
Transport, storage and communication	5	7	6	5	6	7	7	7
Other Activities	23	28	26	22	22	24	23	23

Source: (UNSTATS, 2017)

Manufacturing

This sector is exceptionally underdeveloped, accounting for only 2 per cent of GDP (or 6 per cent of non-oil GDP) in 2010 (AfDB, 2013b). According to the Business Listing Survey in 2010, only 2.7 per cent of businesses (Figure 1) were involved in producing goods or some form of manufacturing. Most of the country's manufactured goods are imported from neighbouring countries. In 2009, goods worth US$42.7 million and US$137.5 million were imported from Uganda and Kenya, respectively; in 2010, imported goods worth US$49.9 million and US$207.3 million were imported from these two countries. On the other hand, exports from South Sudan to Kenya in 2010 amounted to just US$2.1 million.

The government is planning to revive some industries that have been in decline, such as those listed in Box 1, and there are also new industries being set up. For instance, there have been local industry developments in the bottled water sector, reducing the need for imports. Between 2006 and 2009, import values for bottled water from neighbouring countries were between US$1 million to US$6 million. Over the years, Ugandan mineral water exports fell to US$3.7 million in 2010 and even further to US$1.3 million in 2011 (AfDB, 2013a). Kenyan exports of bottled water to South Sudan fell from US$1.25 million in 2008 to US$1 million in 2010 (AfDB, 2013a).

It was expected that this trend in growing investments in South Sudan and a concomitant reduction in the need for basic imports from its neighbours would continue. However, the insecurity in 2013 coupled with foreign exchange shortages has affected recent investments. For instance, Kenyan exports of beer to South Sudan increased from US$0.77 million to US$14 million from 2006 to 2010. In 2009, hoping to tap into that local market, the multinational beer maker SABMiller (now Anheuser-Busch InBev) built a brewery, South Sudan Beverages, just outside Juba. At the beginning, the only raw material sourced from the country was water from the River Nile. However, the company, together with Farm Africa, is encouraging about 2,000 local farmers within a 150 km-radius from the factory, mainly in Yei and Juba, to grow cassava, which can be used in the brewing process (AfDB, 2013a).

BOX 1: **LIST OF AGRO-PROCESSING INDUSTRIES PLANNED FOR REVIVAL**

- Saw mills, fruit canning factory and brewery in Wau, Western Bahr el Ghazal
- Kenaf project for making and packaging Hessian cloth in Tonj, Warrap
- Nzara Agro Industrial Complex, Western Equatoria
- Mongalla Cotton Spinning and Weaving factory, Central Equatoria
- Paper making project from papyrus that grows in the Sudd or swamps of Warrap, Unity, Upper Nile, Jonglei and Lakes
- Shea Butter project in greater Bahr el Ghazal
- Palm Oil project in Western Equatoria

Construction

Data are lacking, but it is estimated that in 2010, value added in this sector was US$190 million or about 3.5 per cent of non-oil GDP; it is expected to increase to about US$600 million by 2020 (AfDB, 2013b). The 2010 Business Listing Survey found that only 1.2 per cent of businesses were involved in construction (NBS, 2011).

At present, almost all construction materials required are imported. In fact, in 2010, mining and quarrying (along with agriculture, forestry, electricity and others) formed just 0.1 per cent of businesses (NBS, 2011). This highlights the enormous potential for local production. For example, current deposits of limestone could provide the raw material for a thriving cement and glass industry. Currently, the price of cement is US$640 per tonne, which is high compared to prices in the region. However, there is a need to quantify the deposits accurately.

There is much potential for cement for construction as homes are rebuilt, and new construction or rehabilitation of infrastructure such as roads and bridges is undertaken.

The tertiary sector

The tertiary sector involves commercial services that support the primary and manufacturing sectors. These include insurance, advertising, consultancy and professional services, retail and wholesale, restaurants and hotels, transportation, teaching and health services, amongst others. In 2010, government services and other services contributed 37 and 12 per cent, respectively, to the non-oil GDP (AfDB, 2013b).

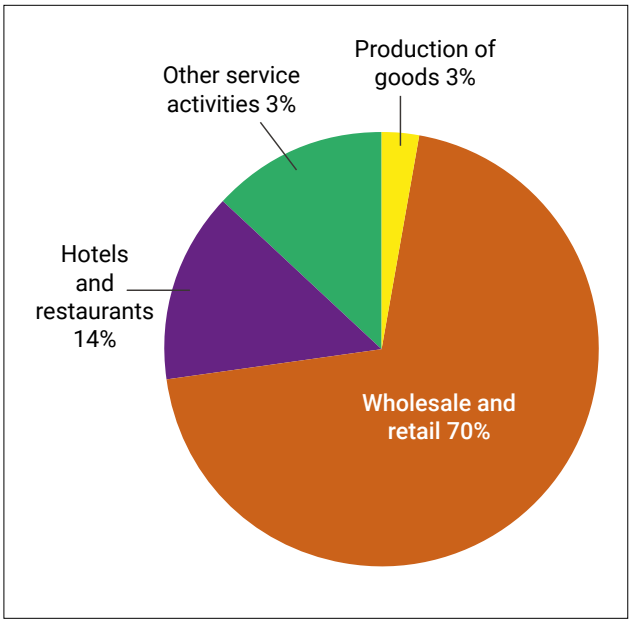
A survey in 2010 listed a total of 7,333 formal businesses in the then 10 state capitals of Southern Sudan, with Torit town having the least (259) and Juba town the most (2,683); the largest proportion of businesses (84 per cent) were shops or restaurants (NBS, 2011). Figure 1 highlights the percentage of businesses by industry sector in 2010.

The informal sector is much more widespread, with about 76 per cent of households involved in some kind of subsistence entrepreneurial activity (AfDB, 2013a). Most of them remain small and are characterised as low capital and low technology as the costs and intricacies of upgrading or registering their businesses are prohibitive.

Although this sector is quite undeveloped, along with agriculture and mining, the government aims to give the services sector the support it needs to grow and make the economy more vibrant. The biggest hindrance to the development of this sector currently is the level of skills amongst the population. For instance, according to the 2008 population census, only 10 per cent of the population were documented as skilled and in official employment. Many government departments lack staff with adequate training to support public service work. For instance, operations in the Ministries of Energy and of Mining are both affected by the lack of trained human resources (AfDB, 2013a). Business sectors such as tourism, hotel management, restaurants, construction services, and retail and wholesale have all been run by nationals from Eritrea, Ethiopia, Kenya,

Market stall near IDP camp in Juba. *Photo credit: Oxfam East Africa/ Flickr.com/CC BY 2.0*

FIGURE 1: PERCENTAGE OF BUSINESSES BY INDUSTRY SECTOR, 2010



Source: (NBS, 2013)

Somalia and Uganda.The lack of local workers to provide trade facilitation services restricts growth in the trade sector, with these services provided by professionals from Uganda and Kenya (AfDB, 2013a).

Growth in the tertiary sector will require investments in basic infrastructure (road, rail and air transport, banking, telecommunications, education and health services, amongst others). The telecommunication sector suffers from a lack of infrastructure. Mobile phone penetration in South Sudan in 2015 was 23.9 per cent, up from 17.9 per cent in 2011, but it is still one of the lowest in Africa (World Bank, 2016b).

Mobile phone charging services provided by a local entrepreneur in Juba. *Photo credit: Oxfam International/Flickr.com/CC BY-NC-ND 2.0*

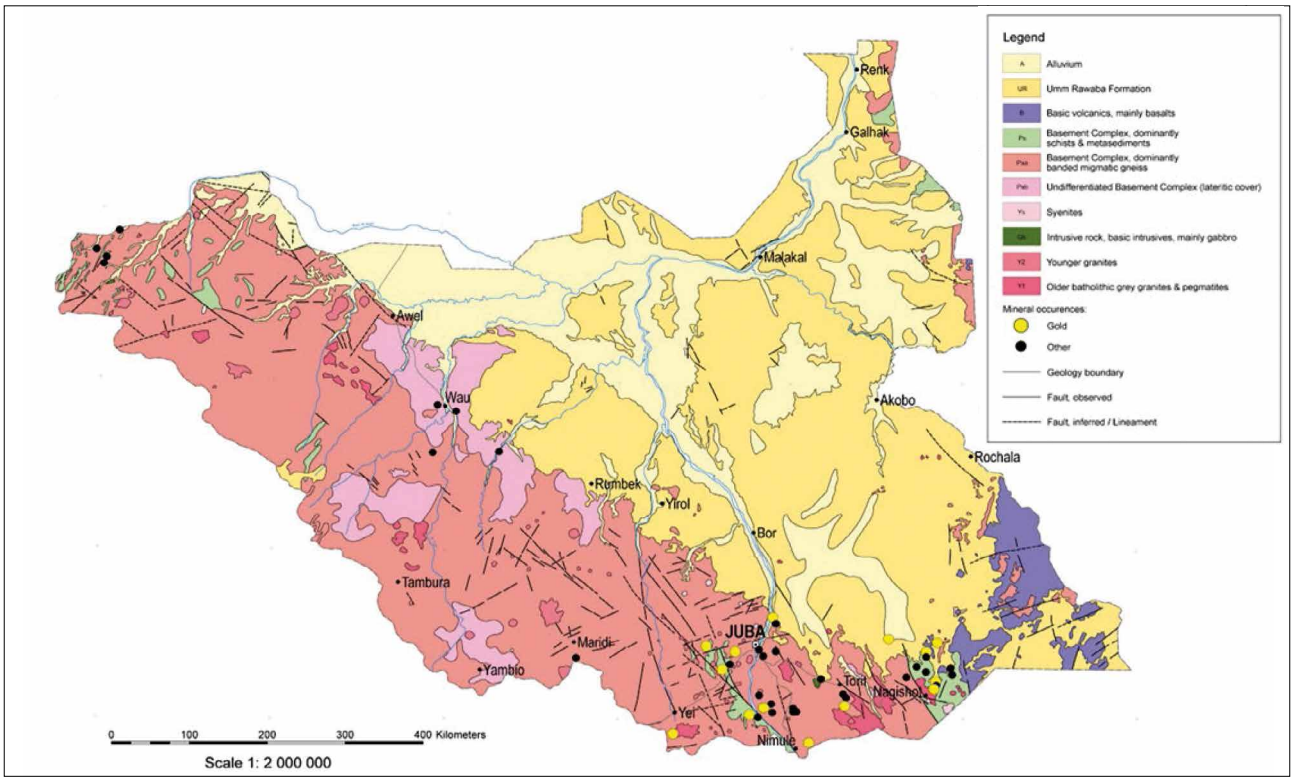
Petroleum and mining

Geological overview of South Sudan

It is thought that South Sudan holds enormous potential for the mining of oil and minerals. It is considered to be one of the world's last large remaining Precambrian terrains yet to be prospected in detail. Such geological formations that exist elsewhere on earth usually host large oil and mineral deposits (Dirks, Blenkinsop, & Jelsma, 2002). Thus, an understanding of the geology of South Sudan is important to inform government decision makers prior to any potential mining activities (AfDB, 2013b). Most of the information currently available is for the hydrocarbon sector. It is likely that geological exploration for non-hydrocarbon minerals is taking place in several areas and states.

In South Sudan, there are three principal geological features consisting of layered rock sequences formed by tectonic activity: the Congo Craton (Archaean and Paleoproterozoic) in the south; sedimentary basins (Mesozoic to Recent) in the north; and pockets of the Arabian-Nubian Shield (Neoproterozoic) in the east, as shown in Figure 2.

FIGURE 2: GEOLOGICAL MAP OF SOUTH SUDAN



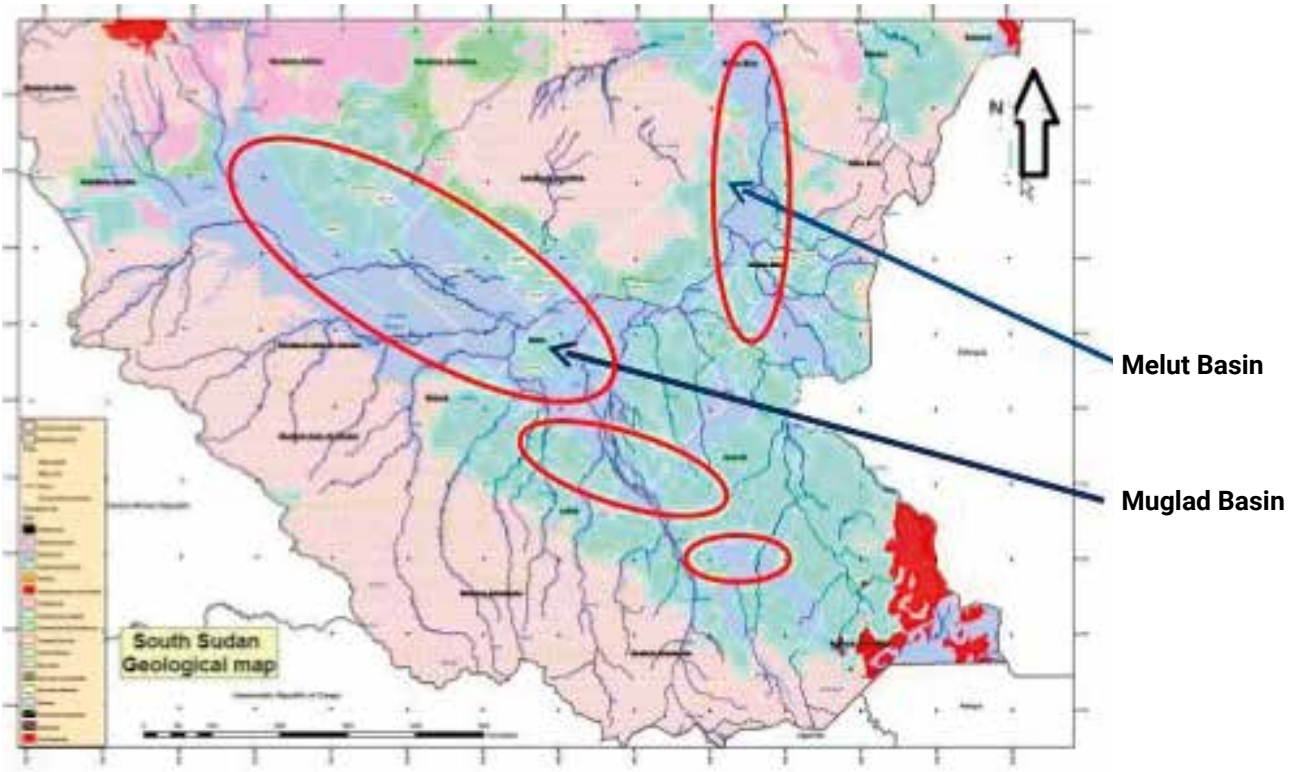
Source: (Cordaid, 2016)

The Arabian-Nubian Shield has been a source of gold since the era of the Pharaohs (Kröner & Stern, 2004). The Congo Craton occupies a large part of central southern Africa. It is an ancient Precambrian craton (cratons are the ancient stable interior portions of a continent) formed between 3.6 billion and 2.0 billion years ago. The Congo Craton, along with the Kaapvaal, Zimbabwe, Tanzania and West African Cratons, covers most of present day Africa.

The sedimentary basins

The rifting activities of the Western, Central and East African Rift Systems formed the Muglad, Melut, Blue Nile, Red Sea, Khartoum and White Nile sedimentarybasins. The Melut basin is located in the states of Upper Nile and Jonglei, south of the capital Khartoum and east of the River Nile. The Muglad basin straddles both Sudan and South Sudan, and covers an area of about 120,000km^2. The build-up of sediments provided the ideal conditions for hydrocarbon accumulations to occur (Mohamed & Mohammed, 2008). The Great Palogue Field is the largest oil field in the Melut basin, with estimated reserves of 900 million barrels. The largest reserves in the Muglad basin are at the Heglig and Unity oil fields. Together these two basins account for most of South Sudan's known oil reserves (Figure 3).

FIGURE 3: **PETROLEUM GEOLOGY OF SOUTH SUDAN**



Source: (MPM)

Petroleum

Petroleum is a liquid mixture of hydrocarbons that can be found in certain rock layers and can be extracted and refined to produce fuels such as petrol, paraffin and diesel oil amongst others (Box 2). The petroleum industry is traditionally divided into three sectors: upstream, midstream and downstream (Figure 4).

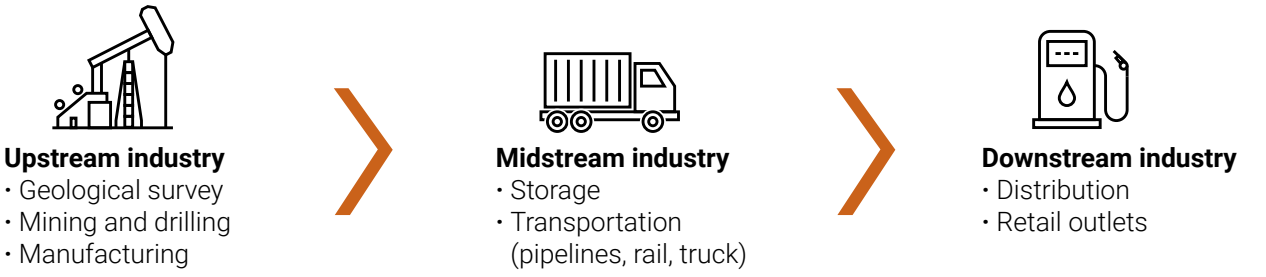
In South Sudan, the upstream segment includes exploration activities, field development, and oil and gas production activities. The downstream sector, which became operational in 2012, comprises activities that refine the crude oil, and the marketing, sale and distribution of any ensuing products. The midstream sector links the upstream and downstream segments, and includes activities and facilities that enable processing, storage and transportation of products, such as pipelines and other facilities.

BOX 2: **DEFINITIONS OF OIL AND PETROLEUM**

"Crude oil is a mixture of hydrocarbons that exists as a liquid in underground geologic formations and remains a liquid when brought to the surface. Petroleum products are produced from the processing of crude oil and other liquids at petroleum refineries, from the extraction of liquid hydrocarbons at natural gas processing plants, and from the production of finished petroleum products at blending facilities. Petroleum is a broad category that includes both crude oil and petroleum products. The terms oil and petroleum are sometimes used interchangeably".

Source: (EIA, 2016)

FIGURE 4: **THE THREE SECTORS OF THE PETROLEUM INDUSTRY**



Source: Adapted from: (E&T, 2013)

The Ministry of Petroleum oversees this sector in South Sudan. The state oil company is the Nile Petroleum Corporation (Nilepet), established in 2003 and incorporated in June 2009 under the New (South) Sudan Companies Act 2003 by the Ministry of Legal Affairs and Constitutional Development. It has joint ventures with the Nile Delta Petroleum Company Limited (Nile Delta), Dietsmann Nile, Eastpet Ltd and SIPET (Nilepet, 2017).

Crude petroleum is produced by joint ventures of state-owned companies from China, India, Malaysia and South Sudan. The government, through Nilepet, holds no less than an 8 per cent share in any of these petroleum joint ventures, as shown in Table 2 (Yager, 2015).

TABLE 2: **STRUCTURE OF THE OIL INDUSTRY IN SOUTH SUDAN, 2013**

Commodity	Major operating companies and major equity owners	Location of main facility	Annual capacity [bpd]
Petroleum, crude	PETRODAR Operating Company (PDOC): China National Petroleum Corp (CNPC), 41%; Petronas Carigali Overseas Shd. Bhd., 40%; Nile Petroleum Corp (Nilepet), 8%; China Petroleum and Chemical Corp., 6%; Tri-Ocean Energy, 5%	Blocks 3 and 7 in Upper Nile	91,500 First oil production was in 2001 and the average current production is 163 bpd
Petroleum, crude	Greater Nile Petroleum Operating Co: China National Petroleum Corp (CNPC), 40%; Petronas Carigali Overseas Shd. Bhd., 30%; ONGC Videsh Ltd., 25%; Nile Petroleum Corp (Nilepet), 5%	Blocks 1, 2, and 4 in Unity	32,200
Petroleum, crude	White Nile Petroleum Operating Co: Petronas Carigali White Nile Petroleum Operating Co. Petronas Carigali	Block 5A in Unity	4,400

Source: (Yager, 2015)

Mining

South Sudan is endowed with considerable mineral resources. Minerals are naturally occurring inorganic solids that have a definite chemical composition and an ordered internal structure. They are spread all over the country. Its metallic minerals include copper, gold, iron, lead, manganese, silver, tin and zinc, amongst others. Industrial minerals include marble, limestone, dolomite, kaolin, clay and asbestos. However, none of these has been prospected to a significant level. Gold is currently being exploited at Kapoeta and Luri, copper at Hofrat en Nahas, bauxite/iron ore in the Wau area and marble at Kapoeta (Tiitmamer, 2014).

The mining industry is still in its infancy, and the government is keen to encourage investment in the sector. Nonetheless, much work needs to be done to study the available mineral resources so as to attract commercially viable investments and to assess the environmental impacts of mining them. It is necessary to carry out systematic exploration (including geochemical and geophysical exploration, and geological mapping programmes) of these resources to inform decision makers and investors (Roll, 2006).

Gold

Gold deposits have been found in the south-eastern and south-western parts of the country in crystalline, basement rocks. The deposits in most of Eastern Equatoria are located along the Aswa Shear Zone (ASZ), a faulted, sheared rocks zone some 16 km wide, which enters South Sudan at Nimule and extends far beyond the north-western borders of South Sudan towards Darfur in Sudan (Cordaid, 2016). Gold is found in Eastern Equatoria in all Kapoeta and Nimule; in Central Equatoria at Luri, Lobonok and Yei; in Western Equatoria at Mundri-Amadi; in Western Bahr el Ghazal in Khor Ghana, Wau; and in Upper Nile State in Sobat (Adde, 2013).

Current mining efforts are at an artisanal level and have been ongoing since around the 1940s. Formal exploration activities have been undertaken from around 2012 by the Equator Gold Ltd. of the United Kingdom at the Luri project and by South Africa's New Kush Exploration & Mining Ltd. at the Eastern Equatoria Kapoeta project (Holland, 2013). In addition, there is interest from companies in Australia, China, the United States and other African countries.

Although there is a dearth of information on the commercial viability of deposits, the presence of the Kibali gold mine just across the border in the Democratic Republic of the Congo (DRC) indicates that there may be industrial-scale deposits in South Sudan too. The Kibali mine is thought to have the largest gold deposits in Africa and to be one of the largest in the world, with estimated deposits of 34 million ounces.

It is estimated that the country's artisanal gold mining activities take place in about 25 counties and involve more than 60,000 miners (Cordaid, 2016). Alongside farming, livestock rearing, fishing, charcoal burning or petty trade, household revenues from gold mining improve the lives of more than 500,000 people, helping to provide education, healthcare and other household needs. On average, between 1-2 g of mainly gold is mined a day and with about 150 days of mining a year this infers between 5,000-10,000 grams per year. In a country where more than 90 per cent of the population lives on less than a dollar a day, this small-scale mining is a lucrative activity.

Artisanal gold mine in Kapoeta. *Photo credit: Peter Gilruth*

Man panning for gold in Kapoeta Region.*Photo credit: Arshad Khan, UN Environment*

Although gold mining employs mostly indigenous South Sudanese, some people from Kenya, Sudan, Uganda and DRC are also involved. They have considerable mining skills and modern equipment such as metal detectors. Both men and women, and at times children, work in the mines.

Most artisanal mining consists of panning for alluvial gold in streams, but in some places miners dig deeper tunnels to extract the soil, which is then panned in water to sift the gold. In Budi and Kapoeta, this method is employed more frequently than in the mining sites in Central Equatorial. The gold found in all sites is of good quality and mostly coarse-grained, meaning that no mercury or cyanide is required for extraction and purification.

With the new legal framework for mining passed into law in 2012, all mining without a licence became illegal.

Copper

Copper-gold ore mainly occurs at Hofrat En Nahas in Western Bahr el Ghazal. Several companies have prospected it. Reserves are in the region of 40-60m tonnes. Chemical analysis indicates 1-5 per cent of copper and up to 3g of gold per tonne. These minerals are sometimes associated with radioactive minerals.

Bauxite and iron ore

The main areas where bauxite ore occurs are west of Wau city, north and east of Juba and west of Yambio town. Bauxite ore resources are estimated at about 3 billion tonnes.

Iron ore is mainly found north and west of Wau city extending to the borders with Sudan and the Central African Republic. In the studied area of 900 km^2, reserves are estimated at about 10 billion tonnes. There is potential to feed a smelting industry to supply local needs (AfDB, 2013b).

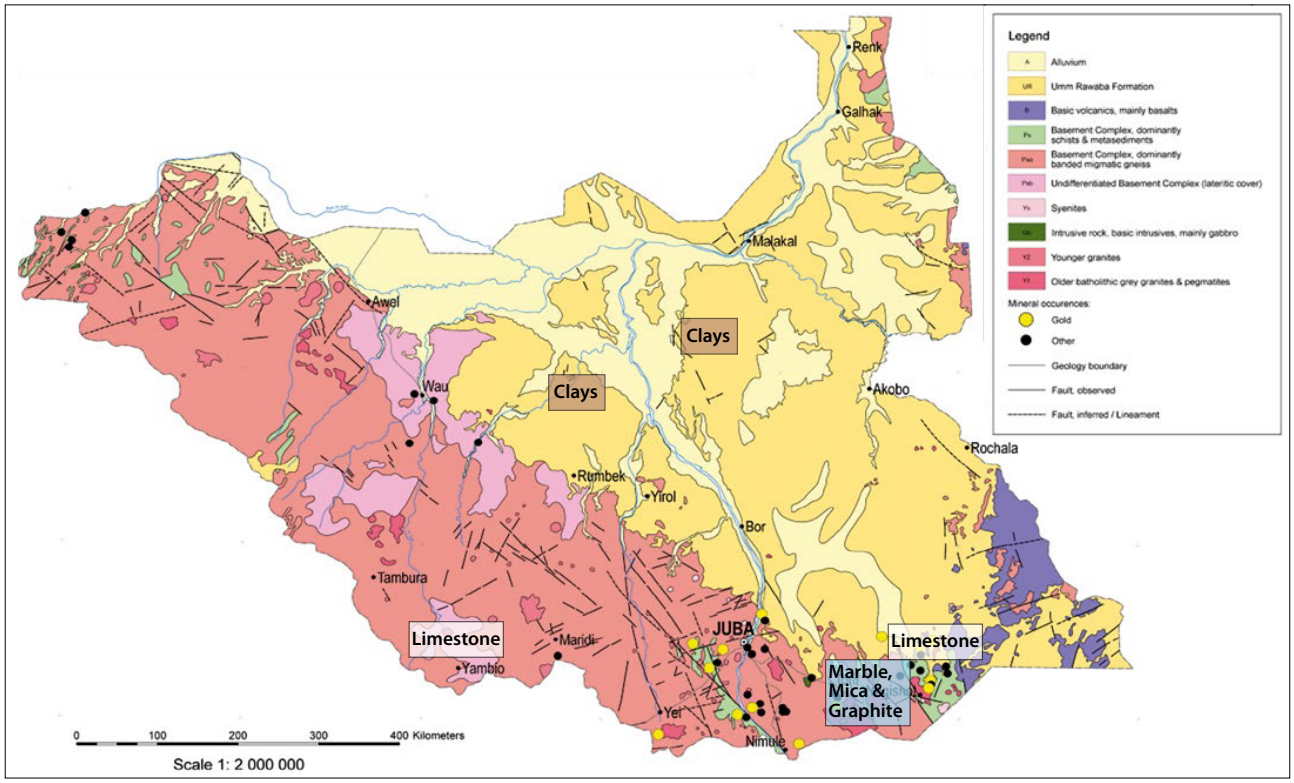
Building and construction minerals

It appears that South Sudan has ample resources to supply the construction industry. Limestone was discovered in Kajokeji in 1997. Other counties with limestone deposits and cement stones are Budi in Eastern Equatoria, Raja in Western Bhar el Ghazal and Mundri West in Western Equatoria as shown in Figure 5.

Aggregates, clays, gravel and sand are plentiful. White sand is present on riverbanks. Khor Romula sand, south of Juba, has been studied for exploitation. It could supply the increasing demand for glass and bottles. Tonnage is unlimited as it is replenished yearly by erosion and deposition. Sample assays reveal more than 95 per cent silicon monoxide (SiO) (Adde, n.d.).

Marble deposits represent enormous potential as a raw material for the cement and burnt lime industries, and for ornamental and building stones, but they have not been extensively studied (Table 3). There are considerable quantities of good quality marble for the cement industry near Kapoeta within the gneiss group of the Basement Complex rocks.

FIGURE 5: LOCATION OF SITES WITH MINING POTENTIAL OF CONSTRUCTION MINERALS



Source: (Akuang, 2011)

TABLE 3: OCCURRENCES OF CARBONATE IN SOUTH SUDAN

Area/state	Carbonate	Status
Kapoeta, Eastern Equatoria	Marble	Explored
Kajokeji, Central Equatoria	Marble/limestone	Unknown
Kineti, Torit, Eastern Equatorial	Dolomite	Prospected
Mangaya, Raja, Western Bahr el Ghazal	Ferroan dolomite	Prospected

Source: (Yager, 2015)

Other minerals

There are numerous other mineral deposits in South Sudan: lead is found mostly east and north of Yei and towards Juba and Torit. Nickel and cobalt occur in patches. Zinc can be mined around Torit, extending to the border with Uganda and south of Juba to Kajokeji. Manganese is found south and west of Juba to Yei and as far as the border with Uganda and Zaire. Diamonds are also thought to occur in Western Bahr el Ghazal.

10.3 Pressures and impacts

The mining, industry and petroleum sectors have significant impacts on the environment and are responsible for the majority of environmental and social impacts on communities. Waste from industrial processes and mining can lead to the pollution of land, air and water courses through effluents, emissions and chemical contamination. Mining can also create large open pits, which contaminate soils and water, and decrease levels of biodiversity.

Environmental impacts of mining

Some of the environmental impacts of mining include toxic wastewater, drilling muds, oil spills and chemical wastes.The socioeconomic impacts can include the dispossession of land, changes to land-use patterns, illness caused by pollution, changes to local population numbers and their access to services, and conflicts between oil developers and communities (Prins Engineering, n.d.). Box 3 underscores the environmental and social impacts of gold mining.

BOX 3: ENVIRONMENTAL AND SOCIAL IMPACTS OF GOLD MINING

Among the socioeconomic impacts of gold mining are food insecurity, increased consumption of alcohol, and negative impacts on health and children's education. Food insecurity is especially exacerbated where people spend too much time mining in place of farming, or where farming has been abandoned altogether (FAO, 2015). For example, the traditional Taposa people of Kapoeta South, have abandoned farming to take up mining, which they see as a quick way to obtain money (Cordaid, 2016).

Children are sometimes forced to miss school to help their parents mine gold. In fact, where the mines are located in remote areas, access to education becomes impossible. In Ngauro Payam of Budi County, it is reported that there is a school with 12 classes but only a few students attend since most of them spend their time in the mines (Cordaid, 2016).

Environmental degradation includes erosion, open pits and deforestation, and impacts on water quality. Mining sites have poor sanitary conditions, with people drinking and bathing in the same water that they use to pan for gold, exposing themselves to water-borne diseases. Furthermore, the mining sites are often far away from settlements or health centres. The incidence of HIV/AIDS is increasing in mining sites because of the prevalence of unprotected sex within the local communities. In 2015, the prevalence of HIV/AIDS was 2.5 per cent of the population ages 15-49 (World Bank, 2016b).

Environmental impacts of oil exploration

Oil exploration is carried out mainly in the central floodplains of Jonglei, Lakes and Upper Nile, which are also endowed with rich terrestrial and aquatic natural resources. Some of the impacts include loss of grazing land, deforestation, loss of traditional livelihood opportunities for some local tribes (Dinka, Nuer and Shilluk), and soil and water contamination of critical ecosystems, such as wetlands. In Unity State, for instance, some of the exploration is within the vicinity of the Sudd wetlands, which is a Ramsar Wetland of International Importance. The oil blocks include part of Block 4, most of Block 5A, Block 5B, and territory south and east of them in the concession of TotalFinaElf (HRW, 2003).

Exploration and oil drilling activities are accompanied by chemicals, drilling muds, toxic produced water and oil spills that pollute the environment in and around oil fields. Toxic "produced water" is an inextricable part of the oil recovery process and is the largest volume waste stream associated with the oil and gas industry. It may originate naturally from the rock formations or have been injected. As it comes to the surface, it emerges with chemicals added during the production processes (Box 4). Data from the United States show that on average, about 7 to 10 barrels of produced water is generated per barrel of crude oil (Veil, 2015).

BOX 4: **PRODUCED WATER**

The briny solution contained in reservoirs of oil and gas is known as formation water. During drilling, a mixture of oil, gas, and formation water is pumped to the surface. The water is separated from the oil and gas into tanks or pits, where it is referred to as "produced water". As the oil and gas in the reservoir are removed, more of what is pumped to the surface is formation water. Consequently, declining oil fields generate more produced water.

Source: (NBS, 2014)

Contaminated soil and water has been an on-going concern in South Sudan's oil fields, responsible for livestock deaths, burned grasses and trees, and unsightly open pits. An analysis of water samples taken from open mud pits near the Thar Jath oilfield in the former Unity State contained high concentrations of salts, mostly potassium chloride, implying that the drilling fluids in these mud pits were not removed after the drilling process was completed. Community water wells have also been found to contain high levels of heavy metals such as lead, which are well known carcinogens. These are all attributed to the oil extraction activities and poor waste-disposal procedures (Cordaid, 2014).

Displacement due to the oil industry

Oil exploration and development activities may require the eviction of communities residing in the environment in which oil is discovered. This results in the loss of traditional livelihoods, grazing lands, ancestral homes and in many cases, sites of cultural significance. Forceful eviction has been known to happen. For example, in 1999 when exploration first started in Block 5A in the former Unity State, there was massive displacement of the indigenous Nuer people. Then between 1998 and 2001, about 204,500 people were displaced from oil fields in Western Upper Nile (Fallet, 2010). There are other indications that almost 500,000 people were displaced from the oil-rich areas in the former Unity State between 1997 and 2003 (ECOS, 2010).

Changes in land-use patterns

One of the impacts of forced displacement is the change in land use as land that was previously used for farming and livestock is abandoned. Subsequently, oil production activities result in unplanned settlements, exploitation of natural resources, such as deforestation, and the building of new access routes. This has affected local activities and livelihood activities such as agriculture, fishing, logging and hunting. For instance, after the war in 2005 a number of villages in Melut in the former Upper Nile State were completely lost and replaced entirely with oil rigs and other geological equipment.

Mala Oil Field

Mala Oil Field, 2005

(Data Source: Landsat, United States Geological Survey)

Mala Oil Field, 2015

Expansion of the Mala Oil Field between 2005 and 2015.
(Data Source: Landsat, United States Geological Survey)

Paloich Oil Field

Paloich Oil Field, 2014

(Data Source: Landsat, United States Geological Survey

Paloich Oil Field, 2016

(Data Source: Landsat, United States Geological Survey)

Satellite images show the expansion of the Paloich Oil Field between 2014 and 2016.
The green colour generally represents vegetation, brown: human settlements or fields and dark blue: water.

Oil extraction and the continuing conflict

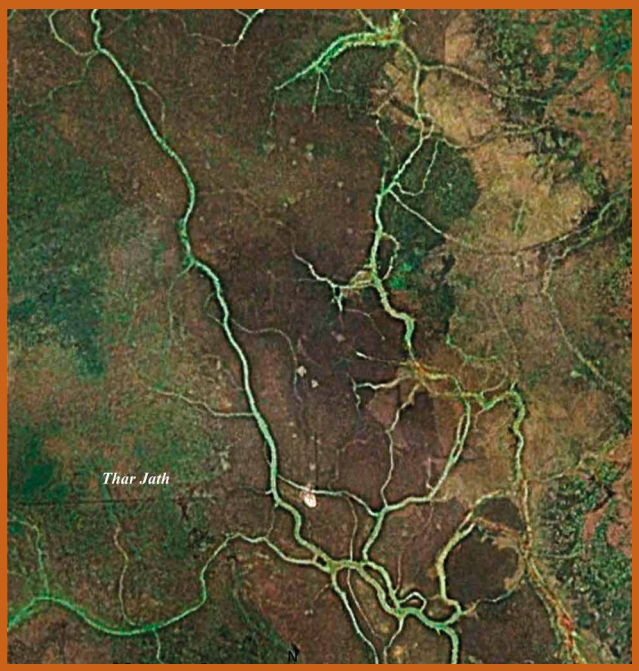
At independence in 2011, Sudan's oil fields were divided between South Sudan and Sudan, but both governments disputed the control of the Abyei area. Since then, civil unrest has continued to affect oil extraction. A major source of conflict is the economic interdependence between the two countries: South Sudan's main oil export route is the pipeline that carries oil from the oil-rich region in the border area between the two countries to Port Sudan in Sudan. South Sudan is dependent on Sudan for export because of the absence of alternative routes. On the other hand, with the cessation of South Sudan, Sudan lost 75 per cent of its oil reserves, representing a huge economic loss.

The current conflict has had a significant financial impact on South Sudan, with GDP in the financial year 2015/16 declining by 6.3 per cent. With oil production disruptions and below-average agriculture production, the economy is expected to contract further in the financial year 2016/2017.

Conflict is also an issue at the local level of government. There is considerable mistrust between local communities and oil companies regarding the adverse repercussions of oil exploration and extraction activities, such as dispossession of land, impacts of pollution on the environment and human health, and lack of services. For instance, in Pariang County in Unity State, there are frequent conflicts between communities and the oil companies due to inadequate consultation before oil works are undertaken, creating conflict when land is possessed or houses demolished. There is also frustration when oil companies fail to build promised houses, schools, clinics or roads. The local authorities have set up committees to liaise with the oil companies to deal with these community issues and there have been some successes; examples include estimating damages linked to oil activities, managing compensation issues and planning development projects financed by oil companies. Some people, however, feel they could be more effective.

Thar Jath Oil Field

Thar Jath Oil field, 1999



Thar Jath Oil field, 2016

Thar Jath Oil field, 2016

(Data Source: Landsat, United States Geological Survey)

These images show the expansion of the Jath Oil Field between 1999 and 2016.The Thar Jath oil extraction plant in South Sudan's Unity state was abandoned by the oil company in late 2013. Four months later, civil war broke out across the country.

Heavy metals, from leaking pipelines and refineries and damage from fighting, have leaked into the groundwater.The green colour generally represents vegetation, brown: human settlements or fields, and dark blue: water.

Impacts on human health

The literature indicates that pollutants from the oil extractive industry are likely to have led to emerging health problems, including rising rates of female infertility, increases in the number of miscarriages, birth defects, and eye and skin problems (Cordaid, 2014); (NBS, 2014). Noxious smells and smoke are also an issue, causing discomfort and distress to people living in or close to production oil fields (Cordaid, 2014).

Research shows that health workers in Melut and Koch indicate a positive correlation between these health issues and increased pollution from the oil industry (Cordaid, 2014); (NBS, 2014). A study in 2014 showed that 88.5 percent of the women in the oil producing areas had delivered babies with birth defects (NBS, 2014). Studies in the U.S. State of Colorado indicate a correlation with proximity to oil and gas fields; and the occurrence of congenital heart defects and neural tube defects in infants (McKenzie, *et al.*, 2014).

The Mala oilfield shows signs of pipe leakage (Nenadic & Koehlere, 2015). Oil spills from leaking pipelines, refineries or corroded or aging equipment and damage from fighting is common and has increased exposure to cancerous petrochemicals in the oil producing areas (MOE, 2014).

Emissions from gas flaring are also a significant environmental issue. During the mining process, gas that is produced along with the oil is flared or re-injected (WEC, 2013), although there is a law regulating against this. The emissions from gas flaring are the products of incomplete combustion. In oil field conditions, many particulates and other harmful gases are dispersed into the air. Some of these hazardous hydrocarbons include benzene, styrene, ethynyl benzene, ethynyl-methyl benzenes, toluene, xylenes, acenaphthalene, biphenyl and fluorine (Strosher, 2000).

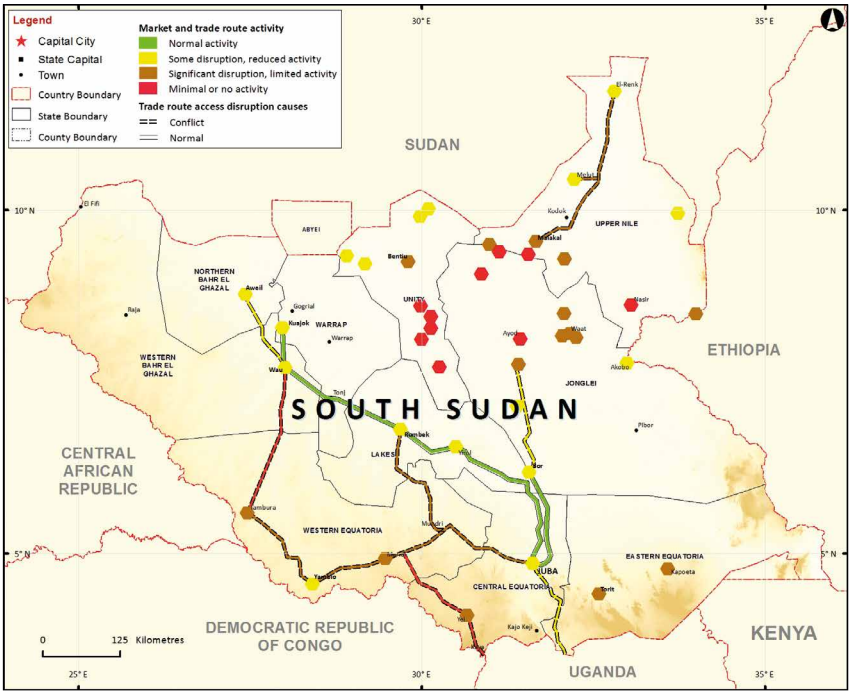
Oil spill around Tharjat oil field, Unity.
Photo credit: Department of HSE, South Sudan Petroleum Authority, Ministry of Petroleum.

Children sort through leaves to eat, Jamam camp.
Photo credit: Oxfam International/Flickr.com/CC BY-NC-ND 2.1

Some of these are well known carcinogens, while others are thought to contribute to complications in foetuses (Nikiforuk, 2014).

Given the superior revenues earned from the oil industry, less support is given to agricultural-based production; coupled with the current insecurity, this has continued to put stress on farming. Already, food production has been disrupted with the displacement of farmers due to the conflict, the destruction of scarce farm capital and the interruption of transportation networks for food distribution (Figure 6). With access to markets impeded, households are unable to acquire goods. Even when the insecurity subsides, returning communities have found their land occupied by oil production or new influxes of people.

FIGURE 6: MARKET AND TRADE FUNCTIONING, FEBRUARY 2017

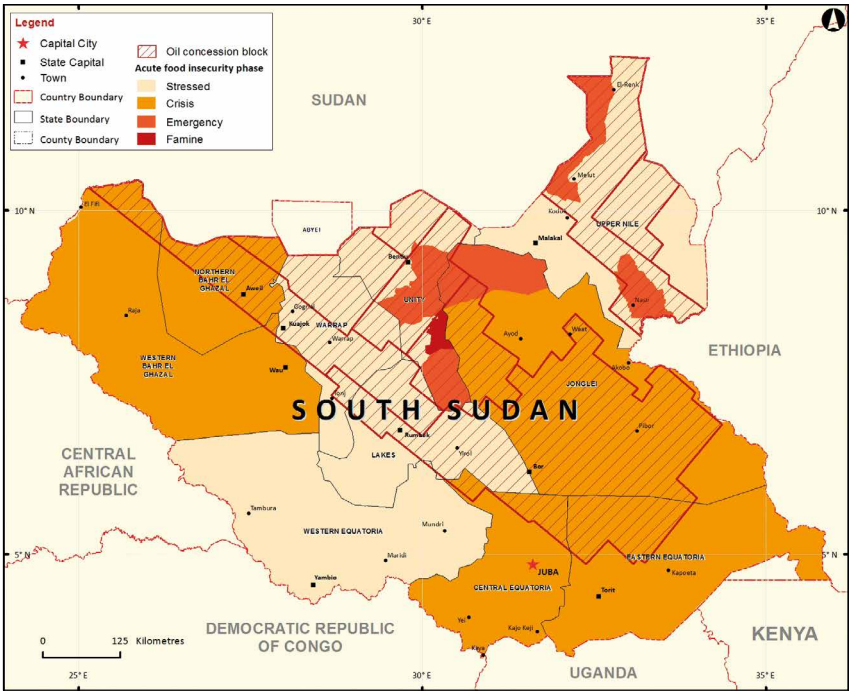


Source: (FEWS, 2017)

Soil pollution by oil spills and produced water further compounds the situation.This has been the case in Rubkona County in Northern Liech State, which lies within the Sudd wetland's floodplain and is fertile land for agriculture (Cordaid, 2014).

Over 90 per cent of South Sudan is considered to be arable land and yet less than 5 per cent is currently farmed. The civil war, continued fighting, shutdown of oil wells and sharp dip in global oil prices have all combined to increase the food insecurity situation in the country (see Figure 7).

FIGURE 7: FOOD SECURITY OUTCOMES IN SOUTH SUDAN, FEBRUARY 2017



Source: (FEWS, 2017)

Habitat loss and land degradation

The development of oil extraction sites requires deforestation and destroys natural wildlife habitat, contributing to the loss of terrestrial and aquatic biodiversity. As well, the dangerous and unprotected pits filled with produced water or crude oil, as well as the thousands of earth holes dug for various purposes by the oil companies, are a serious threat to the safety of the people and their livestock, and contribute to land degradation.

10.4 Responses

Institutional framework for petroleum, mining and industry

Generally, the challenges faced by the industrial sector include poor road and transport infrastructure, high-energy costs, power shortages (if electricity is available) and lack of credit facilities, among others.

Industry
The Ministry of Trade, Industry, and East African Affairs (as gazetted in April 2016) is in charge of the sector and works to encourage investment in the various sectors in the country. The South Sudan Chamber of Commerce, Industry and Agriculture is the umbrella body representing and advocating for the private sector in the Republic of South Sudan.

Petroleum
Since April 2016, the petroleum sector regulator is the Ministry of Petroleum. The Ministry is guided by the Petroleum Act 2012 and the Mining Act 2012, as well as the Mineral Title Regulations 2015 and other bills that are currently being drafted to implement its mandate.

The Ministry is assisted in its duties by three institutions: the National Petroleum and Gas Commission, the National Petroleum and Gas Corporation, and the Petroleum Exploration and Production Authority. The National Petroleum and Gas Commission is the policy-making body for the petroleum sector. It is also in charge of petroleum resources management and coordinates all petroleum stakeholders at national and state levels, from the private sector and including non-governmental organisations.

The National Petroleum and Gas Corporation is a commercial company limited by shares established by the government. It is to be the chief policy making and supervisory body in the upstream, midstream and downstream segments of the sector. The National Petroleum and Gas Corporation handles petroleum agreements for the government while the Ministry of Petroleum is responsible for the management of the petroleum sector. The Petroleum Exploration and Production Authority is to oversee day-to-day activities concerning petroleum operations and advise the Ministry.

Mining
Mining is managed by the Ministry of Mining, with two departments especially relevant: the Directorate of Geological Survey and the Directorate of Mineral Development. The Directorate of Geological Survey is in charge of all geological matters, including the search for mineralised areas and minerals using geo-scientific methods and uses this information to advise the Directorate of Mineral Development. It is empowered to undertake geo-environmental inspections and to ensure compliance with pollution control regulations to minimise environmental degradation. The Directorate is also required to provide technical assistance to artisanal miners.

The Directorate of Mineral Development (Sections 11 and 12) is mandated to manage the mineral resources of the country and to issue mining licences through the Mining Cadastre Office and the Mining Inspectorate. It is also responsible for promoting the sound management of mines by ensuring compliance with environmental laws and other health and safety regulations such as the Labour Bill 2012, which specifies the guidelines for industrial safety in Chapter XI Articles 73-96. Mining Inspectors (Section 14) ensure compliance with the provisions of the law.

The management of mineral resources has been decentralised and each State Government establishes a State Mineral Resources Advisory Coordination Committee (Section 17) for that purpose.

Policy and legal framework

The Petroleum Act 2012 and the Mining Act 2012 are both premised on implementation through voluntary compliance with the law. However, regular audits, inspections and self-reporting are built into the compliance toolbox so as to ensure compliance.

The Petroleum Act 2012

The Petroleum Act 2012 stipulates the institutional framework for the petroleum sector and provides some important requirements to ensure transparency in the management of oil revenues. In particular, the Act provides for public disclosure and publication of information about contracts, oil production data, revenues and ownership of contractors or companies (Tiitmamer, 2014).

The Petroleum Act provides a solid basis for building sound oil company community relations, notably its articles 52, 59, 82, 94 and 100. Unfortunately, these articles have yet to be fully implemented.

The country has enacted the Petroleum Revenue Management Act 2012, in part to establish an Oil Revenue Stabilisation Account and a Future Generation Account. The stabilisation account is intended to protect the country from volatility, particularly when revenues go down, and the future generation account provides reserves for when the oil deposits are depleted. This approach of saving for the future has enabled other resource-rich countries, particularly Botswana, to reduce resource curse (availability of extractive resources).

The Petroleum Act also has features built in to ensure environmental protection (sections 50-62). These include the requirement for Environmental and Social Impact Assessments (ESIA) in Section 15 and 59. An Environmental Management Plan is required in Section 60 to guide the implementation of the Environmental and Social Impact Assessment. Section 61 highlights the responsibility for pollution control. Health and safety considerations are paramount as stated in this Act and are also highlighted in the Labour Bill 2012, which specifies the guidelines for industrial safety in Chapter XI, articles 73-96.

The Mining Act 2012

The South Sudan Mining Act No. 36 of 2012 regulates the prospecting, exploration, development and production of minerals and mineral products in South Sudan. In section 7 of the Act, it formalises the entire sector requiring all miners (large-scale, small-scale, artisanal and others) to be licensed before they can prospect or mine for minerals. The requirement for licensing is likely to increase revenues to the Central Government and there have been calls for the government to create a law similar to the Petroleum Revenue Management Act 2012 to manage mining sector revenues.

The Mining Act is premised on the principles of sustainable development and in section 3 commits to sound environmental management by requiring the integration of environmental management into all mining activities. It also recognises that mining activities should actively engage the three major stakeholders: the government, developers and the communities, so as to ensure good practice and community relations.

Finally, it encourages waste minimisation, restoration of degraded ecosystems and the need to keep up with best practice that encourages the efficiency and competitiveness of the mining industry. Chapter XV states the provisions for pollution control and for the restoration of land after mine closure.

The Act, in section 7(1)(f), recognises the traditional rights to pan minerals from the rivers, streams, the land surface and other areas, and this sets the stage for improvements to be made to the artisanal mining sector. Individual state governments are required to draw up Regulations for Artisanal Mining, which would simplify procedures and processes as subsistence miners apply for licences. But the actual legal framework (Chapter IX, sections 74-79) has bureaucratic requirements that ignore the rural poor who struggle for survival and who have found artisanal mining to be an additional income generating activity that allows them to improve their daily lives.

Mining (Mineral Title) Regulations 2015
These were developed to operationalise article 198 of the Mining Act 2012. The regulations require both large-scale and small-scale miners to acquire mining licences. This basically formalised artisanal mining in the country.Some of the environmental safeguarding provisions of the regulations include these requirements:

- Carry out Environmental, Health, Social and Gender Impact Assessments
- Prepare and implement a Rehabilitation and Mine Closure Plan
- Prepare and implement a Community Development Agreement, which details how any development needs of men, women and children will be met.

The government is in the process of preparing guidelines for establishing a Community Development Agreement. This will provide concrete direction on the issue of development projects.

The Environment Bill 2014
Mining companies in some countries are required to follow environmental and rehabilitation codes, ensuring the area mined is returned to close to its original state. One of the guiding principles of the National Environment Bill 2014 is that the polluters shall be responsible for paying for the pollution that they cause, according to article 20 on the management of mineral resources (MOJ, 2014). Polluters will also pay a pollution tax to the Environment Fund (article 52), that will be used to finance environmental programmes at the local, state and national levels.

The Environment Protection and Management Bill 2012 has provisions for Environmental Impact Assessments and Environmental Audits for projects in mining, all aimed at reducing environmental degradation and ensuring pollution control. The National Environment Policy 2012 also aims to control pollution and ensure protection of the environment and water bodies that may arise from mining activities (GOSS, 2012). For instance, it requires that riverbanks be protected from mining activities through the construction of embankments and to avoid sand harvesting too close to the banks and in vegetated areas. It also requires the restoration of landscapes after the conclusion of the various mineral extraction activities.

10.5 Conclusion

Although South Sudan is endowed with abundant mineral resources and the potential for secondary and tertiary industries, the only modern industrial sector is the oil industry. Gold contributes somewhat to the country's primary sector, but it is currently mined at an artisanal level. There is some construction activity but practically no manufacturing. It is likely that there are industrial-scale gold deposits in South Sudan, and there are ample resources to supply the construction and cement industries, including marble, but the industrial sector is generally grossly under-developed in South Sudan.

The limitations to industrial development include the lack of geological exploration in non-hydrocarbon minerals, the dearth of investments, the shortage of trained human resources, the lack of basic infrastructure, power shortages, and the state of conflict and insecurity.

Industrial developments can have significant environmental and social impacts. In South Sudan, these include effluents, emissions and chemicals emitted to the land, air and water. Mining and oil extraction sites also create large open pits that contain contaminants.

The impacts of oil exploration include:

- Deforestation and loss of habitat and biodiversity
- Loss of grazing land and traditional livelihood opportunities
- Soil and water contamination, especially of critical wetlands due to oil spills
- Eviction of communities and resulting mistrust between local communities and oil companies
- Emerging health problems related to exposure to oil contaminants, including gas flaring.

Although the government has instituted policies and set up ministries to oversee industrial development and help prevent negative impacts on the environment and society, implementation has not kept up with the need to protect ecosystems and human health.

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Restructuring in Wau to accommodate the growing number of the displaced people.
Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0

CHAPTER 11
OUTLOOK & RECOMMENDATIONS FORACHIEVINGTHESUSTAINABLE DEVELOPMENT GOALS (SDGS)

CHAPTER 11
OUTLOOK & RECOMMENDATIONS FOR ACHIEVING THE SUSTAINABLE DEVELOPMENT GOALS (SDGS)

11.1 Context

South Sudan's Draft Vision document 2040, the African Union Agenda 2063 and the United Nations Sustainable Development Goals (2030) provide road maps for the future course of action. The following conclusions and recommendations are offered within this context.

PREAMBLE TO "TRANSFORMING OUR WORLD: THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT, 2015"

People
We are determined to end poverty and hunger, in all their forms and dimensions, and to ensure that all human beings can fulfil their potential in dignity and equality, and in a healthy environment.

Planet
We are determined to protect the planet from degradation, including through sustainable consumption and production, sustainably managing its natural resources and taking urgent action on climate change, so that it can support the needs of the present and future generations.

Prosperity
We are determined to ensure that all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature.

Peace
We are determined to foster peaceful, just and inclusive societies, which are free from fear and violence. There can be no sustainable development without peace and no peace without sustainable development.

Partnership
We are determined to mobilise the means required to implement this Agenda through a revitalised Global Partnership for Sustainable Development, based on a spirit of strengthened global solidarity, focused in particular on the needs of the poorest and most vulnerable and with the participation of all countries, all stakeholders and all people.

Source: Resolution adopted by the United Nations General Assembly on 25 September 2015

Conflict and the Environment in South Sudan

The prevailing conflict and violence in South Sudan has an undeniable impact on the environment, both directly and indirectly. Examples of direct environmental impacts of the on-going conflict as observed in 2017 include the following:

- **Urban areas:** The on-going conflict has destroyed infrastructure (tractors, diggers, shovels, fencing, housing, etc.) around municipal landfills, so the normal processing of solid waste is no longer possible. At the Juba municipal waste dump, spontaneous combustion at a depth of 2-3 meters is continuous and unremitting. The resident community living off the dumpsite inhale the toxic fumes from burning plastics. The Field Visit Team noted reports of marginalised ethnic groups being forced to move onto the landfill site to survive, further exacerbating their poverty and desperation.

- **Agricultural production:** Due to the on-going conflict, many farmers do not plant for fear of having their crops stolen by the combatants. Farmers are forced to accelerate charcoal production to survive, thereby further triggering environmental degradation.

- **Family and community:** In some areas, mature male family members were absent at the time of the field visits, leaving women and children, and sometimes only children, to fend for themselves. Male members were either hiding in the bush or conscripted into militias fighting in the conflict.

- **Wildlife:** Populations of antelope (white-eared kob, for example) have been culled for meat to feed the population, as other sources of protein (beef, small ruminants) have either become more expensive or unavailable due to forced changes in migration patterns. Elephant and rhino horns are sold for cash into a ready market. The Wildlife Conservation Society estimates that 30 per cent of the South Sudanese elephant population has been lost due to poaching.

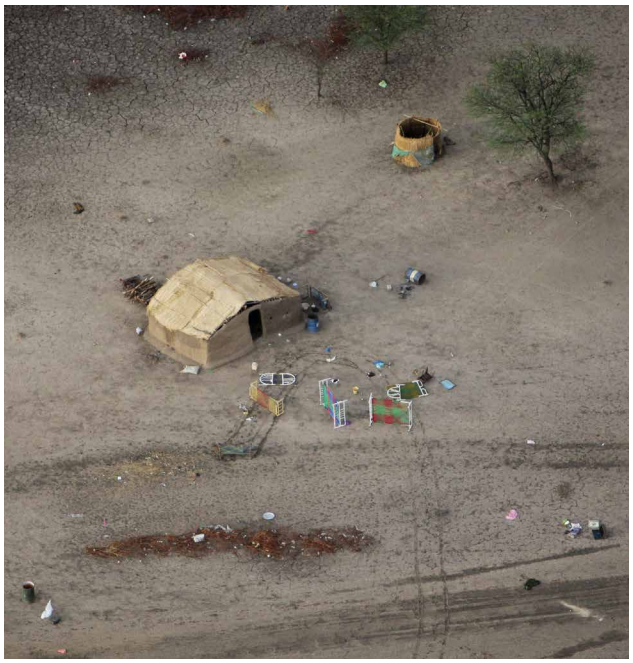
- **Forests and deforestation:** During times of conflict, people naturally avoid insecure areas, thereby concentrating charcoal production in accessible places and further intensifying land degradation around urban centres. Although accurate data were not readily available, it was reported that teak and mahogany are mined selectively to convert to cash to support the conflict. In Jebel Lado County, the Field Visit Team interviewed a charcoal burner who noted that poles are no longer available, probably due to the intensification of charcoal production and the consequent lack of tree vitality.

- **Petroleum:** The urgency to produce income to support the economy creates a situation in which shortcuts are made in production that does not fully protect the environment from pollution that has become the norm. Examples include produced water (in traditional oil and gas wells, produced water is brought to the surface along with oil or gas) and oil spills, amongst others, all of which are exacerbated due to flooding in the rainy season.

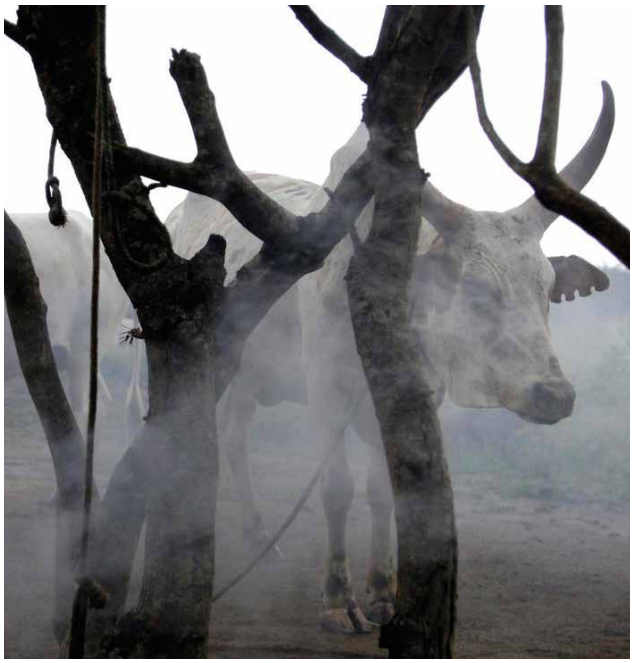
- **Livestock production:** As herders are no longer able to follow traditional and preferred migration routes, cattle are either concentrated on non-productive land causing overgrazing or forced onto pasture where there are no pre-existing relationships between farmers and herders, leading to new sources of conflict. Livestock disease outbreaks associated with non-traditional migration routes have also been documented.

Indirect impacts of conflict are evident throughout the country, demonstrating the complex and deleterious nature of wartime economies. For example, as commodity prices increase, the rural population experiences aggravated poverty, which in turn affects how they manage their natural resources; examples include the increase in charcoal production, artisanal mining and the selling of livestock herds.

Kapoeta girl bringing charcoal to a local restaurant. *Photo credit: Peter Gilruth, Environmental Pulse Institute*



Aftermath of attack on Abyei. *Photo credit: United Nations Photo via Foter.com / CC BY-NC-ND*



Displaced Dinka set up cattle camps as a result of conflicts in the region. *Photo credit: United Nations Photo via Foter.com / CC BY-NC-ND*

Visions and goals

The context for achieving sustainable development in South Sudan is captured in major vision documents that range from the global-level Sustainable Development Goals 2030 (SDGs), to those emanating from regional platforms (African Union - Vision 2063, IGAD Article 7 and Regional Strategy 2016 -2020) to the national level (RSS, 2016). A summary of each of these policy settings and their importance for South Sudan follows.

Sustainable Development Goals (SDGs)

In September 2015 the international community agreed upon a new set of Sustainable Development Goals (SDGs) (Figure 1). This process was one of the main outcomes of the Rio+20 Conference at which UN member states agreed to launch a process to develop a set of SDGs, building on the Millennium Development Goals and framing the post-2015 development agenda. Member States adopted an Outcome Document: "Transforming Our World: 2030 Agenda for Sustainable Development" at the UN Summit for the Post-2015 Development Agenda. Among other things, the document contains a set of 17 SDGs and 169 accompanying targets. These were further elaborated through indicators focused on measurable outcomes. At its forty-seventh session in March 2016, the UN Statistical Commission agreed on a global indicator framework for the post-2015 development agenda's goals and targets.

These goals and targets are action oriented, global in nature and universally applicable. They take into account different national realities, capacities and levels of development, and respect national policies and priorities. They build on the foundation laid by the Millennium Development Goals (MDGs), seek to complete the unfinished business of the MDGs and respond to new challenges. These goals constitute an integrated, indivisible set of global priorities for sustainable development. Targets are defined as aspirational global targets, with each government setting its own national targets guided by the global level of ambition, but taking into account national circumstances. The goals and targets integrate economic, social and environmental aspects, and recognise their interlinkages in achieving sustainable development in all its dimensions.

FIGURE 1: **SUSTAINABLE DEVELOPMENT GOALS**

Source: (Akuang, 2011)

BOX 1: SUSTAINABLE DEVELOPMENT GOALS, TARGETS AND INDICATORS OF DIRECT RELEVANCE TO THE ENVIRONMENT IN SOUTH SUDAN: GOALS 6, 7, 11, 12, 13, 15 AND 17

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable, and modern energy for all

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts* (*Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.)

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation, and halt biodiversity loss

Goal 17. Strengthen the means of implementation and revitalise the global partnership for sustainable development

Source: (UN, 2015)

The UN interagency expert group on indicators has compiled a list of indicators for each of the goals and targets to track progress towards the SDGs that can be customised for national levels, subject to the availability of time series and reliable data. Adapting and implementing the SDGs to a South Sudanese context would require that relevant Ministries review the targets and indicators, and prioritise and incorporate them into national policy documents that in turn serve as a basis for short- and medium-term planning at the sectoral level.

The government also needs to adjust structures to allow stakeholder groups to fully participate. The interplay among the various ethnic groups who are critical for peace building is particularly important for environmentally sustainable development.

The integrated nature of the SDGs suggests that each of these goals should not be pursued in isolation. Indeed, almost all the 17 SDGs cannot be achieved without sustaining the environment, hence the need for cross-sector approaches to achieve the goals.

South Sudan's main challenges related to SDG implementation include: institutional arrangements, adequacy of financing and means of implementation, domestic and external resources, mobilisation and partnership with stakeholders and the private sector. The government needs to undertake a thorough review and analysis of these and other related challenges and opportunities at the highest level.

African Union Vision 2063

At the continental scale, African Union (AU) authorities have effectively captured Africa's uniqueness within the global context of the SDGs through the AU's Vision 2063 (AUC, 2015), which includes the following action items that are applicable to South Sudan:

1. Develop strategies to grow African Green Economies: This action item is directly linked to SDG 12. Although the implementation of a Green Economy may vary somewhat by country, the AU recognises that efficient production and consumption patterns must be adopted if African nations are going to compete in global markets. African nations should not make the same mistake – choosing resource intensive development pathways – from which other countries in the world are struggling to extract themselves.

2. Act with a sense of urgency on climate change and the environment: The AU Vision 2063 recognises the need to confront climate change with a sense of urgency, especially since the Intergovernmental Panel on Climate Change (IPCC) reports that Africa could well be the continent most at risk to the effects of climate change. The IPCC's Fourth Assessment Report notes that warming in Africa throughout the continent and in all seasons, is very likely to be greater than the global annual mean warming, with drier subtropical regions warming more than the moister tropics. However, it is unclear how rainfall in the Sahel will evolve. Agricultural production and food security (including access to food) in many African countries and regions are likely to be severely compromised by climate change and climate variability.

3. In response, the AU proposes implementing the Programme on Climate Action in Africa, which includes:

- Identifying five regional technology centres, linked with national designated climate technology entities;
- Programmes on climate change targeting women and youth;
- A climate resilient agricultural development programme, such as the Comprehensive Africa Agriculture Development Programme (CAADP);
- Sustainable forest management programmes; and
- National adaptation plans, systems and structures (National Designated Authorities and Implementation Entities).

Each of these action items will support South Sudan's sustainable development by offering opportunities to benefit from regional networks that share knowledge on best practices for adapting to climate change. Best practices should target technologies to help mitigate climate change and adapt to its impacts.

The Government of South Sudan's draft Vision 2040

At the national level, the Government of South Sudan's draft Vision 2040 provides a specific focus and a set of follow-up actions. At the highest level, the draft Vision 2040 considers the welfare of its citizens as its top priority:

"The key resources and assets of the country will be equitably distributed between its people. Communities will be involved in the use and preservation of their environmental assets and will benefit directly from their exploitation. The attitude towards natural resources will pay attention to fair distribution between present and future generations. The eradication of poverty will have created a situation where no one will be compelled to damage the environment in order to obtain their basic needs."

Attaining this noble vision will require a system to build milestones and track progress.

> *"Non-oil revenue collection is important because it is a sustainable long term source of income for the country. Oil won't be there forever but agriculture will. We need to diversify the economy. The government currently only receives $10 million dollars per month from oil revenues, which is not enough to sustain the entire country,"*
>
> Hon. Lako, Jubek State Minister of Finance
> Hon. John Ijino Lako and Olympio Attipoe, UNDP Technical Specialist, Support to Public Financial Management project (UNDP, 2017)

Vision 2040 notes the impact of reliance on oil revenues

The draft Vision 2040 notes that since the inception of the Government of South Sudan following the Comprehensive Peace Agreement (CPA), oil revenue has accounted for about 95 per cent of public expenditure. The need to expand and diversify the non-oil revenue base must be emphasised, particularly considering that there is huge potential from other sources, such as agriculture and animal resources, mining, industry, trade and tourism. Despite its bringing needed foreign exchange earnings, the oil revenue has also brought with it additional pressures for expenditure, rent-seeking behaviour and reduced incentives to undertake key fiscal reforms that would help ensure medium- and long-term economic stability. Improving transparency and predictability of oil revenues is a challenge, but it is critical for financial management. Oil revenue in South Sudan has also proven volatile, unpredictable and increasingly witness to the negative aspects of natural resources (RSS, 2016).

Vision 2040 notes the impact of unsustainable land use

The draft Vision 2040 notes that the physical environment in South Sudan has been degraded for decades by the continuous use of wood as fuel for cooking and seasonal burning of forests by pastoralists with the aim of regenerating pastures for their herds. These practices are a direct consequence of the increasing demand for charcoal in towns and the traditional system of animal husbandry practised by pastoralists. Thus, there is a clear need for policies that promote environmental conservation through a combination of mitigation (e.g. a gradual transition to more diverse energy sources, including solar and hydroelectric) and ecosystems-based adaptation (e.g. agroforestry and other resilience building interventions).

In addition, the draft Vision 2040 notes that oil exploration has been contributing to serious environmental degradation, especially around the oil fields in Unity State and Northern Upper Nile State, where pollution has occurred. The negative impacts include the following:

- Decimation of some species of fauna
- Withering of flora
- Degradation of water sources - produced water and spills
- Increasing incidence of diarrhoea
- Miscarriages among women in those areas
- Reports of male impotence.

Vision 2040 notes the impact of poor to non-existent urban management

Proper physical planning and effective waste management have not matched the increasing rural-urban migration. This has resulted in congestion of towns and poor sanitation, with many people residing in poor and over-crowded shelters. This lack of infrastructure is exposing people to communicable diseases such as tuberculosis. Furthermore, poor sanitation and hygiene also exists in and around the major towns in South Sudan, largely due to poor waste management. South Sudan needs to quickly address this issue as it poses a health risk to town dwellers and the surrounding villages due to the risk of epidemics such as cholera and other water-borne diseases.

Vision 2040 notes the impact of conflict on forest resources

The draft Vision 2040 states that the Sudan Armed Forces troops used tree felling as a war strategy around former Sudan Armed Forces garrison towns, with the aim of removing any obstruction to their ability to see Sudan People's Liberation Army forces from a safe distance. This behaviour caused deforestation and irreparable damage to the environment in most towns in South Sudan.

Linkages across policy platforms-from national to regional to global

Using the Government of South Sudan's draft Vision 2040 as the reference point, Table 1 highlights the linkages across the regional (African Union (AU) and Intergovernmental Authority on Development (IGAD) and global SDG levels. The linkages show the high degree of alignment across the policy platforms and serve as a foundation for the government's efforts to seek partnerships for development at all levels.

TABLE 1: LINKAGES BETWEEN POLICY PLATFORMS ACROSS GLOBAL, REGIONAL AND NATIONAL LEVELS

Draft Vision 2040 Strategic Goals	Relevant African Union policies (AUC, 2015)	Relevant IGAD policies (IGAD, 1996); (IGAD, 2016)	Highly Relevant SDGs
To build a prosperous, productive and innovative nation	African Green Economy	Promote peace and stability in the region and create mechanisms within the region for the prevention, management and resolution of inter-state and intra-state conflicts through dialogue	All SDGs relevant
To increase agricultural productivity to enhance food security	Climate change	Initiate and promote programmes and projects to achieve regional food security	2, 5, 6, 12,13, 15, 17
To improve livestock and fish production	Climate change	Initiate and promote programmes and projects to achieve regional food security and sustainable development of natural resources and environmental protection	1, 2, 7, 8, 9, 10, 12, 16, 17
To improve the national marketing system for all national products.	African Green Economy	Create an enabling environment for foreign, cross-border and domestic trade and investment	8, 9, 12, 15, 16, 17
To establish and develop the mining industry	African Green Economy		4, 8, 11, 13, 15, 17
To establish and develop the tourist industry	African Green Economy		All SDGs are relevant
To promote a sustainable environment	African Green Economy and Climate Change	Promote joint development strategies and gradually harmonise macro-economic policies and programmes in the social, technological and scientific fields	1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 17
To ensure balanced, integrated, equitable and sustainable rural development by taking towns to the people and averting urban-biased development	African Green Economy	Develop and improve a coordinated and complementary infrastructure in the areas of transport, telecommunications and energy in the region	

11.2 Challenges and Opportunities

Famine

South Sudan has extensive oil and minerals, forests, rangeland, agricultural land, water resources and abundant wildlife. However, the ongoing conflict prevents the country from sustainably using and maintaining its natural resources for the population's wellbeing.

People have lost their livestock and even their farming tools. The violence has severely impacted people's ability to meet basic needs, such as safe drinking water, food supplies, shelter and health care. In some places, people rely completely on whatever plants they can find, fish they can catch and wildlife they can poach. This has resulted in the United Nations recently declaring a famine in South Sudan (see Chapter 2) (Rowlands, 2017). For the UN to officially declare a famine, three important conditions must be met. Firstly, 20 per cent of the population must have fewer than 2,100 kilocalories of food available per day. Secondly, more than 30 per cent of children must be acutely malnourished. Finally, two deaths per day in every 10,000 people – or four deaths per day in every 10,000 children – must be caused by lack of food. It is estimated that more than 5 million people or 40 per cent of South Sudan's population are at risk of starvation.

The lack of available food triggers poaching and cattle theft, which in turn leads to more conflicts. Any type of conflict has a negative impact on the land, depending on the methods and weapons used – bombs, land mines, scorched earth, etc. Many people displaced by the conflict have found refuge in Protection of Civilian (POC) camps. To survive, they cut trees for fuel and plough land for crops, degrading the land around the camps. Furthermore, sanitation is poor, and water and soils have become polluted around these areas. This in turn leads to land degradation. Thus, the famine is a human-made phenomenon. The solution is to end the conflict so people can get back to farming the land and tending their livestock, which will reduce the food crisis and eventually improve overall health.

Internal Displaced People (IDP) and Refugees

On 19 September 2016, the United Nations General Assembly adopted the New York Declaration for Refugees and Migrants, committing to protect the rights of refugees and migrants, to save lives and share responsibility for large movements on a global scale.

South Sudan has now become the world's fastest-growing refugee crisis, with more than 1.8 million refugees – including one million children – having sought safety in Uganda, Sudan, Ethiopia, Kenya, the Democratic Republic of the Congo and the Central African Republic. Around two million people are displaced internally in South Sudan. The main drivers of food insecurity are the lack of livelihood opportunities, limited access to cooking fuel, restriction of movement in some areas, high prices on local commodities and limited access to land for farming. Furthermore, for these refugees, access to safe drinking water, sanitation and energy is usually inadequate and refugees frequently need to compete for dwindling resources, triggering tensions with host communities. Implementing environmentally sound refugee site planning is critical (UNHCR, 2017).

South Sudan: Displacement in Unity. *Photo credit: EC/ECHO/Anouk Delafortrie*

South Sudan's main challenges that relate to implementing the SDGs include institutional arrangements, adequate financing and means of implementation, domestic and external resources, and mobilisation and partnership with stakeholders and the private sector. The Government of South Sudan needs to undertake a thorough review and analysis of these and other related challenges and opportunities at the highest level.

Opportunities

South Sudan must seize and take action on the following opportunities to be able to sustain development:

- Maintain peace and security
- Manage the internal migration of people
- Develop an industrial base to create income-generating activities and employment
- Attract investments for infrastructure financing and tourism
- Strengthen institutional capacity to manage natural resources
- Develop policy and legislative frameworks for the sustainable development, management and conservation of natural resources
- Establish effective enforcement mechanisms for protecting wetlands, forests and wildlife
- Enhance the capacity to conserve and sustainably use natural resources for commercial and domestic purposes, and to control their illegal use
- Build the capacity of environmental institutions by providing resources, training and tools
- Adapt to the impacts of climate change
- Negotiate transboundary issues, such as Nile River water sharing (IRG, 2007).

By taking these actions, South Sudan has the opportunity to develop as a prosperous nation once peace and normalcy return. It is beyond the scope of this report to address all the challenges; nevertheless, some recommendations are made in the following section towards achieving the Sustainable Development Goals.

11.3 Recommendations

A series of both short- and longer-term recommendations is offered here. The short-term recommendations include those that could move South Sudan from conflict to post-conflict with necessary environmental infrastructure in place, both on-the-ground (e.g. agroforestry, wildlife controls, etc.) and regarding policy/legal provisions (e.g. forest law, urban solid waste environmental acts, etc.). The medium- to long-term recommendations address those needs that should be pursued once the current conflict has lessened, and/or for those areas of the country (e.g. Kapoeta) that are experiencing relative security.

To demonstrate that such transitions are possible, a case study from Rwanda, which resurrected itself after the 1994 genocide against the Tutsis, is presented in Box 2. South Sudan should review this and other such examples, and apply the lessons to its own development.

BOX 2: CASE STUDY OF RWANDA

Peace and security

In the transition from conflict to post-conflict and a peaceful nation, there are several development lessons to be learned. It is useful to review the case of Rwanda, to understand whether the experience of neighbouring countries might apply to South Sudan.

Although it took almost 10 years after the genocide against the Tutsi in 1994, the Government of Rwanda took decisive steps to put policies, laws and institutions in place for the post-conflict rehabilitation of degraded critical ecosystems and for the sustainable utilisation of natural resources as ecosystem services. The Environmental Policy was adopted in 2003.

The Environmental Policy emphasizes Rwanda's constitutional right for all to live in a healthy environment and for decentralised and citizen participation in environmental management. One of the policy statements that directly addressed conflict-related environmental degradation, such as the deforestation of Gishwati and Mukura natural forests, is "to improve the conservation and management of forests and protected areas" through strategic actions, including "the involvement of the resident population in the rehabilitation, protection and conservation of natural forests" and "enhancing the rehabilitation of degraded ecosystems and the restoration of threatened species".

Rwanda's legal and institutional framework for environmental management

As part of the implementation of Rwanda's Environmental Policy, the organic law on environment was passed in 2005 and an Environment Protection Authority (EPA) was established by statute in 2006. Of particular significance is Article 52, which provides for the State to identify critical areas for protection, conservation or rehabilitation including: ecosystems; forests, woodlands, species of biodiversity and protected zones; monuments, historical sites and landscapes; water systems and their quality; and banks and shores, rivers, streams, lakes, plains, valleys and swamps. Article 67 provides for environmental assessments including Environmental Impact Assessments (EIAs) at the project level and Strategic Environmental Assessments (SEAs) at policy, strategy and plan levels. Most significant is the statutory requirement for the Environment Protection Authority to prepare a biennial state of environment report that is presented to the Parliamentary Environmental Oversight Committee for approval, which then leads to national implementation of policy recommendations.

These policy instruments, together with the numerous international environmental protection protocols that Rwanda signed, including the 2008 national ban on plastic bags, brought Rwanda considerable international recognition as an African leader in environmental protection.

The following section offers recommendations to the Government of South Sudan and its partners in development on how to move forward on the path from conflict, to post-conflict, to sustainable development. Firstly, this section reflects on the linkages between peace building and natural resources management, and suggests immediate actions to move from conflict to post-conflict through the lens of the environment. Secondly, it provides recommendations to strengthen government institutions, from both policy, and data and information perspectives. Finally, it addresses recommendations to the specific SDGs/thematic sectors, while recognising the interplay between institutional and thematic development. Recommendations to the UN Environment and its partners are interspersed throughout the sections.

Moving from conflict to post-conflict

A widely-held perception is that the sustainable management of natural resources and the environment are distinct from – and sometimes even conflict with – peacebuilding goals (UNEP, 2012). This perception is misinformed and outdated. Rather, actions to sustain natural resources and the environment have the real potential to foster peace and they underpin many peacebuilding priorities. From economic recovery and government revenues to sustainable livelihoods and the restoration of basic services, the way natural resources are managed and governed can either fundamentally support or undermine peacebuilding objectives. Realising the potential of natural resources to contribute to peacebuilding starts by assessing how they contributed to conflict, how they were directly and indirectly impacted by conflict, how risks can be mitigated and how effective laws and institutions can be construed to support the sustainable use of natural resources.

Recommendations for peace building through natural resources management

There are four types of resource disputes that can present a general challenge to national stability:

1. Secessionist conflicts in which resource-rich regions seek to split away from the rest of a country;
2. Disputes over resources as part of a new national compact (i.e. in the context of a peace agreement or new constitution);
3. Grievances over stand-alone projects, such as mines and hydroelectric dams; and
4. The cumulative impact of multiple small-scale clashes, typically over land, livestock or fresh water (Brown & Keating, 2015).

In addition to dominant ethnic issues, out of the four potentially contentious issues outlined above, currently the latter is at the heart of disputes throughout South Sudan.

The key challenges are to:

- Identify those natural resources that have the greatest potential to contribute to conflict and peace, and
- Determine how they should be managed and which stakeholders should be engaged in the process.

Inception workshop 2016, Juba, working across sectors to plan environmentally sustainable development. *Photo credit: UN Environment*

South Sudan's natural resources – its land, water, grasslands, forests and mineral deposits – are critical to the country's prospects for a peaceful and prosperous future. The majority of South Sudan's people rely on these resources for their daily survival. The country needs to harness these assets to create jobs, generate revenue to fund basic government services and lift the country from its position near the bottom of the Human Development Index. Effectively and sustainably managing South Sudan's natural resources could greatly improve the country's prospects for peace and stability. The literature on peace building and environmental management suggests the following essential elements for an effective natural resource management strategy:

- Improve resource governance and sustainability
- Provide better accountability
- Involve more community participation
- Provide stronger mechanisms to resolve disputes, reduce competition for resources and improve transboundary resource management (UNEP, 2013).

Land

Resolving land-tenure issues and instituting successful land management is a necessity and can be accomplished by the following actions:

- Prepare for and manage the growing demand for land. Rapid population growth, returning refugees and environmental degradation conspire to reduce the availability of productive land and increase competition over land in rural areas (for livestock and agriculture) as well as in urban centres (for infrastructure).

- Stop land grabbing: weak and inconsistent land management, pervasive corruption and insecurity have provided opportunities for powerful elites to engage in land grabbing, which undermines the rule of law and fosters resentment among local people.

- Establish the structures to resolve land disputes by developing more effective mechanisms to resolve land disputes, which are constraining development and disrupting health community relations.

- Launch a major initiative to demarcate and secure people's land rights (UNEP, 2013).

Restructuring in Wau to accommodate the growing number of the displaced people. *Photo credit: UNMISS/Flickr.com/CC BY-NC-ND 2.0*

Forests

South Sudan's forests and bushlands are a source of fuel and timber, the exploitation of which is leading to deforestation and land degradation. They can be protected by the following actions:

- Implement and maintain a forest inventory and monitoring programme
- Reduce the rate of deforestation for firewood by planting woodlots, introducing agroforestry initiatives and involving communities more closely in managing their local forests
- Curb the illegal trade in high-value timber by raising awareness of the impacts of the trade
- Establish a certification scheme that provides a market for sustainably produced, conflict-free timber
- Provide alternative sources of domestic energy (UNEP, 2013).

Grassland

There are nearly 12 million cattle in South Sudan. Yet the country faces famine and continues to import most of its meat from neighbouring countries, losing hundreds of millions of dollars every year without exports in return.

Cattle are an important source of rural livelihoods and play important roles in defining social status. Cows are considered a "walking wealth", especially among herding communities. A large cattle herd increases an individual's importance in the community. Because of this, the nation's huge livestock wealth has not been commercially used or introduced into the country's economic development. If South Sudan develops the livestock industry, it could avoid possible conflicts by undertaking the following actions:

- Create a rangeland policy
- Establish formal grazing rights
- Institute well-defined property rights that are enforced and transferable
- Promote responsible rangeland management
- Enhance the understanding of the importance of sustaining pastoralism as a livelihood among non-pastoral groups
- Negotiate and build peace among the users of communal grazing lands.

Illegal ivory being burned in Juba in the presence of South Sudanese National Ministers, Foreign Diplomats, UN Agencies, and the public.
Photo credit: UN Environment South Sudan

In many parts of the country, cattle are the only path to marriage. The bride price is typically 20 to 40 head, each worth up to US$500. A girl who is perceived as beautiful, fertile and of high social rank can fetch as many as 200 head of cattle. This is a significant incentive for young men to steal livestock. Cattle theft is a common occurrence and stolen animals are a source of meat, milk and dowry. These thefts exacerbate existing conflicts. According to some estimates, more than 5,000 civilians have been killed in cattle raids since South Sudan gained independence in 2011. If currency were used instead of cattle, it could help to solve the theft problem and reduce conflict.

Source: (Burnett, 2012)

Extractives
South Sudan contains rich underground resources including valuable oil reserves. Suggested actions include:

- Make the country's mineral resources a strategic priority. This is a viable strategy for the country to become financially self-sufficient.
- Develop an extractives sector that does not create or exacerbate conflict.
- Minimise the negative social and environmental impacts of extraction operations.
- Strengthen transparency and accountability in the mining sector to improve governance and tackle corruption.
- Provide responsible security around active sites.

Man panning for gold in Kapoeta Region.
Photo credit: Arshad Khan, UN Environment

Water
Water management systems have to tackle these inter-related challenges:

- Prepare for and manage the increased demand for water
- Adapt to the risk of climate-related disasters; prepare for the impacts of climate and other human-driven change that will affect South Sudan's water security. It is recommended that the government implement disaster risk reduction and climate change adaptation and mitigation measures.
- Build and/or rebuild water infrastructure without exacerbating regional tensions.
- Reduce competition over scarce water resources through more efficient irrigation systems, drought resistant crops and public awareness campaigns.
- Increase water supply through water harvesting and infrastructure investments.
- Improve water governance by addressing the inequitable access to water for marginalised groups (including women), reducing corruption in the sector, supporting the community management of water and building capacity for dispute resolution.
- Improve transboundary water management.

Wealth-sharing
In the relatively few instances in which natural resources have been meaningfully addressed in peace processes, it has primarily been through wealth-sharing arrangements, which have three specific functions:

1. If disputes over the control of natural resources were a factor in the outbreak of a conflict, wealth-sharing arrangements directly address such disputes.

2. If natural resources were used to pay for the initiation and perpetuation of a conflict, wealth-sharing arrangements target the means of financing armed groups.

3. If the parties agree to enter into a transitional agreement to lead their country or community out of armed conflict, wealth sharing can shape new governance arrangements and help ensure a speedy economic recovery (Wennmann, 2013).

The following table shows four schemes for wealth-sharing that South Sudan might consider.

TABLE 2: **INCOME-SHARING SCHEMES**

Scheme	Description
Vertical sharing	Revenue from natural resources is shared between the central government and sub-national governments; arrangements specify how much is allotted to the central government and how much is allotted to sub-national entities.
Horizontal sharing	Income is shared among sub-national entities, both natural-resource-rich and natural-resource-poor. This often involves revenue equalisation schemes in which the Federal Government collects and redistributes income from natural resources to sub-national entities according to an agreed-upon formula.
Direct distribution	Direct payments are made to citizens.
Tax-base adjustment	Income sharing from natural resources is converted to authority for sub-national entities over tax bases. Sub-national entities retain a greater share of their tax receipts; the share corresponds to the amount of revenue that they would otherwise have received as income from natural resources.

Source: (Wennmann, 2013)

To stimulate this transition, the Government of South Sudan, together with its partners, should identify actions that link current humanitarian assistance to baseline data and information needed for planning development. A few illustrative examples follow:

- There are on-going, annual crop and food security assessments from the Famine Early Warning System (FEWS.net). These should be fully integrated into early warning systems within the country's agriculture and water ministries to build the capacity to analyse data and to eventually communicate this information to rural communities to help mitigate the impacts of drought.

- Since charcoal and fuelwood will continue to be the main sources of energy for cooking, heating, and brick production for some years to come in South Sudan, the government and its partners should consider performing an inventory and assessment of energy needs and fuelwood/charcoal supply as part of management plans for the current population at POC sites. Such assessments, with a minimum of additional modelling effort, could be broadened to wider geographic areas. UN Environment or other development partners might provide for the additional cost.

- UN Environment and UNDP should join forces to provide technical assistance to the government to draft successful proposals to the Global Environment Facility, the Green Climate Fund and to bilateral donors to try to strengthen the environmental dimension in those areas of the country that are experiencing relative security. As peace spreads to other states, environmental successes can be introduced there in successive phases.

- The government and its partners should build on existing successes by using national research institutions (e.g. the SUDD Institute and academic institutions such as the University of Juba), which represent a source of knowledge and information for environmentally sustainable development. UN Environment can support the government by promoting the network of national experts identified during the State of Environment and Outlook Report Inception Workshop and using South Sudanese expertise whenever possible for project work. Since government funding to these institutions beyond salaries will be minimal in the short-term, the government and partners still need to find ways to maintain the expertise in South Sudan.

- The key challenge faced by the UN system is how to coordinate and deploy the five core operational areas in a more effective and coherent way. These include peace and security, human rights, sustainable development, humanitarian assistance and international law. For its part, UN Environment can only address the conflict risks and peacebuilding opportunities from natural resources by working as a technical partner with other UN entities addressing conflict prevention, mediation, peacekeeping and peacebuilding.

- Specific to the UN system, it is recommended that UN Environment work with the UN South Sudan country team (UNDP, UNOPS, UN-MISS, and WFP) and others to identify synergies between conflict and post-conflict activities, and package them for possible donor support. If time allows, informal contacts among UN environmental focal points could continue to find additional opportunities for building in long-term solutions toward sustainable

development within current funding windows. For example, the UN-MISS Environmental Engineer conducts activities to safeguard the environment in its interventions. These principles can be used to create awareness among local populations at POC sites. More specifically, tree planting can be used by POCs to reduce conflict with local, indigenous populations.

- Working as a team, UN environmental focal points could determine how existing humanitarian relief funding could be adjusted to cover baseline data sets to meet longer term needs, such as in the case of projecting energy needs through charcoal consumption for the POCs.

- Environmental management expertise exists within the UN and should be harnessed to create awareness of the importance of the environment for maintaining peace in South Sudan.

Finalising, approving and implementing Draft Vision 2040

One of the most urgent actions for the Government of South Sudan is to implement Vision 2040. The table below outlines the major players for implementing the draft Vision 2040. Particularly important will be the interplay among the various ethnic groups who are critical for peacebuilding, and as South Sudan moves through the transition, for environmentally sustainable development.

It is incumbent on the government to create an environment to allow these stakeholder groups to fully play their roles (Table 3). Governance structures may need to be adjusted for these stakeholders to participate.

TABLE 3: **STAKEHOLDER GROUPS FOR POLICY IMPLEMENTATION**

Category	Examples
Government of South Sudan	Professional staff in National Ministries
Civil society	National NGOs, faith-based groups, etc.
Businesses and trade partners	Business leaders, Lions Club, banks, manufacturers, market-goers
Academic institutions	University of Juba, Sudd research, secondary and primary schools
Development partners	UN agencies, multi-laterals (EU), bi-lateral aid agencies (such as the UK's Department for International Development)
Sub-national governments	Professional staff in Payam, County, and State governments; city council workers, etc.
Local authorities	Village elders, village chiefs, water providers, etc.

Finalising and approving environmental policies in South Sudan

Since independence in 2011, there has been considerable progress in drafting policies and laws applicable to sustainable development in South Sudan. Table 4 provides a summary of the progress made and gaps that remain.

The new government's capacity to formulate policy and implement programmes is still limited, however it is crucial that it be further strengthened. If the current state of the environment is to improve in the near-to-medium term, South Sudan will need to invest significant resources in first finalising, approving and then implementing these policies. UN Environment and other international organisations can assist by providing targeted and relevant technical expertise to move the process forward. On the government's side, it should re-confirm national priorities with the donor communities and influence funding streams to favour their implementation.

In summary, policy elements exist, but either they are not yet approved or they are not being implemented due to insecurity, and lack of human and financial resources. If the current conflict worsens, government priorities will shift to short-term needs and the vision of sustainable development will become an illusion.

TABLE 4: STATUS OF NATURAL RESOURCES POLICIES AND LEGAL FRAMEWORK IN SOUTH SUDAN (FUNCTIONAL MEANS WORKING AND OPERATIONAL MEANS BEING USED)

Policy and legal framework for natural resources in South Sudan		Period			Objectives	Remarks
		Pre-Comprehensive Peace Agreement (CPA) *Before Jul. 2005*	Southern Sudan Autonomous Region (AR) *Jul. 2005 - Jul. 2011*	Republic of South Sudan *After Jul. 2011*		
Overarching	The Transitional Constitution of South Sudan			Established	The Transitional Constitution of the Republic of South Sudan (2011) under articles 41 & 46 provide that every person shall have the obligation to protect the environment; and 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 biodiversity.	Approved and functional
Overarching	South Sudan Vision 2040		Established		To ensure that by 2040 South Sudan is a united and peaceful new nation, building strong foundations for good governance, economic prosperity and enhanced quality of life for all. This can be achieved through • Improving governance; • Achieving rapid rural transformation to improve livelihoods and expand employment opportunities; • Improving and expanding education and health services; and • Deepening peace building and improving security.	Draft
Environment Policies and Bills	The National Environment Protection and Sustainable Policy, 2014-2024			Established	To provide guidance and direction on the effective management of the environment to all stakeholders: government agencies, the private sector, NGOs, CBOs and the general public.	Approved and operational

Environment Policies and Bills	The National Environment Bill, 2014	Established	(1) To provide a legal framework that covers all matters concerned with the environment in the Republic of South Sudan (2) To promote the prudent use, development, conservation and recuperation of its natural and environmental resources, ecosystem services, and biological diversity (3) To integrate environmental consideration into development policies, plans, programs and projects at local, state and national levels (4) To promote effective, widespread, public participation in the consideration about the incorporation of environmental considerations into development activities (5) To domesticate the international environmental laws, the African Union legislation and the East African Community laws and promote environmental rule of law and (6) To contribute to the resolution and management of conflicts related to the use of natural resources and the environment	Draft
	National Environmental Policy 2013	Established	(1) Set guidelines and regulations on the sustainable management of the environment as well as the prudent utilisation of natural resources; (2) Build the capacities of the state institutions and all other stakeholders in the proper and effective management of the environment; (3) Integrate environmental considerations into the development policies, plans, and programmes at the community, government and private sector levels; (4) Promote effective, widespread public participation in the conservation and sustainable management of the environment;	Approved and operational
Agricultural Policies and Acts	National Environmental Policy 2013	Established	Aims at enhancing measures to mitigate the adverse effects and impacts from climate change in the medium- and long-term. It also provides for the protection of plants, seed management, and development of plant genetic resources conservation programme and a bio safety framework.	Approved and passed by the cabinet. The changes in the government affected the implementation of the policy.
Animal Resources and Fisheries Legal Frameworks	Ministry of Animal Resources and Fisheries Policy Framework and Strategic Plans 2012-2016	Established	To take charge of protecting, promoting, exploiting and developing, on a sustainable basis, the livestock and fisheries resources, for the socio-economic prosperity of the people of South Sudan.	Policy not yet passed but strategic plan passed by the Council of Ministers. Still waiting for legislature approval.

Policy and legal framework for natural resources in South Sudan		Period			Objectives	Remarks
		Pre-Comprehensive Peace Agreement (CPA) *Before Jul. 2005*	Southern Sudan Autonomous Region (AR) *Jul. 2005 - Jul. 2011*	Republic of South Sudan *After Jul. 2011*		
Animal Resources and Fisheries Legal Frameworks	National Veterinary Plan 2012-2014			Established	To develop a more systematic approach to planning with a consequently more precise allocation of available resources, in order to engender a more realistic, efficient and sustainable approach to veterinary services delivery and support to the livestock sector.	On process
	The Fisheries Policy for South Sudan			Established	Provides for a framework to manage fisheries resources of the country so as to maximise production and avoid over fishing and to prevent destruction of wetlands and promote their conservation. One specific objective of the policy is to maintain a healthy environment and ecosystems by adopting measures to prevent environmental damage to aquatic systems through pollution and environmental degradation.	On process
Forest Policies and Acts	Forest Policy 1986	Established	Applicable	Applicable	Protecting, establishing and developing forests resources in the Sudan (South Sudan) in a way that achieves full protection for the environment and meeting the country's needs in terms of food products.	Not operational
	Forest Policy Harmonized 2015			Established	The policy aims at ensuring a sufficient and sustained forest resource base and flow of forest goods and services to support livelihoods and socio-economic development for the present generation without compromising this endowment for future generations.	Still in the legislative assembly awaiting approval.
	Forest Policy November 2013			Established	The policy aims at ensuring a sufficient and sustained forest resource base and flow of forest goods and services to support livelihoods and socio-economic development for the present generation without compromising sustainability of this endowment for future generations.	Updated to Forestry Policy Harmonized 2015
	Forest Policy Framework 2007			Established	The policy aims at ensuring a sufficient and sustained forest resource base and flow of forest goods and services to support livelihoods and socio-economic development for the present and future generations. Ensuring inter-generation equity in its potentially rich forest endowment is a key part of this policy.	Approved by the legislative assembly, signed by the President of the Republic (functional)
	Forestry Bill 2009			Established	The purpose of this Bill is to cover all matters concerned with all forests and woodlands on national forest reserves, provincial forest reserves, and protection forests under custody of GoSS, State Government, communities and individuals.	Draft

Wildlife and Protected Areas Policies and Laws	South Sudan Wildlife Conservation and Protected Area Policy 2012			Established	(1) To guide on the sustainable management and utilisation of wildlife resources including land, water, fauna and flora for the benefit of the people of South Sudan. (2) To protect, conserve and propagate the wildlife species and their habitats in a manner that supports the development needs of South Sudan and the cultural, economic and social well-being of its people.	Draft
	South Sudan Tourism Policy			Established	To develop tourism into a leading export sector contributing to economic growth and employment in a manner that is culturally appropriate and environmentally sustainable.	Draft
	Wildlife Conservation and National Parks Acts 2003	Established			The provisions of this Act shall be applied for the conservation management and protection of wildlife, forests and environmental resources, and establishment of National Parks, Game Reserves, Forest Reserves and other protected areas in the New Sudan.	Draft
	Wildlife Conservation and Protected Areas Bill, 2015			Established	The purpose of this Bill is to cover all matters concerned with Wildlife Conservation, the establishment and management of Protected Areas and to sustainably manage and conserve South Sudan's natural heritage and wildlife for the benefit of its citizens. This Bill also ensures that Wildlife is managed and conserved so as to yield to South Sudan in general and to Protected Areas in particular, optimum returns in terms of cultural, aesthetic, social, economic and scientific values.	Pending in the Legislative Assembly – Not Passed
	Wildlife Forces Act, 2003	Established			The Wildlife Forces shall be deployed for the protection, preservation, conservation, management of Wildlife and Environment, detection, apprehension and prosecution of poachers, protection of clients, visitors and tourists, custody of exhibits on behalf of the Secretariat.	Not passed
Water Resources and Legal Frameworks	GoSS Water Policy 2007		Established		The overall goal of the Government of Southern Sudan (GoSS) Water Policy is to support social development and economic growth by promoting efficient, equitable and sustainable development and use of available water resources, and effective delivery of water and sanitation services in Southern Sudan.	Approved and passed operational

Policy and legal framework for natural resources in South Sudan		Period			Objectives	Remarks
		Pre-Comprehensive Peace Agreement (CPA) *Before Jul. 2005*	Southern Sudan Autonomous Region (AR) *Jul. 2005 - Jul. 2011*	Republic of South Sudan *After Jul. 2011*		
Water Resources and Legal Frameworks	GoSS Water Sanitation and Hygiene (WASH) Strategic Framework		Established		This WASH sector Strategic Framework is a major step for putting into practice the principles laid out in the Water Policy of 2007. It identifies priority areas for future interventions and spells out a number of approaches that these will have to use.	Completed yet to be approved
	Water Bill Final Draft 2015			Established	Is to promote effective management of the quantity, quality and reliability of available water resources in order to maximize social and economic benefits while ensuring long term environmental sustainability.	In process
Petroleum Resources	The Petroleum Act 2012			Established	This act provides a regulatory framework for the development and management of petroleum activities and other ancillary matters related to petroleum activities in the Republic in conformity with the transitional constitution and for the establishment of a national petroleum and gas commission.	Functional
Mining Resources	The Mining Policy			Established	Recognises the need to ensure that mining operations are conducted in a socially and environmentally responsible manner by minimising harmful impacts of mining and that the interests of local communities are fully considered and protected.	Functional
	Mining Act 2012			Established	Provides a framework for the management of the mining sector 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. It also provides for Community Development Agreements for Mining Licences and environment and social provisions.	Functional

Institutionalising environmental assessments

Another recommendation to the Government of South Sudan is to institutionalise the environmental assessment process that started with this report, and to repeat the assessment on a periodic basis, at least every five years. The assessment process combines policy, data and information dimensions, the latter of which is covered in detail below.

As shown, there are many policies relating to the environment in South Sudan that need to be advanced. One policy initiative that supports the national reporting process is to conduct environmental assessments at the sector and/or programme level. Strategic Environmental Assessments can help to identify the areas of greatest environmental impact so that the government can focus on a broad set of preventive and mitigation measures. The design of a Strategic Environmental Assessment should take into account the existing post-conflict institutional capacity and legal framework, and have the ability to adjust as capacities increase or laws change. A tailor-made Strategic Environmental Assessment process may be well suited to multi-donor trust funds, post-conflict needs assessments and development assistance frameworks (UNEP, 2012). The role of this report is to provide a context within which the government could frame its Strategic Environmental Assessments, if it so chooses.

At the project level, Environmental Impact Assessments will have multiple benefits in South Sudan. Environmental Impact Assessments, environmental permits and other environmental planning tools create opportunities to identify the potential harmful impacts of major investments and infrastructure, and to put social and environmental safeguards in place. Ensuring the right process is one of the principal ways that a government can influence the design, technology, scope and financial models of large-scale developments to guarantee that the country receives long-term social and economic benefits and suffers minimal environmental and social damage. At the same time, Environmental Impact Assessments can also be used to build confidence and promote transparency in the wider political process of peace consolidation and as an entry point for public participation in decision-making. Building Environmental Impact Assessment capacity in post-conflict countries is a long-term investment; Environmental Impact Assessments can be streamlined and effectively applied in post-conflict countries without causing approval delays. This typically requires a clearly defined process, well-trained staff, internal compliance mechanisms and flexibility regarding the amount of information needed for a review. Still, it can take ten years or longer to develop a functional EIA system that is fully integrated into the fabric of governance and applied as a decision-making tool (UNEP, 2012).

Despite the potential benefits of Environmental Impact Assessments, a number of factors – weak governance, inadequate legal frameworks, insufficient technical skills and limited baseline data – may prevent national authorities from undertaking them. This is the reality of the petroleum sector in South Sudan, where environmental safeguards have been in operation but are very problematic to implement.

This report also recommends the economic valuation of natural capital and for UN Environment to provide necessary support and capacity building for the valuation and accounting of ecosystem services.

This report recommends that donor agencies contribute technical and managerial expertise and provide critical financial support for the preparation and implementation of the SDG-based national development strategy. Their participation is needed to develop a broad consensus on the country's investment needs and priorities for achieving the SDGs. Such a consensus will form the basis for an honest dialogue about needed development assistance.

Addressing the SDGs

The previous sets of recommendations pertain to all environmental SDGs/thematic sectors, as they address policy and information needs that are cross sectoral in nature. The following recommendations are directed toward implementing specific SDGs.

Goal 6. Ensure availability and sustainable management of water and sanitation for all

South Sudan is located in the "middle" of the Nile Basin, which occupies almost 98 per cent of the country's land base. About 7 per cent of South Sudan is covered by vast expanses of tropical freshwater wetlands that occur at the confluence of the White Nile's main tributaries; the Sudd alone covers 5 per cent of the country. These wetlands have a significant influence on the Nile's hydrologic regime. About 30 per cent of the Nile River's water flow passes through South Sudan on its way to Egypt. But as much as 85 per cent of the total water that flows into the Sudd wetlands is lost to evapotranspiration.

Together, the countries of the Nile Basin use almost 90 per cent of the region's renewable water resources, with Egypt and Sudan, which need water from outside their borders, accounting for the largest water withdrawals, mainly for agriculture. South Sudan's water withdrawal is very low. Annual per capita withdrawal is about 60 m^3 compared to Ethiopia at 106 m^3, Egypt at 911 m^3 and Sudan at 714 m^3. On average, water consumption in rural areas of South Sudan is around 6 litres per person per day, compared to requirements of a minimum of 7.5 litres per person per day for most people under most conditions. Limited access to water resources can trigger conflict. To date, there is no clarity on water sharing in the Nile Basin and no formal decision on South Sudan's share of the Nile's waters. South Sudan needs to support the establishment of a legal framework to assign water rights among riparian countries along the Nile River basin.

Water quantity and quality in South Sudan have declined in the past two decades. In a number of previously perennial rivers, for example, water flow has become seasonal. Lower water flows can lead to siltation. Municipal wastewater, sewage and industrial effluents run straight into water sources due to a lack of wastewater and sanitation management. Hence, water quality is declining in urban areas and contaminated water is responsible for recurring incidences of gastrointestinal diseases.

The Ministry of Water Resources and Irrigation has overall leadership in the water sector and state-level directorates are accountable to it, but there is a need for clear mandates, regulatory frameworks, required funding, and the essential human resources and capacity to operate effectively.

Keep Juba Clean. *Photo credit: Gregg Carlstrom/ Flickr.com/CC BY-NC-ND 2.0*

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

South Sudan has abundant energy resources including petroleum, hydropower, solar, wind and biomass, much of them unexploited. And yet, South Sudan is the most oil dependent country in the world, as about 95 per cent of state revenues are generated from the sale of petroleum. Biomass is used by a majority of South Sudanese for their energy needs. Only 5.1 per cent of people countrywide have access to electricity, with 3 per cent in rural areas and 12 per cent in urban areas.

A strong electrification programme is important to ensure that a critical mass of households in the country has access to electricity. The government should also offer attractive fiscal and non-fiscal incentives to encourage households and industry to invest in renewable sources of energy

Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable

One of the main urban environmental issues in the country is the low level of access to improved drinking water and sanitation. The lack of proper sewage systems and water treatment means human waste contaminates the water people use for household purposes, leading to the risk of water-borne illnesses such as cholera. In addition, because of poor or absent municipal waste collection, households dispose of their waste, much of which is composed of plastics, in unsightly informal dumps, on roadsides and in other public spaces. As much as half of urban waste is burned. The results are the proliferation of vectors (such as flies and rodents), pathogens and foul odours, soil pollution, the destruction of wildlife habitat and air pollution that results in respiratory illnesses among the population. The mortality rate due to environmental pollution in South Sudan is higher than in the rest of Africa.

Unplanned urban expansion, as well as increasing rural-urban migration and lack of investments in infra-structure building, is one of the most pressing issues in South Sudan. There is a dire need for urban planning and the management of water, sanitation and municipal waste. Large investments are needed to strengthen the human and operational capacities of government ministries and municipal-level departments to implement the actions stipulated in the draft Vision 2040.

Goal 12. Ensure sustainable consumption and production patterns

Currently and in the near future, consumption patterns are not significant in South Sudan except for bush meat and wildlife poaching. Regarding extractive industries, the relevant provisions of The Mining Act 2012, The Petroleum Act 2012 and other related environmental legislation should be operationalised.

A strategy for reducing waste generation through prevention, reduction, recycling and reuse should be developed. South Sudan should develop comprehensive Strategic Environmental Assessment and Environmental Impact Assessment guidelines for the mining and petroleum sectors. These assessments will ensure that socioeconomic, environmental and climate change factors, including gender aspects, are appropriately integrated and operationalised in the new national policies and legislations in order to maximise the net contribution of these sectors to the achievement of sustainable development objectives.

In the future, South Sudan has a huge potential to develop wildlife tourism, so sustainable tourism strategies or policies also need to be in place.

Goal 13. Take urgent action to combat climate change and its impacts

The impacts of global climate change are conspiring with all other drivers to form a complex dynamic of causes contributing to environmental change in South Sudan. Already, the country's climate is characterised by extremes and it regularly experiences drought, torrential rains and seasonal flooding. Since the mid-1970s, South Sudan has experienced a decline of between 10 to 20 per cent in average precipitation as well as increased variability in the amount and timing of rainfall from year to year. These changes are exacerbating droughts and flooding events that will adversely affect agriculture, water resources and health, which are South Sudan's most important sectors. Since pastoralists and farmers rely heavily on seasonal rains, these changes can severely affect the land and water resources they depend on for their livelihoods. One of the impacts of increased drought and a more unpredictable climate, when combined with rapid population growth and the expansion of farming, is likely to be a rise in clashes over natural resources, reflecting how climate change can contribute to conflict.

The institutional frameworks to accomplish climate-change commitments, however, are still at the nascent stage in South Sudan due to the low priority given them in the context of the ongoing situation of conflict, as well as the lack of technical capacity and financial resources. The Government of South Sudan would do well to strengthen its institutions and financing for climate change adaptation.

South Sudan should take steps toward implementing the National Adaptation Programme of Actions and meeting its Nationally Determined Contributions (NDCs) and seek donor support in so doing.

These steps include:

- Building national awareness on NDCs among ministries, local governments, the private sector, the general public and other stakeholders.
- Strengthening institutional arrangements and technical capacities to manage NDC implementation. As with SDG implementation, implementing national policies and building capacity to manage environmental information also applies to NDCs.
- Developing NDC implementation plans that prioritise concrete mitigation and adaptation measures to achieve NDC goals.
- Implementing mitigation and adaptation measures in sectors, including enabling conditions to remove barriers to implementation.
- Planning for future NDC rounds beginning in 2020, including institutionalising processes and updating long-term strategies. Within this context, for example, South Sudan should link energy development plans to the overall climate change vulnerability situation. More specifically, vulnerable sectors whose resources (such as water) can be dedicated towards energy development need to be assessed thoroughly in order to plan for allowing energy production without jeopardising the availability of the resources for other uses within the context of climate constraints.
- NDC objectives and targets must be the priority in developing national energy policies and energy projects that seek funding. Specifically, energy policies in the coming years must in principle, take into account the objectives of country's NDCs, and not just to meet energy demands as the only factor that influences the choice of energy sources to be developed or exploited. Energy projects that are likely to get substantial international funding are those that comply with the global mitigation obligations as agreed on in the Paris Agreement, and other international forums. Only by aligning energy proposals and projects with the mitigation goals can countries legitimately justify financial requests, and fit into the existing international financial initiatives for energy projects.
- In revising current Intended Nationally Determined Contributions (INDCs) to Nationally Determined Contributions (NDCs), South Sudan should plan adaptation targets and include them in the NDCs during the five-year revision cycle. If this is attained, energy policies and projects will include adaptation actions and will inform the energy resources to be developed sustainably to meet demands, accelerate growth and adapt to extreme climate events.

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss

Given that the forestry sector will play a key role in meeting South Sudan's energy and construction needs in the near term at least, and possibly in generating foreign income in the longer term, the report presents recommendations for its conservation and optimal use. Furthermore, preserving wetlands will help maintain biodiversity in South Sudan and support a variety of livelihoods over time. Recommendations that address conservation of wetlands are included here.

- The government should build on existing efforts to promote agroforestry in both the short- and long-term. There are on-going efforts to regenerate South Sudanese landscapes that the report Field Visit Team highlighted at the tree nursery from Bor/Aweil. Given that South Sudan is mostly a rural environment with small-scale agriculture, it is doubtful that large-scale, mechanised agriculture will be easy to implement in the near term. Based on these realities and successes, the government should introduce or expand current community forest initiatives to zones not experiencing active conflict. The intent would be to increase soil fertility in the short-term and to provide options for farmers to increase fodder, timber and fruit production in the long-term. Such an approach will create job opportunities in the medium-term and lessen pressure on forest resources in the long-term.
- The government should engage the research community to investigate the plantation of suitable species and the afforestation of degraded lands to meet people's needs. Such efforts were initiated after independence in 2011 but abandoned after the conflict started in 2013. Similarly, the government and partners could investigate whether rotational systems for producing charcoal could be applicable to South Sudan. The rationale is that since South Sudan has extensive forest and woodland resources and a relatively low population density, and because it will be tied to charcoal and fuelwood for meeting its energy needs (cooking, heating, brick firing, etc.) for the foreseeable future, South Sudan should engage the research community to better understand if rotational systems could be adapted to its needs. As South Sudan stabilises itself and moves up the development ladder, the government could engage regional centres of expertise to design sustainable charcoal production through rotation forestry. The intent would be to minimise the environmental damage from charcoal production as South Sudan migrates to a more diversified energy supply over time. In conjunction with improved charcoal production, the government and its partners can provide alternatives to fuel wood and charcoal burning,

such as improved wood stoves, solar panels, solar cookers, gas and electricity.

- Together with its partners, the government should enhance its capacity in using and marketing timber and other forest products, while strengthening enforcement mechanisms to stop illegal logging. They could partner with commodity-tracking schemes, such as the Forest Law Enforcement Governance and Trade initiative of the European Union (EU), which encourages timber-producing countries that export to EU markets to adopt a voluntary timber-licensing system. In exchange, the EU would fund capacity building and institutional development in the forest sector. Forest Law Enforcement Governance and Trade was not specifically designed for peacebuilding, but given its potential to improve forest governance, it may lend itself to peacebuilding purposes in places such as South Sudan. Overall, the intent is to trace the path of commodities from production to consumption and to reduce the market value of noncertified commodities by making them more difficult to sell. Such systems formalise exploitation and trade, and thereby curtail illegal resource exploitation and direct more revenues to state coffers.

- The international importance of the Sudd wetlands was confirmed in 2006 when it was designated a Ramsar site. To build on this national treasure, the government should foster awareness of the importance of the wetlands and their preservation by local communities. Such combined international and local responses are a good basis for successful policy options for the future. Educational curricula should be strengthened with the introduction of environmental principles and pictorial examples from the Sudd so that future generations of South Sudanese will respect their national environmental heritage.

- The government should build on existing successes such as the establishment of conservation sites at the Nimule National Park, Badingilo Park and Boma Park, including the involvement of indigenous peoples. For example, as in the case of the Sudd, the education sector should continue promoting awareness of this natural wealth in school systems (videos, tours, etc.). Local communities should be given the responsibility of improving security around parks as a priority as peacebuilding activities take root. Ultimately, this development will tap into South Sudan's great potential in tourism, based on attractions including one of the biggest animal migrations in Africa and to reduce dependency on petroleum. To capitalise on this resource, it must be protected so that when peace eventually comes, it can be converted to an opportunity.

- South Sudan is the 195th Party to the UN Convention to Combat Desertification and is committed to implementing the provisions of the UN Convention to Combat Desertification. Desertification is an invisible frontline (UNCCD, 2014). South Sudan should seek assistance of international partners to promote scientific collaboration to assess and monitor desertification, leading to sustainable management of land and to achieve land degradation neutrality.

- Finally, as part of the overall effort to build peace in South Sudan, the government should facilitate conflict resolution at the local level to avoid land-use tensions and further deforestation. The international community can support this activity.

The Governor of Kapoeta State pointing the low quality of invasive species inter alia land degradation.
Photo credit: Peter Gilruth, Environmental Pulse Institute

One of the greatest wildlife spectacles in the world - the Tiang migration on the Jonglei plains in South Sudan.
Photo credit: Wildlife Conservation Society

Land Tenure

To attain environmental sustainability, in the long-term South Sudan must address shortcomings in the land tenure system that causes much harm in the country. Land tenure and conflict often have a "chicken and egg" relationship in Africa, and this report recommends that the government review case studies on how to best solve the situation, and propose and implement legislation as needed.

Education

Although some of these recommendations may take a long time to implement, the education sector, which also cuts across all thematic sectors, must be addressed as a priority. Awareness raising programmes, both through traditional school systems and stand-alone programmes, should address production and consumption practices and patterns that are sustainable. Such programmes should be broad in their messaging, targeting, for example, energy use through improved cooking stoves as well as improved lighting options. South Sudan should move toward policy options that favour an increase of Solar Energy (clean) use by many citizens as well as low emission lighting. Water consumption and conservation should be a part of every student's upbringing, as well as practices for vegetable raising and marketing, which are found in many school systems.

Gender

The report recommends that the government continue to build on positive elements such as the introduction of affirmative action with 30 per cent of government posts reserved for women. Government policy should be to achieve this goal over a period of 5-10 years, with yearly targets toward that goal. Perhaps more important is to cultivate the understanding of how women's well-being is affected by conflict and the environment. Efforts to build national environmental data capacity, as described above, should target this understanding and lead to policy recommendations.

Measuring, monitoring and indicators

Whether at the national or local level, or across any of the environmental sectors, errors in data will negatively impact any planning, monitoring or evaluation activity. Clearly, it will be important for the government to work from agreed, high-quality data sets in order to monitor and evaluate its progress toward sustainable development. This fundamental requirement cuts across all sectors.

There is a need to build national capacity to collect, manage and share environmental data and information to track environmental change and assess how programme goals are being implemented. The impact of a lack of coordinated approaches to national statistics is demonstrated in Table 5, which highlights different estimates of South Sudan's forest area that are available from various sources.

POC beneficiaries checking out FAO's fuel efficient stoves in Bentiu.
Photo credit: FAO/C.Spencer

Forest survey and mapping needs technological upgrading.
Photo credit: Urs

Estimates of the percentage of South Sudan's land area covered by forests vary from 11.1 per cent to 35 per cent. If "other wooded land" is included, the estimate rises to 90 per cent. The Food and Agriculture Organization of the United Nations defines "other wooded land" as "Land not classified as 'Forest' spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of 5-10 percent or trees able to reach these thresholds; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban land use" (FAO, 2015).

TABLE 5: COMPARISON OF "FOREST LAND" ESTIMATES FOR SOUTH SUDAN FROM A VARIETY OF SOURCES

Forest		Other Wooded Land (OWL)		Total Forest and Other Wooded Land		References
Area (ha)	%	Area (ha)	%	Area (ha)	%	
7,157,000	11.1	32,582,000	50.6	39,739,000	61.7	(FAO, 2015)
43,470,097	67.5	14,518,339	22.5	57,988,436	90.0	(USAID, 2014) and (MOE; UNDP, 2012)

Principles for improving data for environmental management

The following is a brief summary of the principles that govern how such data and information are best used to improve their role and benefits in environmental management, which are taken from experiences across the African continent and apply equally to South Sudan.

Building an environmental information community

The environmental information community refers to the group of environmental information suppliers and users who share data, data standards and information. The community shares certain fundamental principles, such as the demand-driven approach, wherein environmental information should be produced with an end use in mind rather than gathered simply because it is there. Building such communities will be the cornerstone for successful environmental information management in South Sudan. It is unlikely that a single agency within the community can meet the needs of all potential users, or expect to become the unique central repository of all environmental data in South Sudan. Thus, current approaches to building the environmental information community should embrace a distributed model in which data sets are constructed and hosted by government institutions with the appropriate statutory mandates.

Institutionally, there is often inadequate recognition and support of data custodians, who are the managers of key environmental data sets. When potential data users are unable to access data, usually due to the custodians' lack of willingness to share data, they may undertake fundamental tasks themselves, such as digitising and updating core data sets, leading to the duplication of effort. A common example is the repeated digitising of base maps for the preparation of thematic maps.

Constructing data infrastructure

To avoid the repetition of data development tasks, data producers must construct data infrastructure from core data that can be used and reused. Just as a strong national road network supports development in many sectors, a solid data infrastructure will serve many users and open new doors to environmental applications in the future. The building of a data infrastructure for South Sudan, particularly of the type and geographic scale required at the local level, will require substantial investments.

Metadata

It is recommended that South Sudan start establishing catalogues describing existing information resources. These catalogues contain data describing existing data, or metadata, which include attributes such as theme, quality or origin. Analysis of metadata allows potential users to determine whether a data set may be useful in a given application.

Data interoperability

Environmental management in South Sudan will require that data from different sources be integrated. Easy integration requires that data conform to the same standards. Such data are termed interoperable, since they allow "off-the shelf", "plug and play" usage. A major lesson learned in other African countries is that lack of data interoperability often constitutes an insurmountable roadblock to the use of environmental

information in decision-making. The problem lies with the existence of multiple data projections and coordinate systems, different naming conventions, different database structures and the lack of accuracy standards, which is a particularly insidious issue. Eliminating these problems requires a sustained and coordinated effort by all members of the environmental information community to establish common data architecture, including widely accepted standards.

Applications

The operational objective to using environmental information is to increase the quality, efficiency and accountability of decision-making processes through applications that systematically use environmental information. Ideally, users should always explicitly target their support at specific environmental management processes, following a thorough review and analysis of the extent and manner in which information affects making decisions. Thus, stand-alone projects should be avoided

Building a National Strategy for the Development of Statistics (NSDS) for South Sudan

The build-up of South Sudanese capacity to manipulate environmental information has been constrained due to the on-going conflicts. Nevertheless, skill levels remain a constraint on development, in large part because projects seldom invest enough in developing the technical skills of government staff required to fully master the new technologies and methodologies that they introduce. On the contrary, for budgetary and institutional reasons, many programmes are reluctant to invest in long-term capacity building, focusing instead on short-term results.

To put these principles for effective use of environmental data and information into use, the government should move ahead with the development of its NSDS, which is intended to provide the statistical data needed to monitor and evaluate targets and other indicators that are the measurement and assessment framework for the South Sudan Development Plan, and other important activities that are outlined in central and state government projects and programmes. The NSDS aims to strengthen the production and dissemination of statistics by the National Bureau of Statistics (NBS), key line ministries, departments and agencies, and local government authorities. It intends to do this by improving coordination and collaboration in data collection and compilation, and enhancing quality control through building capacity of data producers and users, providing resources and creating an enabling institutional environment for strengthening statistics production.

Another important objective of the NSDS is to bring together producers and users of official statistics, and to institute a process of continuous quality control and dialogue. It is expected to be a dynamic product whose implementation is assessed on an annual basis as part of a statistics sector review. It will also provide capacity building for the National Bureau of Statistics and ministries, departments and agencies in new areas of statistical concern, including the use of geographical information systems, undertaking regular panel surveys, roles and code of ethics for official statistics, establishing statistical norms and standards, monitoring good governance, and efficiency and effectiveness of public service delivery. It will enable policy makers, researchers and other stakeholders to assess progress during the implementation of the South Sudan Development Plan and to take appropriate actions on this basis. The NSDS will also emphasise statistical training and education and the dissemination and access to micro-data, thereby contributing to the better use of survey data and increased participation of policy makers, researchers and trainers in the collection, compilation and analysis of official statistics (RSS, 2016).

The Government of South Sudan, with its partners in UNDP and UN Environment, can take immediate steps toward building a NSDS network based on the results from this report's national inception workshop held in Juba in November/December 2016. The Government of South Sudan and UN Environment could reconvene workshop participants to create a cross-sector community sharing a common interest in environmental data and information. Their task-driven agenda should be as follows:

- Identifying priority environmental information objectives that link to policy needs and that support reporting requirements to SDGs, draft Vision 2040, INCDs, REDD+, etc. The Ministry of Environment and Forestry should recognise that the State of Environment and Outlook Report is a tool for monitoring progress.
- Identifying status and needs for national standards, including documentation and metadata, quality, periodicity and accessibility for core data sets, etc.
- Agreeing on roles and responsibilities within the network.
- Developing a medium-term plan for improving the role that environmental information will play in the implementation of the draft Vision 2040. In many cases, there will be data gaps, but these are instructive in and of themselves, because they demonstrate which areas do not receive sufficient attention, where institutional capacity may be insufficient or where deeper analyses are required to understand what needs to be measured and how. This should lead to prioritisation of data/information to be collected.

Adopting a set of key environmental indicators to monitor South Sudan's sustainable development

The selection of indicators is a process that engages stakeholders across sectors. Although government line ministries will play the lead role, they should also network with a wider range of stakeholders. The network members will necessarily have skills in data analysis, statistics, geographic information systems and remote sensing, however they should also represent those sectors of society that are actively promoting sustainable development.

As a starting point, SDG environmental indicators should be used as a baseline, following their review and adaptation to South Sudan's specific needs. To adapt SDG indicators to national needs, this report recommends that indicator selection and use should be guided by a set of principles that include the following:

- They should be limited in number and harmonised, e.g. when used together, they provide an integrated view of sustainable development.
- They should be simple, single-variable indicators (disaggregated), with straightforward policy implications. For example, since South Sudan is subject to acute drought, it could decide to focus on sustainable water resource management as one of its immediate objectives, recognising that a comprehensive water resource management strategy will consider the interplay between the local ecosystem (SDGs 14/15), water use within local industry (SDG 12), the impact of the water shortages upon poverty, agriculture and employment (SDGs 1/2/8), and so on.
- They should allow for periodic monitoring as determined by policy needs.
- They should be consensus based and in line with international standards and system-based information.
- They should be constructed from well-established data sources that are science-based and forward-looking.
- They could serve as a proxy for broader issues or conditions.

Further deliberations should be guided by factors such as which indicators are most policy relevant and for which data and information are either available or could be obtained with minimal effort and cost. Relevant indicators for which data are not available or reliable should spur the government to develop policies to eventually monitor and report on them.

Once finished selecting and adapting indicators, cross-sector working groups will continue to build the NSDS, in particular the environmental dimension, which will have the objective to promote the collection and sharing of environmental information for marking trends in the environment and for reporting to global, regional and national platforms.

Concerned stakeholders should create plans for building national capacity to collect and manage environmental information, both within and across Ministries and other relevant actors. These plans can be submitted to the donor community (UN Environment, amongst others) along South-South, North-South lines (in particular to engage the research community), in addition to traditional bilateral aid arrangements. Progress in meeting SDG targets as shown by these indicators will move South Sudan away from sole dependence on the petroleum industry income to expanding its wealth derived from its broad natural resource base.

In recent years, the explosion of social media has resulted in the potential use of "Big Data" (extremely large data sets, the analysis of which may reveal patterns, trends and associations), which provides new opportunities for engaging people and decision makers. There are exciting possibilities to foster and monitor sustainable development by integrating data from new technologies with traditional data to produce relevant high-quality information, with more detail and at higher frequencies. This revolution also entails the increased accessibility to data through much more openness and transparency, and ultimately to more empowered people, better policies, better decisions, and greater participation and accountability, resulting in better outcomes for the people and the planet (UNSD, 2017). In addition the role of informal knowledge or "voices of the locals" should be factored in the decision-making process.

Using the environment as an investment platform in South Sudan

It is proposed that this report, through its various findings and recommendations, can serve as a platform for guiding investments in sustainable development in South Sudan. The report has provided ample evidence that access to natural resources is an important source of the current conflict, and hence it must be addressed when solutions for a sustainable peace are negotiated. The investment platform could consist of a combination of short-term activities and longer-term initiatives, which when implemented, would set a foundation for an improved and growing role for environmental and natural resources in South Sudan's future. It is suggested that the Government of South Sudan, led by the Ministry of Environment and Forestry, prepare a portfolio of opportunities to attract partner interest. Portfolio elements could include, inter alia:

Examples of short-term activities:

- Seeking technical assistance in developing a medium-term plan and proposal for donor support for improving the role that environmental information will play in the implementation of the draft Vision 2040. The proposal should include:
  - Training.
  - Development, approval and implementation of data and statistic standards.
  - Support for strengthening the National Statistical System and spatial data structures to play their role within a data and information network, including confirming agreements on roles, responsibilities and deliverables for creating and sharing core data sets.
  - Software and hardware acquisition.
- Seeking technical assistance for preparing proposals to multi-lateral donors (the Green Climate Fund, Global Environment Facility) as well as bi-lateral donors for thematic issues related to climate change, forestry, wildlife protection, water resources management and urban infrastructure.
- Seeking technical assistance in finalising environmental policy documents that may still be pending.
- Seeking technical assistance in using environmental principles and resource sharing as a means to assist conflict mediation, particularly at local levels, e.g. between pastoralist and farmer communities.

Linked to the above, examples of longer-term initiatives which should be developed into larger funding proposals include:

- Stabilising conservation sites at Nimule National Park, Badingilo Park, and Boma Park through training of staff, including the involvement of indigenous peoples. In time, these sites could serve as a nucleus for a growing tourism industry.
- Strengthening environmental principles within the education sector by developing curricula, building resource materials (literature, videos, etc.), and conducting tours to promote awareness of South Sudan's natural wealth.
- Promoting agroforestry in both the short- and long-term by introducing or expanding current community forest initiatives to zones not experiencing active conflict. The intent would be to increase soil fertility in the short-term, and to provide options for farmers to increase fodder, timber, and fruit production in the long-term. Such an approach will create job opportunities in the medium-term, and lessen pressure on forest resources in the long-term.
- Building capacity and entering into international agreements for the utilisation and marketing of timber and other forest products, while strengthening enforcement mechanisms to stop illegal logging.

The above lists are indicative of projects which could interest partners. It is suggested that the government set up a donor round table, inviting those stakeholders most interested in establishing a sustainable peace through the lens of the environment. The Ministry of Environment and Forestry should prepare a series of project briefs (two pages each) to capture the essence of the proposed initiative which would then serve as a basis for cultivating donor interest and negotiate further support.

11.4 Conclusion

South Sudan will need massive investment in building infrastructure and job creation towards long-term sustainable development. Adapting and implementing the SDGs in a South Sudanese context would require that relevant Ministries review the targets and indicators, and prioritise and incorporate them into national policy documents that in turn serve as a basis for short- and medium-term planning at the sectoral level.

International organisations should provide support and build capacity for sustainably managing South Sudan's natural resources, including community participation and benefits to meet the growing demand for goods and services. Climate change adaptation measures are needed in South Sudan to cope with the adverse impacts and to avoid further clashes over declining natural resources.

Given South Sudan's great natural resource wealth, existing human capacity and opportunity for support from the international community, all it needs to do is to make steps toward peace and internal security in order to put it on a firm ground to sustainable development. South Sudan will then be able to provide its citizens an environment for the livelihoods they deserve, and thereafter play its full role within the global community. In addition to the environmental challenges it faces, this report bears evidence of this potential.

Given that petroleum resources will have a limited time frame as a major income source and that most of the population derives their livelihoods from the natural resources of the country (whether agriculture, fishing, forestry, etc.), the government needs to take steps to protect its environmental heritage for current and future generations. This report provides the context and direction for this transition to occur.

The post-conflict South Sudan provides a rare opportunity to truly embed the principles of sustainable development into the governance architecture in the country. This could make South Sudan a fine example of one of Africa's successful countries.

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Aerial view of Juba Town and surroundings.
Photo credit: Peter Gilruth, Environmental Pulse Institute

SPECIAL FOCUS
INSIGHTS FROM FIELD VISITS

SPECIAL FOCUS:
INSIGHTS FROM FIELD VISITS

Introduction

Field visits were an integral part of the development of the South Sudan State of Environment and Outlook (SEOR) report 2017. The basic objective was to listen to local officials and residents to solicit their perspective on the environmental problems they were facing, obtain a real understanding of the nature of people's needs in an area and glean their ideas for potential solutions. In addition to face-to-face interviews, a simple questionnaire approach was used to stimulate feedback from the people.

The Ministry of Environment and Forestry (MoEF), Republic of South Sudan suggested that the team visit different sites in the country (Figure 1) to gain an on-the-ground appreciation of what is happening to the environment, and the impacts on ecosystems and people's well-being. The sites, visited in April and May 2017, included Aweil (and neighbouring Nyamlele), Bor, Juba Land Fill, Jabel Lado, Kapoeta and Paloch in the former Upper Nile State. Due to logistical reasons and security concerns, the available time was limited for these visits. Nevertheless, the observations and summary of responses provide compelling insights. The results are summarised in this chapter.

FIGURE 1: MAP OF SOUTH SUDAN SHOWING LOCATION OF SITES VISITED

Aweil (Nyamlel)

Aweil town is located in northwest South Sudan and is the capital of the former Northern Bah el Ghazal State. It is situated in the lowlands of the floodplain region that occupies about one third of South Sudan and covers an estimated area of 219,614 km^2. Nyamlele is located about 120 km northwest of Aweil. Aweil was chosen due to concerns of environmental change due to land degradation and desertification. The main environmental issues in the area are as follows:

- Floods/water logging during the rainy season
- Overgrazing and bush fires
- Drought/dry spells during the dry season.

Floods/water logging

The area is prone to annual floods; since it is flat, rainfall intensities during the wet season are beyond the soil's capacity for infiltration. Thus, water stagnates and forms water-logged and flooded areas. Floods are followed by severe droughts when the water table drops, and rivers and streams dry up. The State Ministry of Agriculture and Forestry is fostering the awareness of local communities by addressing environmental issues and sensitising the population to the need to adapt to climate change. The Ministry advises them to plant crop varieties that are tolerant to adverse changes in the climate. However, these efforts are not effective in solving problems caused by floods.

The staff at the Ministry of Agriculture in Lol State plan to establish a Department of Environment and to initiate projects to encourage people to engage in their livelihoods without affecting natural forests. It also intends to enforce law and order in controlling and managing forest reserves and community forests.

Overgrazing and bush fires

The local communities as well as the Ministry of Agriculture and Forestry staff reported overgrazing and bush fires. Overgrazing is due to the fact that the livestock population is greater than the area's carrying capacity. Overgrazing can lead to severe soil erosion and land degradation, and a consequent decline in food production and increased poverty. Bush burning and burning agricultural residues can contribute to soil loss, cause air pollution and destroy biodiversity, with the same impacts.

Climate change and drought

The local communities reported that rainfall used to start in March and farmers used to harvest in September. Today, however, they cultivate in June and harvest before the beginning of the August floods. They explained that floods can thwart attempts to cultivate. They also cause road closures, which limits access to health services and increases the severity of diseases.

The river Lol, the area's main river, used to be perennial and deep most of the year, but today it has become shallow and partially dry. This has resulted in a decline in wetlands and less fishing than in the past. Cattle watering points have been more difficult to locate in the dry season, such that herders have to travel farther to water their cattle.

Livestock watering in the dry season in Aweil region.
Photo Credit:Rodrigo Mena

The local population feels that their climate is changing. They claim that temperatures have increased, and that sometimes children fall unconscious due to heat stroke.

An old man from the community of Angole village said that in the past, if you sold a cow in the market, the profit would cover all your needs, but now the earnings from such a sale can't meet his needs. An old woman from the same community also said that the challenges in sustaining food production and livelihoods have led to changes in behaviour among young men and women, many of whom have become idle or adopted poor social habits.

To address the challenge of protecting crops from animals, demonstration farms for growing vegetables during the dry season have been set up in the various Bomas in the Northern Bah el Ghazal State.

These demonstration farms also face water shortages during the dry season, so they use manual pumps and watering cans to irrigate crops.

Women pump water in Khor Dileb.
Photo credit: Ministry of Environment and Forestry

Bor

The town of Bor in Jonglei is located in the Sudd swamp, an inland delta of the White Nile made up of lakes, swamps, marshes and extensive flood plains; the Sudd Swamp occupies an area of about 30,000 km^2 and covers an estimated five per cent of the surface area of the Republic of South Sudan.

The characteristic vegetation includes papyrus, reeds, Napier grass and bush scrub. The MoEF suggested a visit to Bor because of its national importance for biodiversity, the Sudd's status as a Ramsar wetland of international importance, and the risks of environmental degradation it faces due to deforestation, land degradation and flooding.

Sudd community and wetland environment

The main environmental issues in the area include:

- Flooding conditions and wetland protection
- Tree cutting
- Overgrazing.

People living in Sudd wetland. *Photo credit: Eugene Apindi Ochieng, Environmental Pulse Institute*

Flooding and wetland protection

According to local officials, the frequency of floods in South Sudan has increased in the last two decades. In the years 1988, 1996 and 2007 flooding intensity was particularly high. However, the area's inhabitants have been living with these conditions for a long time. For example, the floods of 1960-1963 killed millions of trees, and still today, the pre-flood landscape has not been fully restored, as reported by an elderly wildlife officer. Officials claim that the increasing frequency of floods in South Sudan is largely due to the following factors:

- Deforestation in the catchment areas
- Destruction of surface vegetation
- Change in land use
- Increased urbanisation and other developmental activities
- The physical environment, including:
  - Poor water infiltration due to predominately clay soils
  - The flat topography
  - The amount of recharge of water flowing into the River Nile.

There are numerous impacts on residents' lives:

- Infrastructure development becomes very difficult due to the unavailability of local construction materials, such as sand and marram.
- The destruction of cultivated lands and woody vegetation, resulting in a progressive decline in areas available for cultivation and grazing.
- Increased water-borne diseases in local communities.
- Firewood becomes extremely scarce.
- The loss of biodiversity and soil erosion.

To minimise the impact of seasonal floods, local authorities have constructed a 17 km long dyke around Bor town.

Dyke near Bor.
Photo credit: Eugene Apindi Ochieng, Environmental Pulse Institute

Tree cutting

Trees are cut indiscriminately, except the Desert Date *(Balanites aegyptiaca)*, which is protected by most communities for its date-like fruit and other purposes. Trees are used for fuelwood, charcoal making, firing brick kilns, building huts, fodder, etc.

Tree cutting in Bor Region to fire brick kilns.
Photo credit: Justin Samuel, Ministry of Environment and Forestry

Deforestation exposes soil to high temperatures, which break down organic matter, increase evaporation and make soil vulnerable to erosion, leading to decreased biodiversity and habitat loss as well as increased risk of flooding. To mitigate, the Ministry of Agriculture and Forestry is expanding tree-planting programmes by producing thousands of seedlings of different types of woody plants and freely distributing them to local communities. Each Payam will have a central nursery offering a balance between fruit trees and other native/exotic trees.

Tree Nursery. Experts from EPI, UN Environment, University of Juba, National Ministry of Environment and Forestry, and State Ministry of Agriculture and Forestry in the Tree Nursery in Bor Town.
Photo credit: Eugene Apindi Ochieng, Environmental Pulse Institute

Overgrazing

During periods of conflict, local communities and their cattle were temporarily displaced away from their ancestral lands, which allowed the vegetation cover to regenerate. As these local communities return to the Bor region, however, there is the risk that overgrazing may occur again. There are policies and legal frameworks to control overgrazing practices and cattle raiding, but they need to be improved and/or reinforced for better results

Fisheries

Jonglei is one of the country's states with the greatest fish production and highest potential for growth. There is a plan for a commercial fishing and transport barge to begin operating soon to take fish harvests as far as the Juba market.

Barge for commercial fisheries in Bor.
Photo credit: Eugene Apindi Ochieng, Environmental Pulse Institute

Jebel Lado County

Jebel Lado County was selected for the field visit because it is considered an environmental "hotspot" due to the impact of rapid population growth on the Juba surroundings. The local population is mixed, but consists mainly of Dinka, Lokoya and Bari, among others. These communities expected that proximity to the national capital would provide employment opportunities, however the on-going conflict has diminished these possibilities.

Jebel Lado County is representative of a woodland savannah landscape, where sorghum farming and livestock production dominate livelihoods.

The field site visited was located about a 45 minute drive from central Juba, with the purpose of understanding how land degradation from extensive charcoal production is affecting the region around Juba city.

Aerial view of Juba Town and surroundings. *Photo credit: Peter Gilruth, Environmental Pulse Institute*

Charcoal production

A recent survey in Juba City estimated that 88 per cent of households, 74 per cent of businesses and 40 per cent of institutions use charcoal (MoAF & UNEP, 2015). The study also found that 15 per cent of households, 8 per cent of businesses and 40 per cent of institutions use fuelwood. Most use fuelwood to supplement charcoal when cooking.

To calculate how many trees are felled to meet the charcoal demand from the Juba population, it was estimated that 2.5 million bags of charcoal were consumed by the population of Juba in 2014, based on their rate of charcoal use. Since it takes about two trees to produce one bag of charcoal, this equates to roughly 5 million trees cut each year to supply Juba alone. This intensification of charcoal production has led to demonstrable environmental degradation.

Effects of charcoal production in the area surrounding Juba town.
Photo credit: Peter Gilruth, Environmental Pulse Institute

Because of insecurity in the area, farmers abandon their fields for fear of having their crops stolen, and they begin producing charcoal instead, which can be quickly converted to cash.

Forest Guards noted that only certain areas were safe for the field visits. The Guards explained that they have tried to promote extension and awareness programmes to help control charcoal production, but there was no budget to implement them. For example, they promoted the use of mud stoves instead of the traditional three-stone stoves, but are finding that cultural barriers prevent implementation. The Forest Guards found that one indicator of the increasing scarcity of energy sources for cooking is the fatigue factor among women who increasingly have to travel further afield to collect fuelwood.

The SEOR team met with Mr. James Jada, a farmer, charcoal burner, and herder of sheep and goats. He cuts 10-15 trees on average to make 8 bags of charcoal.

Charcoal burner (far left in photo) showing his production.
Photo credit: Peter Gilruth, Environmental Pulse Institute

Mr. Jada confirmed that due to insecurity, and also because it is the dry season, more farmers are leaving their fields to go into charcoal production. He remembered that Darfurians had come from Sudan in 2015, and they paid the local chief money for the right to use the land to make charcoal, but with no condition to replant or otherwise improve the local environment after harvesting.

Mr. Jada noted the impact of insecurity: the reduced safety led to less mobility, which meant that he had to concentrate charcoal in a limited area. He noted that he could not collect poles for construction as the trees no longer produce the taller stems needed, and he cannot travel far to harvest them. He noted a similar restriction in access to pasture, which causes overgrazing. His biggest challenge was food and water security.

Juba landfill site

Waste management

The Juba Municipal Landfill is located outside of town, next to the planned government buildings that were destroyed during the 2013 conflict. Combatants also looted dumpsite machinery (bulldozers, etc.), which are no longer operational, thus the City Council staff were no longer able to process the waste and minimise the associated hazards.

In April 2017, the site was still in use as an open dump, given the lack of equipment to bury the waste. During the field visit, the SEOR team noted that the landfill was 2-3 meters deep, and there was an ongoing, subsurface fire that burned 24 hours a day due to high temperatures and the presence of fuel. The burning of plastics, paper and other materials was emitting toxic smoke.

The Government of South Sudan noted that this was another example of how conflict has led to increased environmental degradation. Extreme poverty has

Juba landfill showing open dumping and constant combustion of hazardous wastes. *Photo credit: Peter Gilruth, Environmental Pulse Institute*

forced marginalised people to live off the dump. In the past, when the site was better managed, there were a limited number of residents. Now, although conditions at the dump are more dangerous, the lack of employment in the area has led to an increase in the resident population trying to live off the dump. Conflict has been the driver of this situation due to the following factors:

- Many family members capable of generating income were killed or went into the bush
- Infrastructure was destroyed
- There are fewer opportunities to generate income during times of conflict
- Populations most at risk (persecuted, fatherless families) were forced to live off the dump as a last hope for survival.

The staff of the City Council Solid Waste Department listed the top overall problems as security and health. Indeed, without peace and stability, no sustainable development is possible. They noted that the principal environmental problems were the unavailability of clean water and the lack of sanitation. They recommended that government budgets prioritise sanitation needs.

City Council staff noted numerous environmental changes, including loss of wetlands, increased pollution and a rise in diseases such as typhoid, cholera, malaria, hypertension, diabetes, hepatitis and cancer. On the positive side, the staff noted some improvements in sanitation to control cholera, where Oxfam, the Japanese International Cooperation Agency, and Unicef have been supporting the Government.

City Council staff also noticed the influx of an increasing number of marginalised groups that may have been persecuted during conflict and forced into precarious livelihoods.

Women with children of school age were picking through garbage to find plastics for resale and recycling. They were living in extreme poverty with signs of disease due to exposure to hazardous substances. The residents were worried that medical and electronic wastes are not separated out, creating an additional hazard.

Plastic collected from dump by women and children for recycling. *Photo Credit: Peter Gilruth, Environmental Pulse Institute*

The struggle to survive forces families to take risks to eke out a living. Children run to climb onto a moving truck, so as to be the first to pick out items for collection. The local chief told stories of children falling under the wheels and being crushed to death.

The residents stated that they were simply asking for the basic necessities in life: schools for their children, access to clean drinking water and access to minimal health services.

The residents were worried that medical and electronic wastes are not separated out, creating an additional hazard.

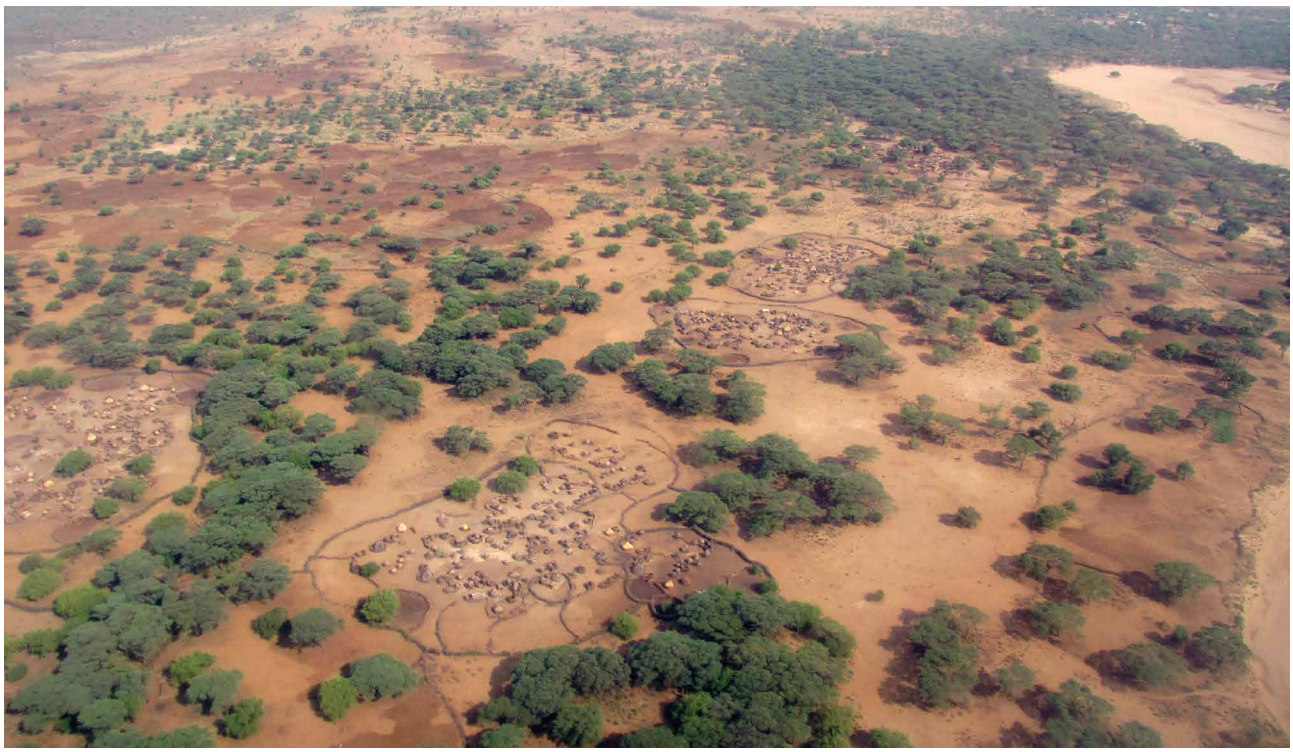
Dump truck arriving at dumpsite with new waste, which the residents will pick through.
Photo credit: Peter Gilruth, Environmental Pulse Institute

Kapoeta

Kapoeta is an example of a semi-arid landscape in South Sudan where sorghum farming and livestock production dominate livelihoods. The MoEF considers Kapoeta an environmental "hotspot". It is important to understand how land degradation and climate change are affecting the region.

The local population is mixed, but consists mainly of Toposa and Turkana. Access to education, health facilities and other government services is already limited but these services are even less available during periods of national conflict. Poverty and underdevelopment are the way of life.

Reports from the Famine Early Warning System (FEWS.net) show conditions of chronic drought; indeed, at the time of the visit in April 2017, Kapoeta was experiencing the third successive year of drought, which was putting the population at risk for food insecurity. The following photos show a Kapoeta farming family and the foods they eat to cope with drought.



Aerial view of a village around Kapoeta. *Photo credit: Peter Gilruth, Environmental Pulse Institute*

Kapoeta family in a sorghum field waiting for the rains. *Photo credit: Peter Gilruth, Environmental Pulse Institute*

Coping with drought in Kapoeta: famine food.
Photo credit: Peter Gilruth, Environmental Pulse Institute

Coping with drought in Kapoeta: famine food.
Photo credit: Peter Gilruth, Environmental Pulse Institute

Kapoeta has experienced population densification within the town limits, which has led to land degradation in the surrounding area.

During the field visit, the SEOR team noted that the three main overall problems in order of priority were food security, income/employment and water availability. The three principal environmental issues were climate change, deforestation and drought. All these topics are closely interrelated. Over the past several years, Kapoeta State officials noted that the region has experienced significant environmental change, such as the loss of wetlands and trees, poaching and an increase in malaria.

Solid-waste dump site outside of Kapoeta town.
Photo Credit: Peter Gilruth, Environmental Pulse Institute

As with other towns in South Sudan, solid waste management is a problem.

The team was able to interview a limited number of farmers, water collectors and charcoal dealers, in addition to the Governor of Kapoeta State who had lived in the region since his childhood.

Climate change

Kapoeta residents confirm reports of delayed rains and stronger winds, which desiccate fields and pastures. Local people often blamed climate change. There is a lack of long-term data to corroborate the perceived increase in drought frequency over time. Nevertheless, it was clear that the changing weather patterns have affected the migration of pastoralists, triggering overgrazing, erosion and the invasion of non-productive vegetation.

Inhabitants suffer from streams drying up earlier than usual and the inability of water pits from the seasonal Sangaita River to produce throughout the dry season. Inhabitants pleaded for infrastructure development through the construction of water-holding ponds emanating from such seasonal streams.

Women travel several miles each day to collect water in the drought hit area of Kopeata. *Photo credit: Arshad Khan, UN Environment*

Invasive species

During the field visit, the Governor of Kapoeta showed examples of invasive species that prevent nutritional grasses from growing and limit grazing potential. These bushes are hard to eradicate and have little use except for fuelwood. The Governor believed that the changing vegetation cover was due to both human (overstocking, poor rangeland management) and natural causes. He also noted that the overstocking might have been an unintended impact of vaccination programmes in the 1990s, which led to an increase in the cattle population.

Kapoeta Governor showing invasive species as evidence of environmental change. *Photo credit: Peter Gilruth, Environmental Pulse Institute*

Invasive species. *Photo credit: Peter Gilruth, Environmental Pulse Institute*

Kapoeta residents noted that although they have not experienced direct armed conflict since 2013, the impacts are ongoing. The inaccessibility of basic goods has driven up market prices and the devaluation of the South Sudanese Pound has exacerbated the economic downturn. As is the case in other regions in South Sudan, conflict has forced pastoralists to alter migration routes, with an associated rise in livestock disease.

Mining

The economic downturn has forced some villagers to turn to artisanal gold mining as an alternative livelihood, but these mines are at high risk from cave-ins during the rainy season.

Man panning for gold in Kapoeta Region.
Photo credit: Arshad Khan, UN Environment

Upper Nile (Paloch)

Oil production

In 2014, the Government of South Sudan noted that the social and environmental costs of oil production were extensive, including the destruction of wildlife and biodiversity, the loss of fertile soil, air pollution, drinking water contamination, the degradation of farmland and damage to aquatic ecosystems, all of which have caused serious health problems for the inhabitants of areas surrounding oil production. Pollution is caused by gas flaring, above-ground pipeline leakage, oil-waste dumping and oil spills.

Given the current economic importance of petroleum as a financial lifeline for the Government, and because of the associated risks of environmental pollution, the MoEF selected the Upper Nile State (Paloch) for a field visit. Although circumstances did not allow the SEOR team to conduct the site visits and interview the local population, after a brief fly-over it was decided to include information from a previous survey of health and environmental impacts so as not to neglect this sector. The information taken from the 2014 survey reflects findings from across the oil producing regions, and was not specific to Paloch only (RSS, 2014).

The Ministry of Petroleum staff noted the importance of monitoring and control systems in the production process that would avoid or minimise the damage to human, livestock and environmental health. They provided the example of the Gummry Oil Spill in 2015, wherein basic monitoring of production sites (installation and maintenance of CCTV, etc.) would have avoided substantial clean-up costs that rose to millions of US dollars.

Gummry Oil Spill. *Photo credit: Mr. Hamoun, Ministry of Petroleum*

The staff also advised that the best way to handle produced water, a polluted by-product of pumping oil, was to re-inject the water underground.

A community health survey was conducted in both oil producing and non-oil producing areas to have a basis for comparison. The survey found that on the one hand, the local population was concerned about human, livestock and environmental health, and on the other hand about the opportunities for employment that the petroleum industry offered.

The majority of households from the oil producing areas consumed unsafe water. Their common sources were local wells, water from ponds along the roads and water discharged by companies. These sources were exposed to environmental contamination and therefore may have contained chemicals brought up from underground or additives used in oil production.

Further complicating access to clean water, the containers used to store chemical additives were sometimes being used to transport water to residences. While the communities complained about the emergence of new diseases, they did not seem to know that some of these may be caused by indirectly consuming unsafe chemicals through household water stored in containers.

Regarding the impacts on human health, both the respondents in the oil producing and the control areas reported a high prevalence of sickness, possibly due to the pervasiveness of malaria in the region.

Delivery of deformed babies was more prevalent in the oil producing areas, in particular in Melut, Pariang and Rubkona, where oil production has continued over many years. The other complications included fever, diarrhoea, headache, dizziness, bleeding, skin rash, vomiting and blindness. These were also more common in the oil producing areas. The survey concluded that the length of exposure to the pollution was a critical factor in disease incidence and severity.

Regarding animal health, a greater proportion of the respondents who reported higher-than-normal animal deaths were from oil producing areas. The highest percentage occurred in Pariang, followed by Koch, Guit, Melut and Rubkona. Most households in the oil producing areas grazed their animals around the facilities. The suspected causes of animal deaths were grazing in areas where the grass had taken up chemicals resulting from oil production or drinking polluted water.

Finally, the survey found that oil production did indeed have an environmental impact, with a majority of respondents reporting that the grass and trees had changed their appearance, and particularly so in the oil producing areas that had been in operation for several years. The changes were reported to have covered large areas.

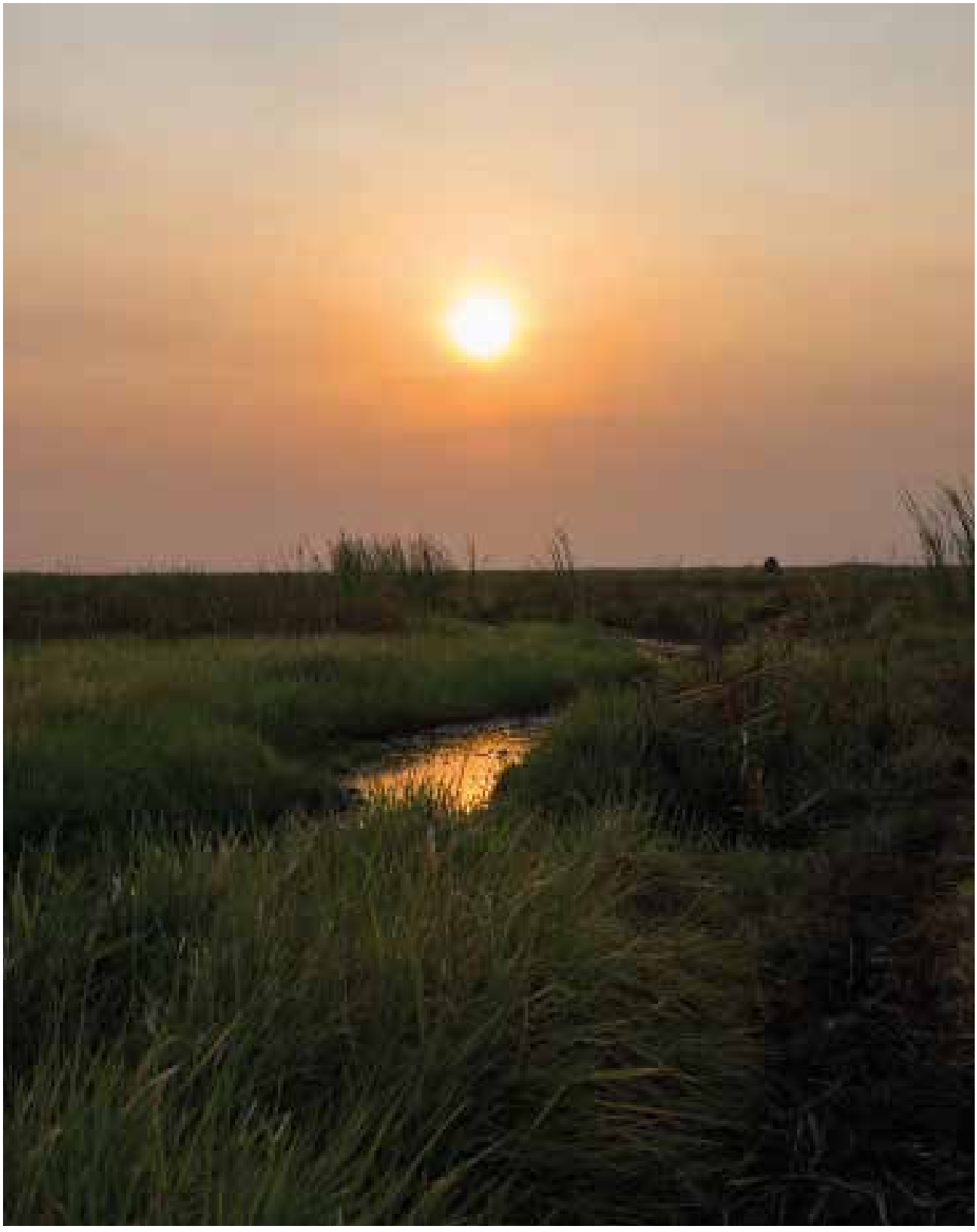
Finally, the survey recommended that additional safety precautions be taken in the production process. While many were happy with the industry because it provided community development opportunities, the industry would gain additional confidence from the local population if environmental standards were better respected than at present.

Containers used for transporting chemicals.
Photo credit: Mr. Hamoun, Ministry of Petroleum

Dead goats that were victims of drinking from the contaminated mud pit at GMR – 17, Gummry Oil Field, on the 14th of January 2017. The mud pit was neither treated nor backfilled and contained mud cuttings and the chemicals brought up together during oil drilling.
Photo credit: Mr. Hamoun, Ministry of Petroleum

Conclusion

In summary, the visits to the various environmental hotspots in South Sudan provide ample evidence of environmental change from both natural and human causes. In particular, the impact of conflict touches all aspects of life (economic, social and environmental), a fundamental fact that the visit to the field confirmed.



The sun sets over the Sudd in Leer County. *Photo credit: UNMISS*

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Annex 1 – Workshop participants and interviewees

Participants at the Inception Workshop 30th November 2016, Juba

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