SOUTH SUDAN CLIMATE VULNERABILITY PROFILE: SECTOR- AND LOCATION-SPECIFIC CLIMATE RISKS AND RESILIENCE RECOMMENDATIONS

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1. EXECUTIVE SUMMARY

South Sudan is experiencing a historic violent conflict resulting in a humanitarian crisis. More than one-third, or over 4.4 million people, of South Sudan's estimated population of over 12 million are displaced. Approximately 2.4 million people have fled to neighboring countries, and another 2 million are internally displaced. The situation in South Sudan is currently Africa's worst refugee crisis, and the world's third worst (behind the crises in Syria and Afghanistan).

Approximately 80 percent of South Sudanese are rural subsistence farmers. As a result of the reliance on subsistence farming -- combined with other factors such as the current political crisis decimating livelihood safety nets and lack of institutional capacity -- most communities in the country are highly vulnerable to climate variability and change, which will likely impact all economic sectors.

The purpose of this report is to provide an overview of historical climate trends and future projections, asses climate vulnerability in select sectors, and provide recommendations to improve climate resilience in South Sudan. In particular, this analysis provides an overview of how the climate has and will likely change – including resultant impacts – with a focus on the Candidate Partnership Areas (CPAs) where USAID is working: Torit, Yambio, Yei, Aweil, Rumbek, Wau, and Bor (see Figure 1). The analysis addresses the role of climate change and variability on migration and conflict in South Sudan, and potential ways to increase climate resilience. We also examine climate vulnerabilities and potential actions to improve resilience in the agriculture sector. Climate change online summary tables (aka 'dashboards') are also included that summarize historical and future climate change trends specific to each CPA. Finally, this report includes a case study of how climate change may impact one of the world's largest wetlands, and most important ecosystems, the Sudd.

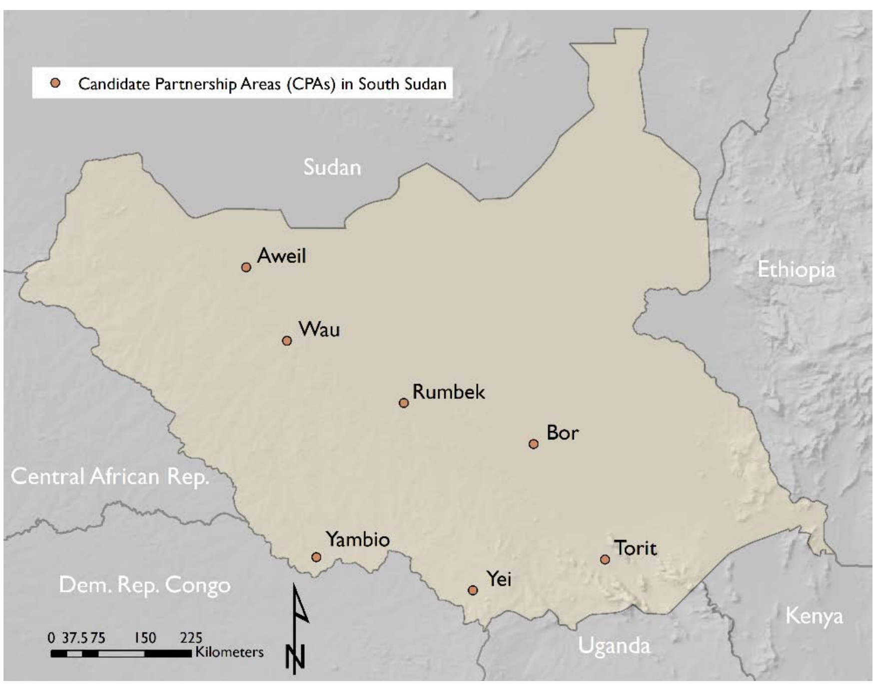

Figure 1. Candidate Partnership Areas.

This analysis considers the four principles for ‘sustainable adaptation,’ as explained by Eriksen (et al. 2010), and integrates these principles throughout the report; these principles are especially helpful to identify sustainable adaptation activities during the crisis in South Sudan. The four principles are:

1. Recognize that the context for vulnerability includes many stressors in addition to climate change.
2. Understanding that different values from different groups are relevant for adaptation outcomes.
3. Local knowledge is important for adaptation actions.
4. Consider links between local and global processes.

While this assessment is not intended to be a summary of climate policy in South Sudan, it builds on recent assessments, such as: the National Adaptation Programmes of Action (2016); the Intended National Determined Contributions (2015) (currently being updated); South Sudan: First State of the Environment and Outlook Report (2018); as well as several other relevant sector-specific assessments.

FINDINGS AND RECOMMENDATIONS

The report presents findings and recommendations on: general climate change issues in South Sudan, agricultural vulnerability and resilience, migration and conflict, and vulnerability of the Sudd wetland.

HISTORICAL AND FUTURE CLIMATE CHANGE IN SOUTH SUDAN

HISTORICAL CLIMATE FINDINGS

- Average temperatures have increased by approximately 1-1.5°C since the 1970s.
- Station data suggests annual and rainy season average precipitation levels have either remained broadly constant or declined since the 1970s, while gridded observational datasets suggest slightly increasing precipitation over the past decades.
- Large year-to-year variability in precipitation, often shifting from 50 percent lower than average rainfall in one year, to 50 percent higher than the average the next year. In 2017, extreme flooding led to the displacement of approximately 100,000 people.
- Increasing delays and early finishes of the rainy season, resulting in overall shortening of the season and making predictions of the onset and cessation of the rainy season extremely difficult.
- Droughts have become more frequent and widespread since the 1960s, when flooding occurred in the Upper Nile. In 2015 South Sudan experienced severe drought that accompanied an El Niño event.

FUTURE CLIMATE CONSIDERATIONS

- The average annual temperature across South Sudan is expected to increase by approximately 1-1.5°C by 2060, which will likely result in more extreme heat days and longer heat waves.

- A majority of climate models project a likelihood of slightly increasing total annual precipitation, particularly increases in the November – March dry season. However, projections for changes in precipitation vary greatly; some models project decreasing rainy season length and total annual precipitation, potentially resulting in increased drought occurrence.

AGRICULTURE VULNERABILITY AND RESILIENCE

FINDINGS

Increased temperatures may lead to impacts on the agricultural sector:

- Increased evapotranspiration in plants and reduction of soil moisture, increasing the amount of water crops will need.
- Potential increase in pest and pathogen outbreaks in crops and livestock.
- Increased evapotranspiration, combined with prolonged dry periods, leading to shrinking wetlands, and perennial rivers becoming seasonal. This could negatively impact pastoralists access to water resources and reduce fishing resources by reducing the health and size of fish.
- Crops that reach their thermal maximum temperature producing less yields. This is especially likely for wheat and sorghum.
- Combined with changing rainfall patterns, desertification may increase, particularly in the north and southeast of South Sudan, and the Sahel shifting southward, leading to changing habitats.

Increased variability of rainfall, including potential increases in droughts, floods, and changes in the onset and duration of the rainy season, may lead to additional agricultural impacts:

- Increased competition for water resources during droughts between pastoralists and farmers, potentially leading to increased local conflict.
- Floods decreasing crop and livestock yields.
- Delay or shortening of rainy season causing crop failure or reducing water resources, leading to decreased livestock health.
- Extreme flooding or drought leading to the loss of grazing area or access to water for pastoralists.
- Droughts leading to potential drop in water table, drier seasonal rivers, and reduction of wetland size. The combination of drought and high temperatures might contribute to wildfires that destroy grazing and agriculture habitats.
- Grains and cereals – the main staples in the country – are especially sensitive to changes in rainfall, and almost 70% of the variability in their production can be explained by variations in rainfall.

RESILIENCE RECOMMENDATIONS: AGRICULTURE SECTOR

1. ***Promote policies that encourage actors throughout the value chain,*** from farmers to agribusinesses, to utilize farming practices and technologies that are suited for higher temperatures and variable rainfall conditions. Promote sustainable climate smart agriculture, such as introduction of drought tolerant crops and crop varieties, livestock improvement. and soil erosion control.

2. ***Work with local communities to understand the local political, social, and cultural context of the agriculture sector,*** and improve understanding of what types of behavior change can lead to more climate resilient agricultural practices to be adopted. Strengthen community-based adaptation strategies.

3. ***Provide early warning systems at national, sub national, and village levels to strengthen preparedness and build resilience.*** These systems can provide timely information and advisories about roads/routes that are unreachable due to climate-related disasters, ensuring that remote populations can access markets. Other innovative mechanisms such as the utilization of geospatial tools, remote sensing and earth observation data can assist planners and decision makers with the required evidence-based science required for enhanced resilience.

4. ***At the community level, support conditional asset transfers after a crises or disaster,*** including through food/cash-for-work interventions such as slope stabilization, landscape management, and disaster mitigation infrastructure. This approach can reduce disaster and climate-related risks. Ensuring vulnerable communities have access to social protection and using innovative insurance schemes is also critical to enhancing resilience.

5. ***Given the high reliance on rain-fed agriculture, support strategies and development of work force skills for livelihood and income diversification to improve resilience.*** Support to additional income sources -- such as mining, fishing, skilled non-farm activities and forest management -- can help improve livelihoods.

6. ***Work closely with individuals who resettle after the current crises*** to introduce culturally appropriate climate smart practices and access to markets, including the development of an agriculture extension service.

7. ***Improve land access and land tenure policy and regulation,*** particularly regarding pastoralists rights and access to grazing land and water. Improve social networks and understanding of how climate change may contribute to shifting dynamics of power between genders.

8. Given the frequent droughts, flash floods, and land degradation issues, ***prioritize promotion of harvesting and retention of water for different uses.*** Consider community-based watershed management with a focus on multi-use and stakeholders. Strategies to ensure sustainable food security under a scenario of decreased rainfall should focus on improving water management practices at all levels.

9. ***Build, improve, and maintain infrastructure,*** such as river channels, raised embankments, floodwalls and culverts to reduce flood risk.

10. ***Introduce a well-coordinated seed-distribution program*** 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.

CLIMATE CHANGE, MIGRATION AND CONFLICT

FINDINGS

While current research does not suggest direct correlation between conflict and climate change, the impacts could be severe, and climate change and variability could exacerbate conflict. Data and research in this area is lacking.

Climate change and variability may exacerbate migration. While large uncertainly exists about the role of climate change on migration, there is risk and concern that climate change and variability, particularly extreme events, may have significant impacts on migration, potentially exacerbating conflict (e.g., competition for resources). Waiting for overwhelming evidence to act may lead to devastating consequences in the country.

Lack of access to natural resources is creating more vulnerable populations: Due to violence and the threat of conflict, many pastoralists have been blocked from traditional water sources, which has forced them to change migration patterns or flee. Farmers have been forced to change livelihoods and move into wetland or swampland areas where there is less access to food. The result is that already vulnerable populations, especially women and children, are more vulnerable to climate and weather events.

RESILIENCE RECOMMENDATIONS: MIGRATION AND CONFLICT

Improve local capacity to address disputes. As a result of significant internal migration, the capacity of local institutions, including wherewithal to address local resource disputes, is lacking. Improving this capacity could improve climate resilience and contribute to national capacity and resilience in the future. There is an opportunity to learn from other regions, such as the Sahel, which have been addressing similar challenges.

Improve resilience to prevent climate impacts to livelihoods. Build climate resilience by strengthening local institutions, natural resource management, and individuals safety nets so that livelihoods are less likely to be impacted by climate change and variability.

Improve research, including local knowledge, on the role of climate change and variability in migration and conflict. Because of a lack of data it is difficult to assess the potential impact of climate change and variability as threat multipliers to migration and conflict. Improved research -- including local oral history, community engagement, and working across communities -- would contribute to potential local and national climate resilience efforts, and the confluence with migration and conflict.

THE VULNERABILITY OF THE SUDD WETLAND

FINDINGS

Combination of climate change and Jonglei Canal could devastate ecosystems and livelihoods. Although the Sudd is able to absorb significant excess water, variable rainfall does threaten water resources and the overall ecosystem in the region. The planned completion of the Jonglei Canal, combined with precipitation variability, could drastically alter the ecosystem function of the region and ways current communities use water resources for livestock, farming, and fisheries.

Water resources threatened due to variable rainfall when combined with other drivers. While the Nile Basin, which drains into the Sudd, is highly vulnerable to annual changes in precipitation, the Sudd is more resilient to variable precipitation. However, when combined with drivers such as migration into the Sudd and changing demands for water resources by pastoralists and farmers due to conflict, the impacts of variable precipitation across sectors -- including on biodiversity, fisheries, farming, and pastoralism -- are magnified. This will be especially true during dry or drought years.

RESILIENCE RECOMMENDATIONS: SUDD

Conduct additional research. Additional research into climate change and variability impacts to the Sudd wetland, and the climate regulation capacities of the Sudd itself, will improve information for management and decision making in the area. Research should include data collection with local communities to understand historical climate changes and impacts at the local level.

Improve regional and local conservation policies and practices. Promote and support policies that maintain the integrity of the Sudd Wetland and its ecosystem services, including additional protected area designations such as the tentative UNESCO World Heritage Site listing. This may include encouraging sustainable wildlife and ecotourism in the Sudd to socialize its value as a potential contributor to economic growth.

POTENTIAL AREAS OF INVESTMENT TO IMPROVE CLIMATE RESILIENCE

While the key findings and resilience recommendations listed above are specific to sectors (agriculture; migration and conflict) or regions (the Sudd), below are broad recommendations that could improve country-wide climate resilience.

Improve baseline information. As highlighted in the South Sudan 2016 National Adaptation Programmes of Action, there is limited information -- and ability to collect and store information -- on climate vulnerabilities and adaptation actions in South Sudan. Moving forward, improving research, monitoring and evaluation, and data collection and research on climate change adaptation would provide baseline information to improve future climate resilience efforts.

Improve sector specific, local, climate services: Invest in improved climate information and delivery of information at a sector-specific and local scale to improve local decision making and understanding of the impacts of climate change and variability. For example, seasonal forecasts for farmers with suggestions on how seasonal climate conditions will impact certain crops, water resources, and grazing lands for pastoralists could be valuable. Furthermore, this type of information should be readily distributed to local communities, such as on a mobile/cell phone platform.

Promote community-level resilience efforts. Focus on improving resilience at the local level, including improved understanding of how local communities are already adapting to climate change, how climate change impacts various sectors, and using local knowledge and oral history. Identify resilience building actions at the community level, such as promoting climate smart agriculture practices or improved water management, that could be scaled up when the current crisis in South Sudan ends. For example, obtain information during household surveys about the role of climate and weather in overall resilience, and integrate these data into effective resilience building efforts. South Sudan has a decentralized government with local traditional leaders often acting as the most important community decision makers; this context should be considered for an increased role for women (and youth) and how to create gender-equality in climate related decision making.

2. HISTORICAL AND FUTURE CLIMATE CHANGE IN SOUTH SUDAN

South Sudan has a humid equatorial climate that is hot and dry, with seasonal rains generally occurring April through October (GERICS 2015, USAID 2016a, UNEP 2018). The northeast is drier than other parts of the country, with average annual precipitation of 200-800 mm, while the southeast receives more precipitation, with average annual rainfall between 1,000 and 2,400 mm (UNEP 2017). Seasonal rains are an important water source for agriculture, pastoralism, and fishing, but also result in seasonal flooding in the floodplains (USAID 2016a, UNEP 2018). The driest parts of the country are the semi-arid areas of the southeastern region, which are also the areas with the highest food insecurity levels. Average temperatures are typically higher in January through May and cooler June through September, ranging between 26°C and 32°C across the country (USAID 2016, WB 2019).

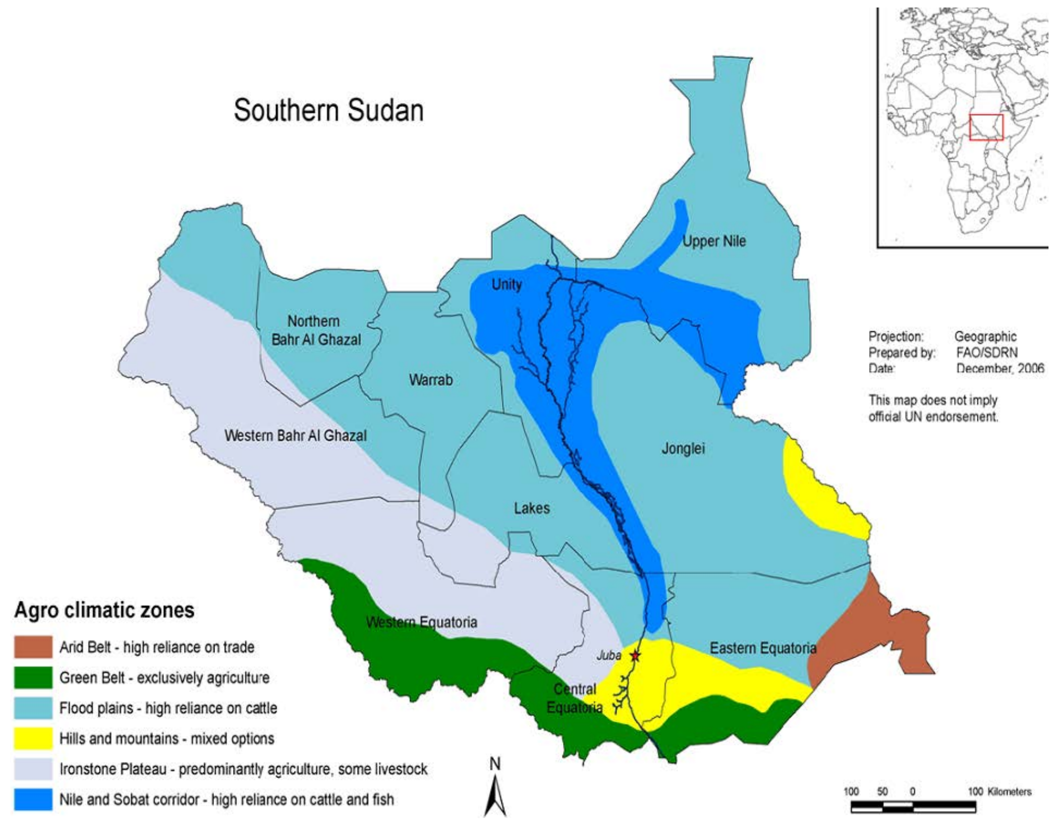

Figure 2. Agro Climatic Zones of South Sudan

HISTORICAL CLIMATE CHANGE CONDITIONS

South Sudan has experienced changing climate conditions and weather patterns over the past several decades. Average temperatures have increased by around 1-1.5°C since the 1970s (GERICS 2015, USAID 2016a, UNEP 2018, PREPdata 2018). While temperatures were already increasing since the 1950s, the rate of increase has increased significantly in the past three to four decades (GERICS 2015, UNEP 2018). The increase in maximum temperatures is slightly higher than the increase in average temperatures, elevating the incidence of extreme heat conditions (GERICS 2015).

Assessment of the historical precipitation data is less conclusive than temperature information. A USGS and USAID (Funk et al. 2011) climate trend analysis for Sudan indicates that the average rainfall during the wettest months, June through September, for Southern Sudan between 1990-2009 is around 20% lower than the average for the same months from 1900-1989 (Funk et al. 2011). Numerous resources, such as the USAID Climate Risk Profile (USAID 2016a) and UNEP State of Environment (UNEP 2018), have relied on this data. A decreasing trend for both annual and June through September precipitation over the 1951-2000 trend is also observed across three rainfall stations (Juba, Wau, and Malakal) in South Sudan (WB 2015), with Wau experiencing the greatest precipitation decrease. However, station data collected by FAO and shown in the UNDP/MOE Environmental Impacts, Risks and Opportunities Assessment (UNDP 2011) shows no clear change in annual rainfall between 1980 and 2010. Additionally, the historical data in the PREPData dashboards, which are summaries of historical and future climate trends and shared below in the future projections section, generally suggest little change or slight increases in precipitation between the 1970s and 2010 (PREPdata 2019). This data is based on downscaled model projections informed by observed climate records[1]. Finally, spatially averaged observed data for the area show no substantial change in the precipitation overall over the past century, but a slight increase of around 10% since the 1980s (GERICS 2015).

Ultimately, station data appears to suggest annual and rainy season average precipitation levels have either remained broadly constant or declined in recent decades, while gridded observational datasets suggest slightly increasing precipitation level. These discrepancies highlight the potential that different observation methods can yield different results, potentially based on location of observations, and reinforce the need for spatially significant observations and projected trends that are tailored to the needs of a specific sector, such as agriculture.

The importance of precipitation variability should not be overlooked. Historical precipitation exhibits large annual variability, often shifting from 50 percent lower average rainfall in one year to 50 percent higher than the average the next year (UNDP 2011, GERICS 2015, UNEP 2017). The variability in both timing and amount of rainfall has been increasing (USAID 2016a). Analysis from weather station data for the period 1961-2013 indicate high rainfall variability across the regions. Whereas the southern and central regions have experienced decrease in rainfall, some parts of the western and eastern regions have experienced increase in rainfall (USAID East Africa 2018). There also appears to be increasing delays and/or early finishes of the rainy season, resulting in overall shortening of the rainy season (UNDP/MOE 2011). It is also reported that droughts have become more frequent and widespread since the 1960s (Funk et al. 2011, UNEP 2011).

FUTURE CLIMATE PROJECTIONS

There is broad agreement across climate models that the average annual temperature across South Sudan is expected to increase by around 1-1.5°C by 2060 compared to current average temperature (USAID 2016a, UNEP 2018 , PREPdata 2019). In addition to increasing average temperatures, maximum and minimum temperatures are expected to increase at around the same rate (GERICS 2015, PREPdata 2019). The higher temperature regime is projected to result in shorter cold spells as well as both more

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1 More information on data can be found on the NASA Earth Exchange Global Daily Downscaled Projections website.

extreme heat days, or days with temperatures in the top 1% of temperatures project[2], and longer heat waves (estimated at 5 to 32 days longer by 2085) (GERICS 2015, PREPdata 2019).

There is less agreement around projections of future precipitation changes. Because there is greater uncertainty regarding future precipitation changes, it is important that adaptation and resiliency-building efforts consider a wide range of potential future precipitation scenarios. In the relatively near term (up through 2040), continuing trends from station data suggest the potential for decreasing rainy season length and total annual precipitation (USGS/USAID 2011). This could result in increased drought incidence. However, for the coming decades, a majority of climate models project greater likelihood of slightly increasing total annual precipitation, particularly increases in the November – March dry season (GERICS 2015, PREPdata 2019). These differences may be explained because the near-term trend analyses are projecting forward based on historical results while the models are accounting for changes in global and regional atmospheric conditions. Unlike temperature projections, there is very significant variation between model projections for total annual precipitation, with numerous model simulations showing decreased rainfall and many showing increased rainfall (GERICS 2015, PREPdata 2019).

While difficult to predict, overall, both the frequency and length of dry spells are projected to stay relatively stable or decrease in the coming decades (GERICS 2015, PREPdata 2019). This aligns with the general expected increase in precipitation levels. However, the increased temperatures could result in greater evapotranspiration, increasing drought impacts if not incidence (Funk et al. 2011). Decreasing rainfall in some years, combined with increasing temperatures, could also result in more intense or longer dry spells and droughts. There is also broad agreement that the frequency and intensity of heavy rainfall events is projected to increase (GERICS 2015, USAID 2016a, PREPdata 2019).

While the overall average across models suggests slightly increasing precipitation in the coming decades, it's important to account for the possibility of drier future conditions and increased drought. Even if overall rainfall increases, it is also expected to be more variable, and thus dry years may also become more likely even in a slightly wetter future. The projections through 2040 developed by USGS/USAID (Funk et al. 2011) for the Famine Early Warning Systems Network (FEWSNET) that suggest continued decreasing rainfall are based on both extrapolated trends as well as local ocean-climate patterns. These findings have been referenced in and shaped many of the climate change analyses for South Sudan, including the USAID Climate Risk Profile (USAID 2016a) and the recently-released State of the Environment report (UNEP 2018) by the UN Environment Programme. Given the uncertainty around precipitation projections, it is important to consider and plan for a wide range of possible future precipitation conditions.

FUTURE CLIMATE PROJECTIONS BY LOCATION

This section summarizes future projected climate changes for USAID/South Sudan's seven Candidate Partnership Areas (CPAs) and the Sudd. The information presented in this section is based on a NASA dataset drawn from 21 downscaled climate models and informed by observational climate records[3]. The models are the same as those used across many other climate modeling efforts (e.g., the

2 Days with temperature in the top 1% of all temperatures projected for any day in the relevant data set.
3 For more details on the data source, see the technical document for the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP): https://nex.nasa.gov/nex/static/media/other/NEX-GDDP_Tech_Note_v1_08June2015.pdf

Intergovernmental Panel on Climate Change (IPCC) and the US Fourth National Climate Assessment). All of the models were run using both low and high future emissions scenarios (RCP 4.5 and RCP 8.5, respectively). The ranges in the table below are based on the model averages for each scenario.

Each summary is accompanied by a much more detailed, interactive online summary, or dashboard, which is hosted by the multi-stakeholder Partnership for Resilience and Preparedness (PREPdata 2019). These dashboards can be used by each CPA to prepare for projected future climate change for their specific location and help decide resilience building actions. The link to each individual dashboard is provided for each location. The table below present projections for 2090, the individual dashboards for each location provide projections for earlier years. Displaying 2090 in the table below displays some potential variation among locations over time easier (Table 1).

TABLE 1. SUMMARY OF PROJECTED CLIMATE CHANGE FOR CANDIDATE PARTNERSHIP AREAS (CPAS), WITH CORRESPONDING LINK TO CPA SPECIFIC DASHBOARD PROVIDING RESULTS IN DETAIL.

Location	Projected average temperature increase by 2090 compared to current levels	Projected cumulative annual precipitation increase by 2090 compared to current levels*	Projected increase in extreme heat days by 2090 compared to current levels	Projected increase in extreme precipitation days by 2090 compared to current levels
Torit Equatoria	1.5-3.3°C	78-244mm/yr (7-22%)	20-55 days/yr	1-4 days/yr
Yambio Equatoria	1.6-3.5°C	55-249mm/yr (4-16%)	17-54 days/yr	1-3 days/yr
Yei Equatoria	1.5-3.4°C	121-269mm/yr (8-18%)	19-48 days/yr	1-4 days/yr
Aweil Bahr el Ghazal	1.5-3.5°C	73-176mm/yr (7-17%)	13-36 days/yr	1-3 days/yr
Rumbek Bahr el Ghazal	1.7-3.6°C	54-123mm/yr (5-12%)	23-58 days/yr	1-3 days/yr
Wau Bahr el Ghazal	1.5-3.3°C	51-177mm/yr (4-15%)	17-47 days/yr	1-3 days/yr
Bor Great Upper Nile	1.7-3.5°C	57-194mm/yr (6-20%)	24-58 days/yr	1-4 days/yr

TABLE 1. SUMMARY OF PROJECTED CLIMATE CHANGE FOR CANDIDATE PARTNERSHIP AREAS (CPAS), WITH CORRESPONDING LINK TO CPA SPECIFIC DASHBOARD PROVIDING RESULTS IN DETAIL.				
Sudd Great Upper Nile	1.6-3.5°C	57-173mm/yr (7-21%)	19-51 days/yr	1-4 days/yr

* Precipitation projections in the climate models have considerable variance; the figure provided is the average across all models.

3. VULNERABILITY AND RESILIENCE IN THE AGRICULTURE SECTOR

Agriculture is the principal livelihood in South Sudan. Approximately 80 percent of South Sudanese are rural subsistence farmers (UNEP 2018, Table 3). They primarily grow cereal crops such as sorghum, maize, millet, and rice, which comprise about 50 percent of the South Sudanese diet. Almost 70% of the variability in production of grain and cereal in the country is due to variable rainfall (WFP 2014). Maize is especially sensitive to variable rainfall patterns, particularly dry periods and increased temperatures, while sorghum and millet, while likely to be negatively impacted by climate change, are more resilient to projected climate changes than maize (Sultan et al. 2013, Abera et al. 2018). Other common crops are cowpea, okra, peanut, and pumpkin. In more tropical regions such as Equatoria, farmers frequently grow cassava, sweet potato, mango, and papaya, in addition to cereals (ADB 2013, Figure 3). Irrigation is virtually non-existent, except in one rice producing area in Aweil (NBI 2017). Farming is often led by women-run households, who, as a result, may be more vulnerable to climate change due to reliance on rain fed agriculture (ADB 2013). Women may be further marginalized, not only in the agriculture sector, due to patriarchal traditional customs that favor men to the detriment of women. The South Sudanese also have a strong pastoralist culture. Approximately 74 percent of households own livestock – mostly cattle, which rainfall variability may have a large impact. Meat and dairy comprise about 30 percent of total basic food consumption (RSS 2015). Pastoralist practices are most common in western parts of Greater Upper Nile, in Bahr el Ghazal, and in Eastern Equatoria. Livestock systems face multiple stressors in South Sudan, such as fragmentation of grazing areas, variable access to water, and weak social safety nets and markets. Climate change and variability are likely to magnify the already existing challenges to livestock (Dougill et al., 2010). Other agricultural activities, although less common than farming and pastoralism, include fishing and harvesting wild food from forests (Figure 3), which are

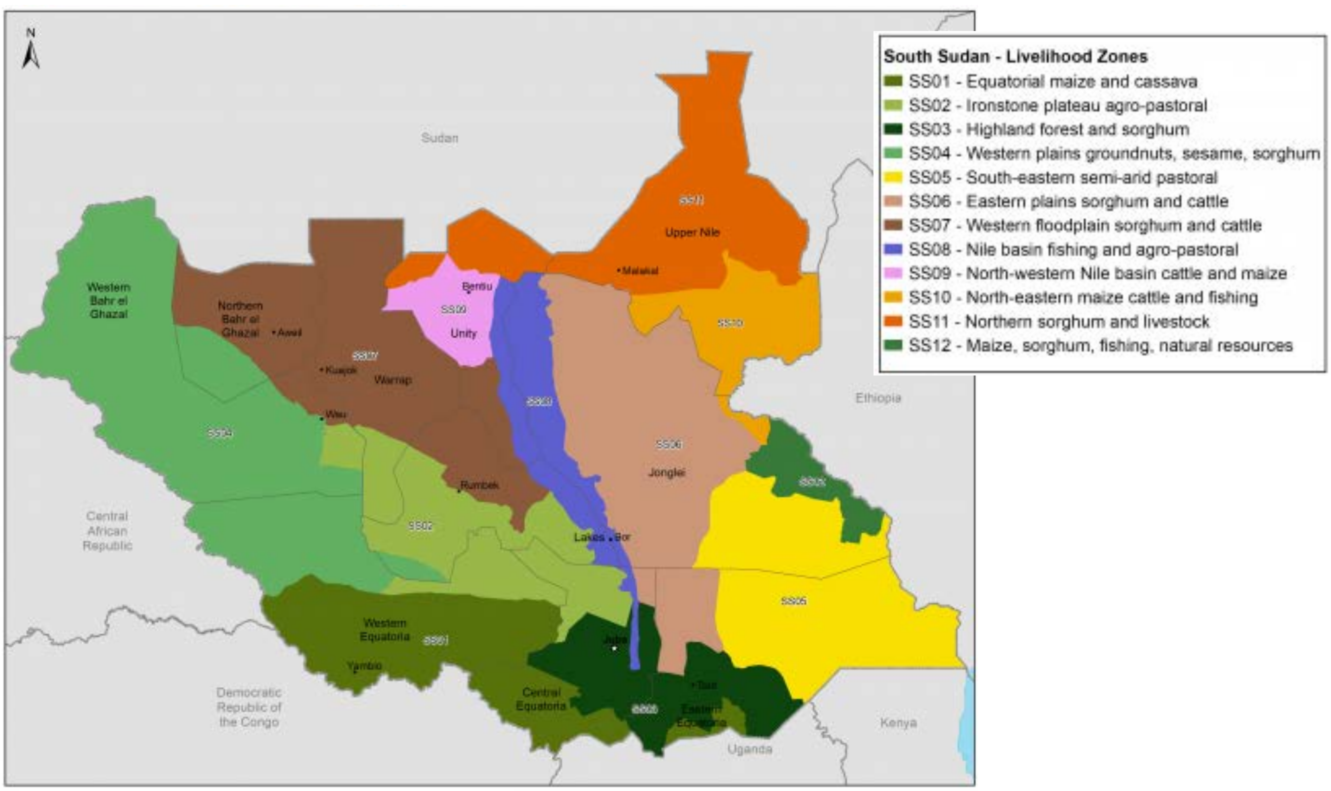

Figure 3. Livelihood zones. Source: FEWSNET

threatened due to variable rainfall and increased evapotranspiration. As a result of the reliance on subsistence farming, combined with other factors like lack of institutional capacity, most communities, and therefore the country, are vulnerable to climate change and variability.

Over the last several years, food production and food security in South Sudan have deteriorated to alarmingly low levels, particularly since the current conflict began in 2013, and exacerbated by the drought beginning in 2015. Recent extreme events such as floods (2014, 2017) and droughts (2011, 2015) have led to deaths, displacement, and destroyed livelihoods for many working in the agriculture sector. Variable rainfall puts these communities further at risk. Potential increase in either intensity or frequency of extreme weather events and continuation of erratic rainfall threaten food security and the sustainability of rain fed agriculture sector in South Sudan. Violent conflict and economic collapse have displaced populations, destroyed property, and ruined livelihoods and local trade. Consequently, and despite the population's heavy dependence on agriculture, South Sudanese agricultural practices are critically underdeveloped. Farmers typically cultivate plots by hand and do not use or have access to high-yielding seeds or other inputs such as synthetic fertilizers or pesticides, and generally lack access to irrigation, making farmers even more vulnerable to climate change and variability. Although about half of South Sudan's land area is suitable for cultivation, only about four percent is currently cultivated. Livestock are frequently raised by nomadic pastoralists who are dependent on uncertain access to grazing land and watering points; social conflict and displaced populations make access to land and water even less secure for these communities. Agro-pastoralists and farmers in South Sudan have already noticed changing weather patterns (Murray 2016). South Sudan's State of the Environment Report (UNEP 2018) indicates that farmers have noticed the delayed onset of rains and longer dry spells at the beginning of the rainy season, as well as increased rainfall intensity which has led to more variable and serious flooding.

If seasonal rainfall declines or is poorly distributed, food access could be affected in two inter-related ways. First, reduced seasonal crop production due to low rainfall would force households to purchase more of their food. Second, climate-induced food price volatility could require households to spend more of their income on food. In addition, climate-related disasters such as floods limit physical access to markets. Furthermore, grazing land and access to water will likely become less reliable as rainfall continues to become more variable. While reliable information on frequency and intensity is scarce, South Sudan experiences wildfires that may negatively impact grazing land. Commercial fisheries are practically nonexistent. There are also gender inequalities in the agriculture sector, as women and girls face disadvantages, including gender-based violence, which, when combined with climate change and variability, make women a vulnerable population to climate shocks (UNEP 2018).

South Sudan is currently dependent on food aid from international donors and imports from neighboring countries. But agriculture and food security in South Sudan could be dramatically improved. In the 1980's Southern Sudan was a net exporter of agricultural products to regional markets. According to the United Nations Environment Programme, World Bank, and other development institutions, if South Sudan were to achieve a stable peace and make appropriate investments in agriculture, the country would have massive potential to expand agricultural production, thereby improving livelihoods and increasing food security and economic growth. To ensure this potential is reached, it is important to consider climate risks and resilience building activities and policies to the agriculture sector.

TABLE 2. IMPORTANCE OF AGRICULTURE TO THE ECONOMY OF SOUTH SUDAN (SOURCE: RSS 2015)	
GDP	15% of GDP; 36% of non-oil GDP
Employment	63% of working population (aged 15 and above) 78% of total population
Trade	Imports: 12% Exports: less than 1% Trade deficit: 11-12%
Households	Total households 81% Engage in cultivation 22% Engage in fisheries 74% Own livestock Rural Households 89% Engage in cultivation 24% Engage in fisheries 80% Own Livestock
Livelihoods	Total population 69% Farm crops 7% Animal husbandry Rural population 78% Farm crops 8% Animal husbandry

Along with food insecurity, malnutrition has increased since the beginning of the current conflict. Likely due to a combination of factors, including lack of access to food, increased disease incidence, and lack of access to health service, all of which can be exacerbated by climate change and variability. For example, increased temperatures can decrease some crops' nutrient content, while variable rainfall patterns could make access to food less reliable, increasing the need for foreign assistance. Furthermore, many water- and vector-borne disease incidence increase with increased temperatures and increased rainfall, which could make existing problems worse. Both admissions of Severe Acute Malnutrition (SAM) and Outpatient Therapeutic Programs (OTP) increased between 2014 and 2018 (Figure 4). In 2017 almost 50% of the population suffered severe malnutrition (GIZ 2018). Further exacerbating the problem is the reliance on humanitarian aid that can't be delivered to many places due to violence (EC 2018), and in 2018 the UN stated that "food insecurity outlook has never been so dire" (GIZ 2018).

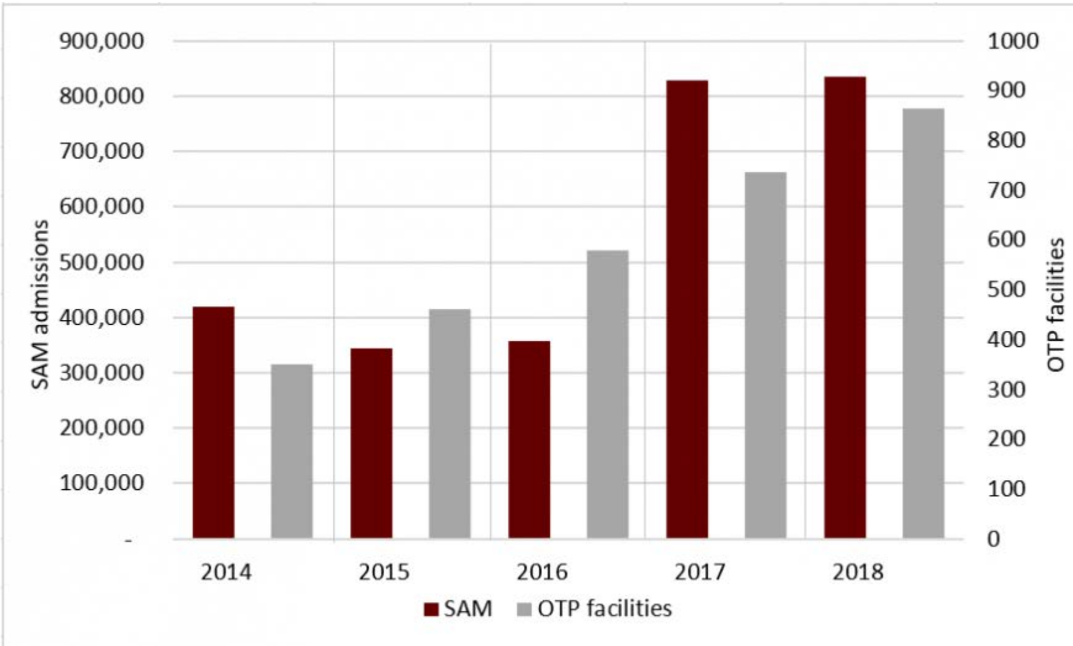

Figure 4. Severe Acute Malnutrition (SAM) admissions and Outpatient Therapeutic Programs (OTP) facilities between 2014 and 2018.

In a country with already significant development challenges to the agriculture sector, including to being in the midst of one of the world's worst humanitarian crises, climate change and variability can be expected to exacerbate the challenges to improving an already decimated sector that is inherently climate sensitive.

SUMMARY OF CLIMATE RISKS TO THE AGRICULTURE SECTOR

Risks due to projected increasing temperatures (UNEP 2007, Taha et al 2013, USAID 2016a, UNEP 2016, UNEP 2018):

- Increased evapotranspiration, combined with prolonged dry periods, leading to reduced wetlands, and perennial rivers becoming seasonal. This could negatively impact crop yields, pastoralists access to water resources, and reduce fishing resources by reducing the health and size of fish.
- Increased temperatures leading to increased evapotranspiration in plants, and reduction of soil moisture, increasing the amount of water crops will need.
- Potential increase in pest and pathogen outbreaks in both crops and livestock, leading to decreased crop and livestock production. Crops and livestock in South Sudan already suffer from a myriad of endemic diseases, for example the country currently faces an infestation of Fall Armyworm, which increased temperatures could worsen.
- Increased heat stress in livestock, decreasing food security for pastoralists.
- Crop yields negatively impacted by increased temperatures. For example, temperatures may become too high for wheat and sorghum. Conversely, higher temperatures may lead to increased yields of millet.

- Combined with aridity and land use change, increased temperature could contribute to desertification, particularly in the north and south east of South Sudan, and the Sahel shifting southward, leading to changing habitats.

- Decreased crop yields due to increased temperature increasing food insecurity and negatively impacting nutrition, especially in children, pregnant women, and nursing mothers.

Risks due to increased climate variability, including potential increases in droughts, floods, and changes in the onset and duration of the rainy season (UNEP 2007, USAID 2016a: UNEP 2016, UNEP 2018):

- Delay or shortening of rainy season causing crop failure or reducing water resources leading to decreased livestock health.

- Extreme flooding or drought leading to the loss of grazing area or access to water for pastoralists.

- Increased variability of rainfall leading to variable production of grains and cereals, the country's primarily crops, as well as variable access to water for pastoralists, which leads to potential food insecurity and unpredictable dependence on imported food.

- Extreme drought or flooding causing crop failure, contributing to lack of access to nutritious foods, food insecurity, and famine.

- South Sudan generally has poor infrastructure, including lack of roads in rural areas to connect agriculture to markets, flooding, particularly in flood plains and wetlands, could increase the challenge to move agricultural goods and disrupt value chains.

- Increased competition for water resources during droughts between pastoralists and farmers, potentially contributing to increased local conflict.

- Droughts leading to potential drop in water table, drier seasonal rivers, and reduction of wetland size, which decreases both famer an pastoralists access to water.

- The combination of drought and high temperatures contributing to wildfires that destroy grazing and agriculture habitats.

RECOMMENDATIONS TO IMPROVE CLIMATE RESILIENCE

To improve resilience of the agriculture sector it is important to consider increased temperature projections, and likely increased variability in precipitation, potentially leading to dry periods, floods, and changes to the rainy season duration. New investment in agriculture should consider climate stressors and shocks, focus across the value chain, and consider cultural, socially, and political contexts to tap into South Sudan's agriculture potential. Much of this potential lies at the community level, which should likely be the focus until the current conflict is resolved so that local communities are ready to take advantage of improved national institutional capacity in the future.

- Promote policies that encourage actors throughout the value chain, from farmers to agribusinesses, to utilize farming practices and technologies that are suited for higher temperatures and variable rainfall conditions. (IFPRI, 2013). Promote sustainable climate smart agriculture, such as introduction of drought tolerant crops and crop varieties, livestock improvement. and soil erosion control.

- Work with local communities to understand local political, social, and cultural context (IFPRI, 2013) of agriculture sector, and improve understanding of what types of behavior change, and their determinants, can lead to more climate resilient agricultural practices to be adopted. Identify the role of gender in creating unequal vulnerability between genders, and solutions to improve gender equality, and strengthen community based adaptation strategies.
- Invest in small scale agriculture related infrastructure, such as improved drainage, construction of agriculture storage, and improved irrigation.
- Provide early warning systems at national, sub national, and village levels to strength preparedness and build resilience. These systems can provide timely information and advisories about roads/routes that are unreachable due to climate-related disasters, ensuring that remote populations can access markets. Integrating this information into existing early warning systems for food security can also provide an additional layer of information for better food security and adaptation planning. Other innovative mechanisms such as the utilization of geospatial tools, technologies, remote sensing and earth observation data can assist planners and decision makers with the required evidence based science required for enhanced resilience. Ensure that development of these systems is done closely with end users to ensure effectiveness.
- At the community level, provide conditional asset transfers after a crises or disaster, including through food/cash-for-work interventions such as slope stabilization, landscape management, and disaster mitigation infrastructure, can reduce both disaster and climate related risks. Ensuring vulnerable communities have access to social protection and using innovative insurance schemes is also critical to enhancing resilience
- Given the high reliance on rain-fed agriculture, support strategies and development of work force skills for livelihood and income diversification to improve resilience. Potential support to migration (both seasonal and permanent) and additional income sources, such as mining, fishing, skilled non-farm activities and forest management can help improve livelihoods.
- Given the frequent droughts, flash floods, and land degradation issues experienced in the country, need to prioritize promoting harvesting and retention of water for different uses. Consider community based watershed management with a focus on multi-use and stakeholders. Strategies to ensure sustainable food security under a scenario of decreased rainfall should focus on improving water management practices at all levels.
- Build, improve, and maintain hard and soft infrastructure, such as river channels, raised embankments, floodwalls and culverts to reduce flood risk.
- Introduce a well-coordinated seed-distribution program 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.
- Work closely with individuals who resettle after the current crises to introduce culturally appropriate climate smart practices and access to markets, including the development of an agriculture extension service.
- Improve land access and land tenure policy and regulation, particularly regarding pastoralists rights and access to grazing land and water.

4. CLIMATE CHANGE, MIGRATION, AND CONFLICT

More than one-third, or over 4.4 million people, of South Sudan's estimated population of 12 million are displaced. Approximately 2.4 million people have fled to neighboring countries (Figure 5), and another 2 million are internally displaced (CIA 2019). The situation in South Sudan is currently Africa's worst refugee crisis, and the world's third worst (behind the crises in Syria and Afghanistan) (UNHCR 2018, Mercy Corps 2019). Women and children are impacted the most; 85% of South Sudanese refugees in neighboring countries are women and children, and 63% are under the age of 18 (UNHCR 2018). To exacerbate the challenge, South Sudan hosts almost 250,000 refugees who have fled violence from Sudan (CIA 2019). How climate events and climate change contribute to migration and conflict, including the current crises in South Sudan, is not well understood.

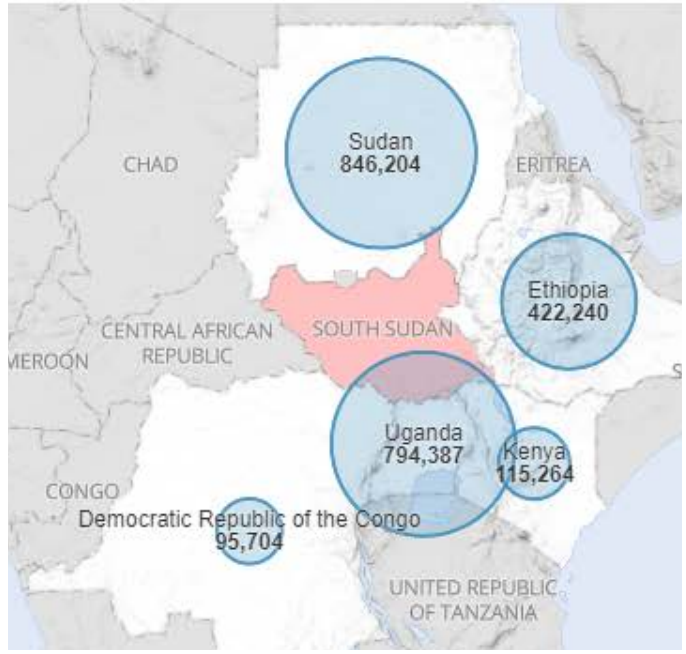

Figure 5. Location of South Sudan Refugees (source: UNHCR)

Violent conflict is currently prevalent in South Sudan, and the displacement crisis is expected to continue and worsen as a result. The root causes of the current conflict are complex, but consist of political instability and warfare between ethnic groups, as well an many other contributing factors. Displacement caused by the conflict is potentially exacerbated by a number of factors including severe drought, famine, and lack of governance, institutional capacity, infrastructure, social services, and trade (MPI 2019).

Considerable attention has been given to the role of both climate change and variability in migration and conflict (Hsiang et al. 2013, Burke et al. 2015, Brzoska and Frölich 2015). However, there is still a large amount of uncertainty about the role that climate plays in specific migration and/or conflict events (Burrows and Kinney 2016). One of the challenges is identifying the role of climate as one of the many complex drivers of migration and conflict over varying spatial and temporal scales, and how climate interacts with these other drivers. This section explores how climate change and variability contribute to migration and conflict in South Sudan.

MIGRATION

While climate is sometimes a contributing factor, it is rarely the sole, or most important, driver of migration (Brzoska and Frölich 2015). Many climate stressors, such as change in precipitation patterns, increased temperature, and increased frequency or intensity of extreme weather events, are expected to impact livelihoods, health, food security, infrastructure, and access to water. When these impacts of these stressors are severe, difficult to overcome, and contribute to fragility, climate change and variability may contribute to migration. Not all groups are equally likely to migrate as a results of climate impacts. Usually the poorest, or those that rely on rainfed agriculture, are the most vulnerable and the most likely not to have safety nets, resources, and lack resilience to climate impacts. Oftentimes these are the groups that are the first to migrate, however, in some instances, the poorest are unable to migrate and suffer the brunt of exposure to extreme climate events (USAID 2016b). Droughts are one of the most cited reasons for climate induced migration, particularly country specific internal migration, and can lead to temporary migration as individuals search for access to food and water to improve livelihoods during drought, as was seen in western Sudan in the 1990s. Drought can also lead to permanent migration if livelihoods are abandoned due to severe and persistent drought, as was seen in area surrounding Darfur in the 1970s and 1980s (McLeman and Smit 2006). Flooding can also drive migration. However, literature suggests that much of migration due to flooding is temporary, as communities are often willing to rebuild after flooding events. There is less evidence that increased average temperatures lead to migration, but, as some crops reach their thermal tolerance in some areas of sub-Saharan Africa, migration may be a viable adaptation option. Furthermore, climate shocks, such as drought, may not lead groups to migrate, but may change migration patterns of pastoralist groups, which already migrate seasonally.

While the mechanism for how climate change and variability can contribute to migration is clear, there is uncertainly around the extent to which climate change and variability does contribute to migration. The decision to migrate is part of a complex decision making process, where climate is only one component. This is reflected in projections of how many people will be displaced by climate change and variability in the future. Estimates of those displaced by climate change and variability globally by 2050 range from 50 million to 1 billion (Christian Aid 2007). According to the World Bank (2018), most climate-induced migration will occur within countries, not internationally. A recent report by the World Bank predicts that over 85 million people in sub-Saharan Africa will be 'internal climate migrants' by 2050. This is largely a result of sub-Saharan African communities and countries being highly vulnerable and exposed to climate impacts, and that a large amount of the population relies on rainfed agriculture for crop production (WB 2018). While the extent of climate change on migration is uncertain, there is risk and concern that climate change and variability may have such significant impacts on migration, potentially leading to conflict, and that if we wait for overwhelming evidence to take action that devastating consequences may be unavoidable.

CONFLICT

There is little evidence of climate change and variability directly causing conflict. However, climate change and variability can be a threat or risk multiplier of conflict. Several studies show a correlation between climate shocks or stressors and increased conflict. Increased drought, floods, and a more unpredictable climate, when combined with other drivers such as population growth, may increase clashes over natural resources. The probability of conflicts occurring doubles in the tropics during El Niño events, which causes vast climate shocks throughout the tropics, compared to La Niña events (Hsiang et al. 2011). Warmer temperatures and more extreme rainfall events significantly increase frequency of both interpersonal and intergroup violence (Hsiang et al. 2013, Burke et al. 2015). The start of conflict in Syria in 2011 may have partially been caused by severe drought in the Syrian crescent valley (Kelley et al. 2016). Burke et al. (2009, 2015) suggested that climate conditions can help lead to conflict, even though they may not be the primarily driver, and using data between 1981 and 2002, suggested that the risk of civil war in Africa increased by 4.5% with a 1° C temperature increase.

Much of the literature speculates that climate induced migration can lead to conflict due to competition for natural resources, and that while climate induced migration is not a root cause of conflict, such migration may serve as a threat or risk multiplier and exacerbate conflict and should be considered during natural resource policy and management decisions (Burrows and Kinney 2016). There are relatively few examples in the literature directly linking climate events to migration contributing to conflict. Below are examples from sub-Saharan Africa that Burrow and Kinney identified in 2016 (table 2)

TABLE 3. SELECT EXAMPLES OF CLIMATE EXTREMES LEADING TO MIGRATION AND POTENTIAL CONFLICT IN SUB-SAHARAN AFRICA SINCE 2000.

Location	Climate Event	Years	Impact on Migration	Presence of Conflict	Reference
Kenya	Drought/soil degradation	2004 and 2007	Increase in temporary labor migration with decreased soil quality	N/A	Gray 2011
Western Sahel	Drought/water scarcity	2005-present	Increase in labor related migration of pastoralists	Strong evidence of contributing to clashes between pastoralists and farmers over resources	UNEP 2011; Nyong 2011
Nigeria	Desertification	1993-2013	Increase in labor-related migration of farmers	Strong evidence of ethnic conflict between farmers over rangeland	Folami 2013; Werz and Conlet 2012

In already fragile countries or communities, the impact of climate change induced migration leading to conflict is likely greater. Migration leading to conflict also usually occurs internally to countries as opposed to across borders (Hendrix and Glaser 2007, USAID, 2016b). For example, climate induced food and water insecurity may lead communities to search for water and food elsewhere in the country leading to competition for water resources, and potential conflict, with other local communities (Gleick 1989, Brzoska and Frölich 2016). It is worth noting that this type of migration to conflict can escalate and contribute to national crises (USAID 2016b). The research providing evidence for climate change and variability contributing to migration and conflict is in its infancy; further research between the relationship between climate change and variability, migration and conflict is needed (Burrows and Kinney 2016). Climate Change, migration, and conflict in South Sudan

While there is some understanding of how the climate has and will change in South Sudan, as described in Section 2, there is little understating of the role of climate change and variability in migration and conflict in the country. Studies have shown that there is currently a poor correlation between climate change and variability and the current national conflict in South Sudan, although noting that this may be due to lack of data and evidence (Braced 2017). The political crisis and violence have resulted in pastoralists' lack of access to traditional water sources, which has changed migration patterns, and increased pastoralist and farmer conflict (UNEP 2018).

Both migration and conflict have been prevalent in South Sudan for decades, and some of these conflicts have been exacerbated by climate. There are a number of historical battles in the 19th and 20th century between tribes in South Sudan where droughts or floods led to increased competition for resources and either partially caused or exacerbated the conflict (Braced 2017). The region of the Upper Nile has both more frequent conflict and more frequent floods and drought than the rest of South Sudan, which consist of Bahr el Ghazal and Equatoria (Sudd, 2018), although, some have speculated that conflict may increase in resource rich years due to more access to resources needed to engage in conflict. The Upper Nile average over 12 armed local conflicts (based on Armed Conflict Location and Event Data (ACLED)), more than twice as many as Bahr el Ghazal and Equatoria, per year between 1997 and 2016. Furthermore, areas prone to floods and droughts, particularly flood plain areas compared to other areas, are also more prone to conflicts in South Sudan (Sudd 2018). One example of a climate event likely intensifying a conflict is the 1991 Dinka – Nuer Conflict. In 1991 flooding destroyed crops and livestock throughout the Upper Nile, destroying livelihoods and devastating communities that relied on agriculture in the region. 1991 also marked the beginning of a deadly conflict between the Dinka and Nuer tribes in the same region. It is widely thought that many young men in the area joined the conflict to gain an opportunity to raid cattle to compensate for livelihoods lost by the flood. This may have had the additional impact of leaving women and children at home and more vulnerable to both climate events and other direct impacts of the ongoing conflict. By leaving a large part of the population vulnerable, the flood may have indirectly magnified the intensity of the conflict (Salehyan & Hendrix 2014, Von Uexkull 2014, Raleigh & Kniveton 2012).

Drought and Conflict in Darfur

Perhaps the best-known case of climate shocks leading to migration that contributed to conflict is the violence that began in the Darfur region in Sudan in 2003. After a regional drought during the 1970s and 1980s, many people migrated to the fertile Darfur region in the subsequent years. This led to rapid increase in population in the region, particularly of pastoralists and farmers. The demand for land and competition for resources among pastoralists and farmers increased. Darfur had an informal land management system in place, called hakuras, to prevent land disputes and conflict (Wilson Center 2015). However, this system broke down due to political challenges, leading to conflicts among many groups, and eventually escalating to a crisis that resulted in 2.5 million people displaced and approximately 300,000 deaths (USAID 2016b). While the exact role the drought of the 1970s and 1980s played in the conflict is difficult to determine, it is an example of migration potentially playing a contributing role to a conflict that occurred decades later.

Cattle theft has long been an issue in South Sudan, and there is evidence that this has been getting worse since 2005, and that 2015 and 2016 had especially high rates of livestock theft (FEWSNET 2018). During the current nation-wide conflict in South Sudan many pastoralists have experienced food insecurity due to the violent conflict, which has likely been exacerbated by drought. Food insecurity has also likely contributed to increased cattle theft. Furthermore, the conflict has simultaneously led to lack of institutional capacity to address cattle theft, potentially increasing the likelihood of local conflict. Currently, about 80 percent of the population of South Sudan is engaged in subsistence agriculture, including some combination of rain-fed agriculture, livestock grazing, pastoralism, fishing, and wild food grazing (UNEP 2018). As a result, and in additional to lack of institutional capacity, the livelihoods of many people in the country are vulnerable to climate shocks, and potentially climate shocks contributing to migration.

While there is little concrete evidence to support a direct relationship between climate stressors and either migration or the current conflict in South Sudan, that does not mean a connection does not exist. There are many climate-sensitive migration and conflict issues to consider, including:

- **Increased climate vulnerability due to migration:** Due to internal violence, many pastoralists have been blocked from traditional water sources, which has forced them to change migration patterns or flee. Farmers have been forced to change livelihoods, and potentially move into swampland areas where there is less access to food (UNEP 2017). The result is that already vulnerable populations, including women and children, are left more vulnerable to climate stressors and shocks, like flood and drought.

- **Lack of access to natural resources leading to migration, competition for natural resources, and conflict:** Violence has led pastoralists and farmers to migrate or change migration patterns. Lacking access to traditional natural resources, such as water resources, that they relied on for livelihoods, may lead to increased competition for limited resources, particularly water resources during drought, and local conflict.

- **Drought caused by El Niño exacerbating the conflict:** The 2015 El Niño event resulted in drought in many parts of South Sudan, mostly in the eastern and central regions. Drought, while usually not a primary driver of conflict, can contribute to sustaining conflict (Von Uexkull 2016). In addition, El Niño significantly increases conflict in the tropics (Hsiang 2011). The drought beginning in 2015 in South Sudan led to decreased agriculture production, and less water resources for livestock, contributing to famine in two South Sudan regions (USAID 2016b). The drought may have exacerbated both migration and conflict that was initially caused by political instability.

- **Decreased local and national adaptive capacity potentially resulting in increasing conflict:** The vulnerability of citizens to climate change and variability impacts has increased as a result of the conflict due to a decrease of institutional capacity to address both short-term extreme weather events and long-term climate trends. For example, there is currently a lack of local institutional capacity to address local land tenure disagreements. Particularly during prolonged or extreme weather events that damage crops and limit water resources, this could contribute to conflicts between pastoralists and farmers that could otherwise be averted. South Sudan has a highly decentralized government structure, and governance at a local level is often dictated by traditional leaders than government officials. Working in this context is important to achieve success to resolve conflict.

RECOMMENDATIONS TO IMPROVE CLIMATE RESILIENCE:

Based on both the current broad and local understanding of how climate can act as a multiplier and exacerbate both migration and conflict, and the understanding of historical and future climate change projections in South Sudan, the following are recommendations to improve climate resilience in South Sudan surrounding migration and conflict.

- **Improve local capacity to address disputes:** As noted by USAID in 2016 (USAID 2016a), as a result of large amounts of internal migration, the capacity of local institutions, including capacity to address local resource disputes, is important to peacekeeping both locally and nationally. Improving local intuitional capacity to address resource disputes could improve resilience now and contribute to national capacity and resilience building in the future once the humanitarian crisis subsides.

- **Improve understanding of climate as a driver of conflict and migration:** Understanding the role of climate as a driver of migration and conflict in relation to the political, social, and economic context in South Sudan is important, but poorly understood. Improving this understanding, especially by obtaining local historical and contextual knowledge, is key to identifying resilience interventions.

- **Decrease local communities' climate vulnerability**: Improve local populations ability to withstand climate shocks, such as droughts and floods, so that communities are less likely to migrate during these shocks. This may decrease the amount climate magnifies both migration and subsequent conflicts. Focus on local and specific interventions that are sensitive to cultural and social norms.

5. CASE STUDY: CLIMATE VULNERABILITY IN THE SUDD

5.1 OVERVIEW OF THE SUDD

Covering approximately 57,000 km2, the Sudd wetland is one of the largest freshwater ecosystems in the world. The Sudd is made up of channels and lagoons spread out across a shallow depression fed by the White Nile and rainfall runoff from the surrounding catchment (MCYS 2017). Like the rest of South Sudan, the rainy season in the Sudd is between April and October with temperatures averaging around 30-33 degrees Celsius in the summer and 18 degrees Celsius in the winter (Seymour n.d.). During the rainy season, the Sudd can expand to 90,000 km2, and shrink to 42,000 km2 during the dry season. The Sudd includes the Bahr el Jebel swamps, the Bahr el Ghazal swamps, the wetlands of Baro-Pibor-Akobo and the Machar marshes (UNEP 2018). Vegetation ranges from permanent swamps, to river and rain-flooded grasslands, to floodplain woodlands (MCYS 2017). Importantly, the Sudd is part of a much larger ecosystem, the Jonglei Plains, which forms the largest area of intact savannah in Africa. The Sudd, and surrounding savannah, is an important ecosystem for diverse wildlife, including endemic species of fish, birds, mammals, and plants. Migratory mammals depend on the Sudd for grazing in the dry season and birds of international and regional conservation importance use the Sudd as a wintering ground (Moghraby et al. 2006). The Sudd was designated as a Ramsar wetland of international importance in 2006 (Moghraby et al. 2006) and is the largest designated Ramsar wetland in the world (RSS 2015). It is also currently on the tentative list for designation as a UNESCO World Heritage site (MCYS 2017).

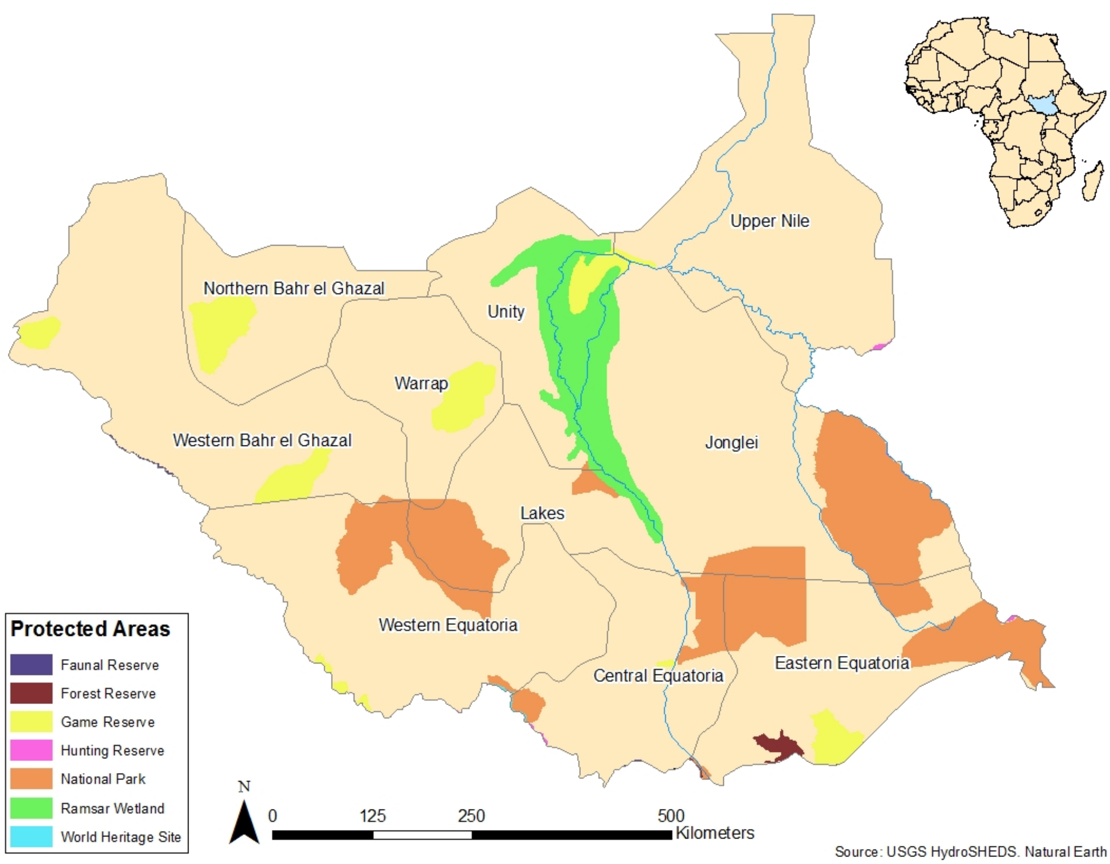

Figure 6. Map showing the Sudd Wetland in Green.

FLORA & FAUNA

The Sudd contains rich biodiversity and is home to some of Africa's and the world's most important species and habitats. Outside of the Masai Mara-Serengeti wildebeest migration, the Sudd hosts the only other long-distance movement of Alcelaphinae antelope species (the tiang) on Earth (MCYS 2017). Other notable wildlife species include the African elephant, Nile lechwe (endemic to South Sudan), white-eared kob, and buffalo. As noted above, the Sudd is also an important wintering destination for migratory birds like the Great White Pelican, Black Crowned Crane, White Stork, and Black Tern. The Sudd is part of the East-Asian/East-African flyway of palearctic birds, which links the southern wintering grounds to summer breeding ranges in central-Europe and Asia. The Sudd is also home to the largest population of the shoebill stork in Africa (between 5,000 to 8,000 birds), which is a globally threatened species (Ministry of Culture, Youth and Sports, 2017). In addition, over 100 species of fish can be found spawning, rearing, growing, or feeding in Sudd habitats, including eight endemic Nile dwarf fish species (MCYS 2017).

The ecosystem is home to a variety of plant species. Papyrus dominates riparian areas and the wettest swamps with reeds and cattails found extensively behind papyrus stands. Macrophytes (aquatic plants) are abundant in open waterbodies, with wild rice and antelope grass dominating the seasonal floodplains. Jaragua grasslands cover the wetlands and red acacia and desert date woodlands border the outside of the floodplain (Seymour, n.d.)

ECOSYSTEM SERVICES

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 foods, and soil protection. These ecosystems services are seriously threatened by anthropogenic activities and by the effects of climate change.

Wetlands deliver a large variety of critical ecosystem services[4] that humans depend on, such as fish, water supply and purification, flood regulation, and tourism. The Sudd is the largest designated Ramsar Wetland of environmental importance, pivotal to regulating weather patterns in the Sahel, the Horn of Africa and the greater East Africa region. These wetlands also provide invaluable ecosystem services at a both the local and national level, described below. These ecosystem services are vulnerable to the impacts of climate change, particularly if exacerbated by unsustainable infrastructure development.

- *Economic Value.* An UNEP report found that the Sudd wetland, if managed appropriately, could become the greatest economic asset in South Sudan in terms of income, jobs, and the ecosystem services described below (Goudy and Lang 2016). For example, the Sudd has great potential to serve as a tourist destination for wildlife viewing, assuming a stable and well-managed tourism industry can be established.

  Further, the Sudd supports (and has the potential to support more) a diversity of economic sectors, such as agriculture, cattle farming, fishing, hunting, tourism, research and education. The environmental impacts of industrial development in the Sudd, such as for oil, or the proposed Jonglei canal, could limit the ability of the Sudd to sustainably contribute to South Sudan's

[4] Ecosystem services are broadly defined as the benefits that humans derive from ecosystems and are typically categorized into provisioning services (food, water, timber, etc.), regulating services (affecting climate, floods, disease, water quality, etc.), cultural services (recreation, aesthetic, spiritual), and supporting services (soil formation, photosynthesis, nutrient cycling) (Read et al., 2015).

economic diversity, and ultimately reduce the country's resilience and stability, which are already threatened by worsening climate change and ongoing conflict (Goudy and Lang 2016).

- *Carbon Sequestration and Climate Regulation*. Wetlands sequester large amounts of carbon, primarily as soil organic matter. The degradation or drainage of wetlands releases this carbon dioxide into the atmosphere as disturbances allow for the oxidization of previously inundated organic matter (Villa & Bernal, 2017). Using proxy indicators, Gowdy and Lang (2016) found that at a minimum, the Sudd sequesters 11.9 million tons of carbon per year (by comparison, South Sudan emits 1.9 million metric tons of carbon per year). Generally, increased atmospheric CO_2 increases the productivity of most wetland plants which can increase carbon sequestration in tropical wetlands (in the absence of other limiting factors). However, this increased productivity can also increase methane emissions from wetlands (Kusler 2006). In the Sudd, other human activities, such as the drainage of the Sudd proposed as part of the Jonglei canal, would have severe negative consequences in terms of reducing the ability of the Sudd to serve as a carbon sink.

  At a more local level, the Sudd has a significant influence on the regional climate. The Sudd plays a critical role in regulating weather patterns in the Sahel, Horn of Africa, and East Africa, and acts as a barrier to the encroachment of the Sahara Desert towards the south. If not for the Sudd, the ground temperature in the local area would be 2 degrees Celsius higher and rainfall would be up to 40 percent lower (and 15 percent lower over central Sudan). Any changes to the evaporation patterns in the Sudd, such as drainage, would therefore result in significant rainfall changes in nearby regions (Van der Ent et al., 2010 via Gowdy & Lang, 2016).

- *Flood control and Groundwater Recharge.* The Sudd acts as a natural dam that regulates the flow of the White Nile. During the rainy season, the Sudd expands to accommodate the Nile's water, and releases it steadily during the dry season. This function helps to balance the White Nile's flow, and the communities and wildlife nearby have adapted to this seasonality of water resources. Further, while there is limited detailed information on aquifers in South Sudan, it is believed that large areas of the country contain aquifers. During seasonal rainfall and flooding, the Sudd, which overlays a transboundary aquifer, replenishes groundwater, thus contributing to the countries water security (UNEP 2018).

- *Local Use.* The Sudd's resources support 1 million indigenous Dinka, Nuer, Anyuak and Shilluk people in subsistence and livelihood activities (UNEP 2018). This includes livestock, agriculture, fishing, and collecting wild foods (UNEP 2018). Communities have adapted their lives livelihoods to the Sudd's annual flooding which regenerates grasses to feed cattle, provides domestic and cattle water supplies, and brings in fish species from nearby rivers to the nutrient-rich floodplains (UNEP 2018). The Sudd is one of the only remaining Nile water bodies that is not over-fished, and the Sudd's soil retains enough moisture during the dry season to support livestock grazing (UNEP 2018). Further, trees and shrubs provide timber, firewood, medicine, and other household resources to the local people (Moghraby et al. 2006). The Sudd also has socio-cultural values to the communities that rely on it, which in turn supports the conservation of the Sudd. For example, the Shilluk people consider the killing of the Nile lechwe (antelope endemic to South Sudan) a taboo, which supports its preservation and sustainable use (Ministry of Culture, Youth and Sports, 2017).

- *Wildlife refuge.* The Sudd plays a crucial role as a wildlife sanctuary, particularly for transboundary animal migrations. Wildlife in the Sudd migrate to neighboring regions and parks including Bandingilo National Park, Boma National Park, and Southern National Park. A 2010 aerial survey found 400,000 Tiangs, 165,000 Mongolian gazelles, 112,578 White-eared Kob and more than 10,000 endangered Nile Lechwe, as well as 8,000 elephants (Gowdy and Lang 2016). With the appropriate institutions in place, the Sudd could become a major ecotourism and safari destination, contributing to economic growth (Gowdy and Lang 2016).

- *Water purification/filtering.* As water seeps through soil and vegetation in wetlands, many impurities are processed and filtered out, such as metals, viruses, oils, excess nutrients, and sediments (Ecological Society of America, n.d.). In the Sudd, the majority of people use the river or groundwater for drinking water. However, most of the population does not have access to toilets which means that the wetland absorbs a significant amount of waste. A study using the Okavango Delta as a proxy estimated that replacing this ecosystem service would cost about 8.9 million USD per year, considering water treatment, transportation, and potential health consequences (Gowdy and Lang, 2016).

- *Scientific and Educational Value.* There has been limited research into the flora, fauna, and functioning of the Sudd. There is therefore significant untapped potential for research and education that can support local employment and create opportunities for students (Gowdy and Lang 2016).

Figure 7. Communities living in the Sudd. Source: UNEP 2018.

MIGRATION, CONFLICT, AND THE SUDD

South Sudan's civil war led to over four million people being displaced (Oxfam, n.d.). It is estimated that up to 100,000 internally displaced persons escaped into the Sudd to seek safety in the remote natural barriers of the wetlands (Strochlic 2017). As the populations supported by the Sudd grow, people are spreading into more remote areas and straining resources that were previously only used seasonally by pastoralists (Strochlic 2017). While a peace deal was signed in 2018, conflicts are expected to continue as a result of dwindling natural resources, which could result in competition and additional migrations, bringing different communities in contact with each other. The impact of climate change on conflict is discussed further in the following section.

5.2 CLIMATE VULNERABILITY IN THE SUDD

PROJECTED CLIMATE TRENDS

The Sudd's climate regulation services make these wetlands South Sudan's most important priority in terms of mitigating climate change impacts at both the local and regional level (Republic of South Sudan, 2015). As mentioned above, climate projections for South Sudan vary depending on the source of data, particularly for rainfall estimates. PREPdata projects that temperature in the Sudd could increase by 1.6 to 3.5 degrees Celsius by 2090, while rainfall is projected to increase by between 57 -173 mm per year. However, other projections suggest an increased drying trend throughout the country with intermittent droughts (USAID, 2016). Therefore, it is crucial that adaptation strategies are robust and flexible enough to account for various scenarios. The following sections describe the likely impacts of climate change and variability on several important sectors: water resources, ecosystems and biodiversity, agriculture and livestock, and health. These sectors were chosen based on their importance to the region, their role in supporting livelihoods and economic growth, to align with the sectors outlined in the South Sudan National Determined Contributions (UNFCCC, 2016) – yet to be ratified – , and to inform USAID programming in these areas.

WATER RESOURCES

The Sudd depends heavily on inflow from Lake Victoria via the White Nile, as well as local rainfall. Up to 85 percent of the total water that enters the Sudd wetlands is lost to long-term evapotranspiration (UNEP 2018), which will likely increase with increased temperatures. This water is partially recycled as rainfall (Ministry of Environment, 2012). Studies indicate that climate change alone is unlikely to have significant effects on water resource availability in the Sudd. This is primarily due to the ability of the wetlands to mitigate potential local changes in rainfall and evaporation, as well as possible higher flow rates from the White Nile because of increased rainfall in the Nile Basin (Nile Basin Initiative, 2012). As explained by the Nile Basin Initiative (2012), the wetlands attenuate local changes "because an increase in Sudd inflow leads to a greater surface area of wetlands, which in turn leads to higher evaporation losses, and vice versa."

In general, the Nile basin is particularly sensitive to changes in rainfall, where a 10 percent change in precipitation equates to at least a 25 percent change in runoff (Nile Basin Initiative, 2012). Lake Victoria, which supplies the White Nile, is known to be sensitive to fluctuations in precipitation and temperature (Figure 6). Projections indicate that the Lake Victoria Basin will have increasing river flows, but that most rivers will have highly variable discharges, ranging up to 70 percent variability from average discharges (Lake Victoria Basin Commission, 2018). While there is limited research on the impacts of climate change on Lake Victoria levels and resulting Nile flow rates, any changes will inevitably impact the extent and seasonal fluctuation of the Sudd wetlands (Nile Basin Initiative, 2012). As mentioned above, the wetlands can considerably attenuate this variability, but additional human-induced impacts to the watershed could exacerbate potential climate change impacts significantly, as well as reduce the Sudd's ability to attenuate climate variability.

Flooding in the Sudd increased beginning in the 1960s due to increased rainfall in the region but has gradually decreased since that time due to decreasing rainfall in the 1970s and 1980s (PREPdata, 2019) and increasing water use upstream (Figure 8, Ministry of Environment, 2012). Additional upstream water use could continue this downward trend, particularly if a potential drying trend materializes, rather than an increase in rainfall.

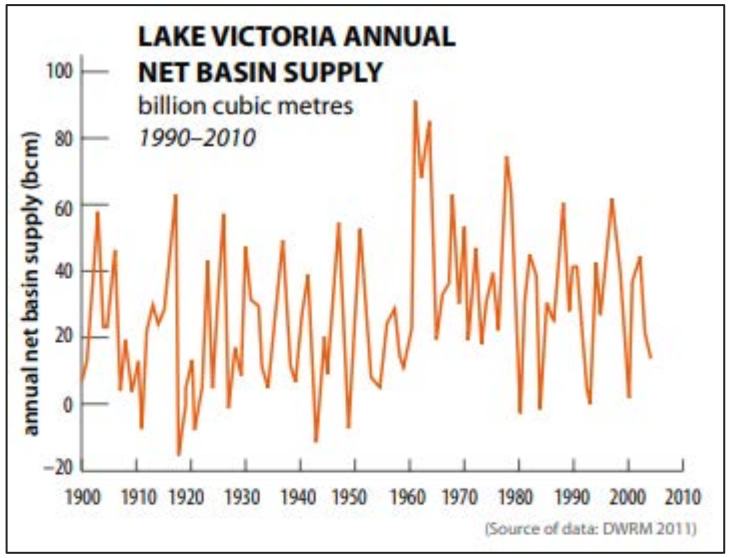

Figure 8. Inter-annual fluctuations in Lake Victoria net basin supply. Source: DWRM 2011 via Nile Basin Institute, 2012

For example, the completion of the Jonglei Canal could exasperate climate change impacts locally in the Sudd and generally have disastrous impacts for local communities. The canal would divert part of the White Nile to avoid the evaporation losses in the Sudd and provide more water for irrigation and other downstream uses. This could result in biodiversity loss, loss of water for grazing and domestic use, as well as massive resettlements of the pastoralist populations that depend on the Sudd for subsistence (UNEP 2018). Conflicts would likely increase as resources, particularly grazing land, decrease (USAID, 2016). Additionally, Ethiopia has set a precedent of making unilateral decisions on water resources that have transboundary impacts. For example, in 2011, Ethiopia began construction of the Grand Ethiopian Renaissance Dam on the Blue Nile, which is expected to be the largest hydropower plant in Africa (International Crisis Group, 2019). Despite various benefits this project can provide, Egypt relies on the Nile for about 90 percent of its freshwater and is therefore concerned about the downstream consequences of the dam's construction (International Crisis Group, 2019). While the Sudd relies on the White Nile and is therefore unlikely to be impacted by this project, it is important to track and consider the impacts of development projects of other countries in the Nile Basin region.

The sectoral implications for water resource variability because of climate change and unsustainable development are explained below for agriculture and livestock; ecosystems and biodiversity; and health.

AGRICULTURE AND LIVESTOCK

As noted above in the agriculture section, climate risks from increasing temperatures include increasing crop water requirements; increases in pest and pathogen outbreaks; reduced crop yields; and reduced access to water resources (and therefore fishing resources). Further, climate vulnerability could lead to increased competition for resources, as well as crop failures and reduced livestock yields from flooding and/or delays in the onset of the rainy season.

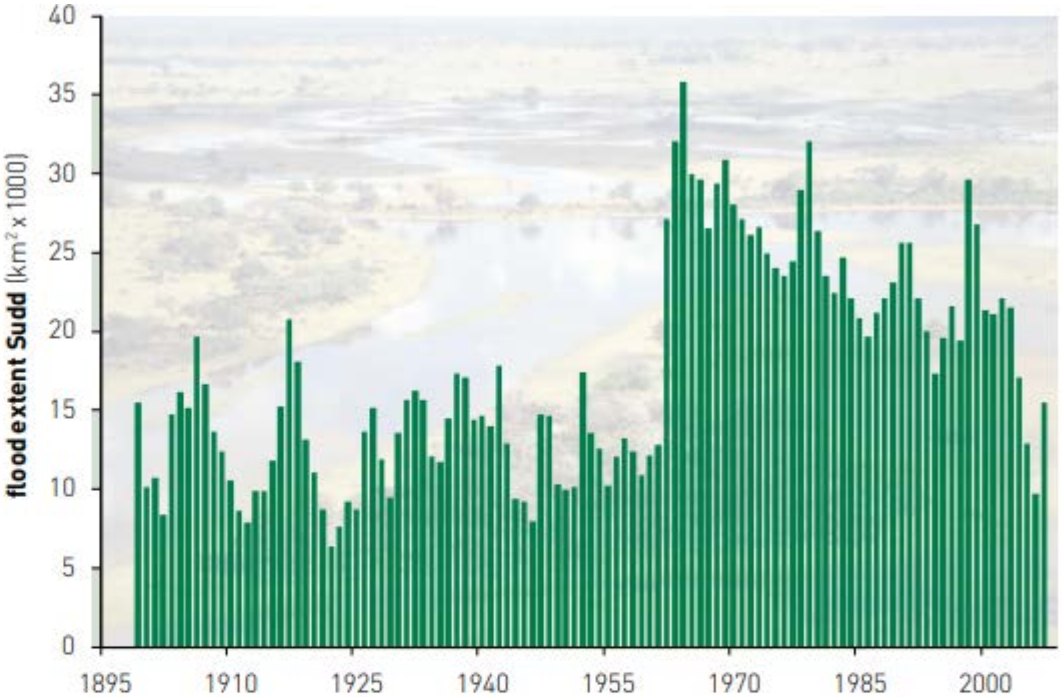

Figure 9. Annual maximum flooded area of the Sudd marshes. Source: Ministry of Environment, 2012

These impacts are particularly acute for the Sudd, where agriculture and livestock are the main livelihoods of the pastoralist communities. These livelihoods are dependent on the natural resources of the Sudd, namely water for irrigation and livestock and vegetation for grazing, all of which are vulnerable to the impacts of climate change. As mentioned above, climate change alone is not likely to significantly impact water resource availability for domestic, agriculture, or livestock use, but continued unmitigated human interventions in the region can interact with and exacerbate potential climate change impacts and reduce water resource availability.

It is important to note that if the Jonglei canal (Figure 9) were to be complete, there would be significant indirect impacts to agriculture and livestock in the Sudd. Firstly, draining part of the Sudd would impact the microclimate in the area, likely decreasing rainfall locally and in nearby regions (Van der Ent et al. 2010) and therefore exacerbating expected climate change impacts. Outside of anticipated increases in downstream irrigation potential because of the canal, the drainage would cause the loss of fish habitats and grazing areas in the Sudd (Environmental Pulse Institute 2018). However, there is also speculation that by drying out previously inundated land, new land might be available for grazing and agriculture (Doran 2009). Regardless, opening up additional land in the Sudd through drainage is likely to accelerate development in this region (Doran 2009). For example, intra-basin trade between the upper and lower Nile regions is limited, except for tea exports from Kenya, Rwanda and Uganda to Egypt (Doran 2009). The Sudd (which translates to "The Barrier" in English) and Sahara Desert have typically acted as a barrier to trade by restricting the movement of goods and people (Nile Basin Initiative, 2012b). While the Sudd is flooded, both agriculture and trade are difficult (Doran, 2009). Draining the Sudd to create the Jonglei canal would open up the potential for larger-scale irrigation and farming, as well as agricultural trade opportunities (Doran, 2009). This would likely come at the cost of the local people, who would lose traditional cultural and social values and livelihoods connected to their current ways of life which revolve around the seasonal inundation of the Sudd (Doran, 2009).

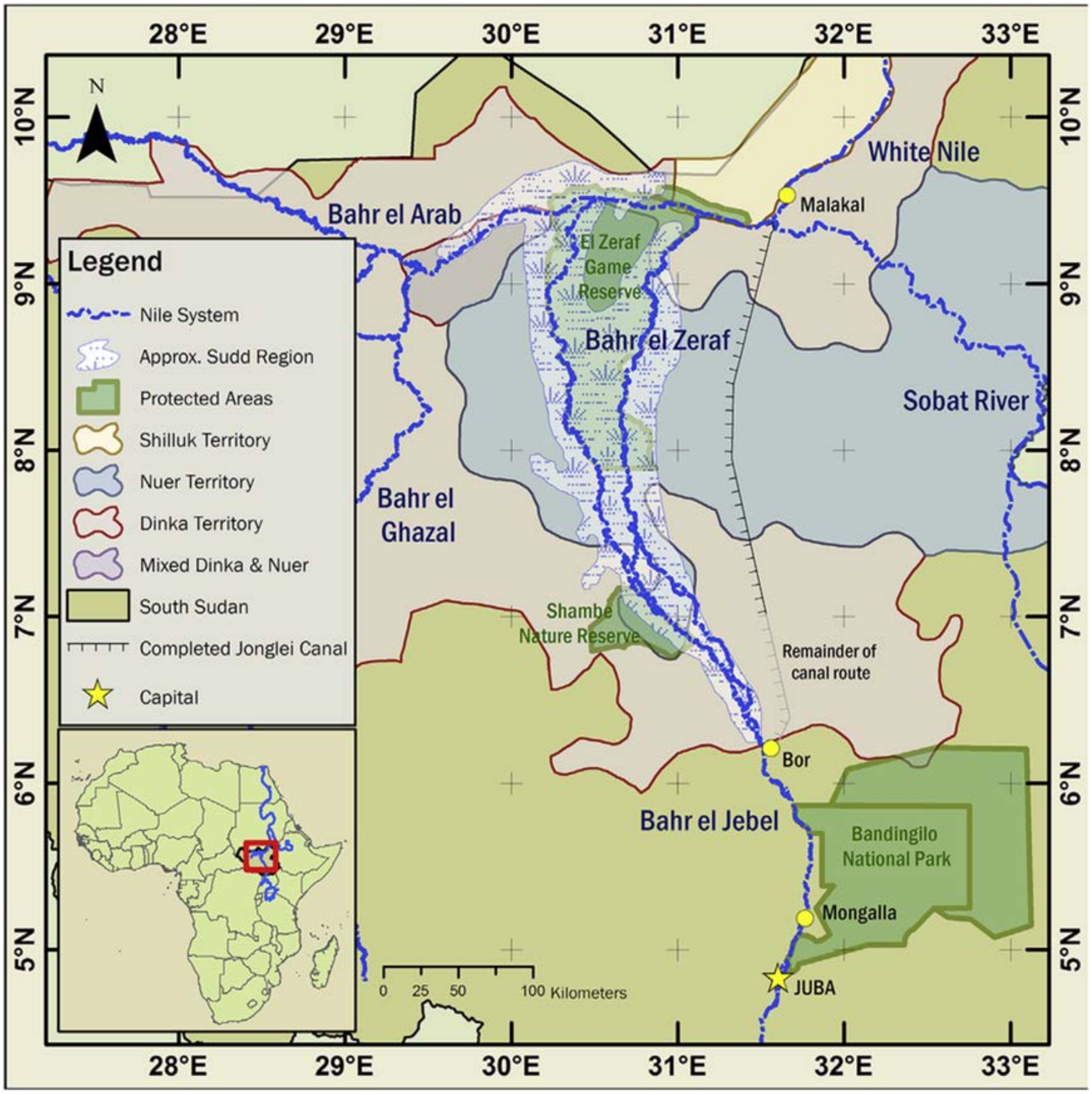

Figure 10. Regional map showing the Sudd in relation to the Nile, Protected Areas, Indigenous People's territory, and the already-constructed portion of the Jongle Canal. Source: Sosnowski et al., 2016).

ECOSYSTEMS AND BIODIVERSITY

As mentioned above, the Sudd wetlands support a vast diversity of ecosystems and biodiversity. Annual flooding is critical to maintaining this biodiversity, as floodwater "regenerates the floodplain with nutrients and allow the growth of forage plants" (Seymour, n.d.). The floodplain borders the dry Sahel region and thus also acts as an important water source for species as they migrate (Seymour, n.d.). The general inaccessibility of the Sudd has contributed to the flourishing of wildlife (Ministry of Environment, 2015), although conflict has opened up opportunities for poachers in recent years (UNEP 2018).

Generally, climate change is expected to be a significant driver of biodiversity loss as temperatures shift faster than species can adapt. In order to survive, many species may need to shift their ranges or migration patterns and evolve to meet the increasing range and intensity of diseases (Nile Basin Initiative, 2012c). Similar to the other sectors described, climate change alone is unlikely to severely impact the ecosystems of the Sudd. If a drying trend continues, some of the Sudd wetlands could be reduced, impacting food and fodder resources for wildlife, particularly if the Sahel shifts south as a result of desertification, which is projected (USAID, 2016). UNEP confirms that "increased variability in the hydrological cycle could cause inland wetlands to dry out and hence reduce their species diversity." Otherwise, it is likely that the most significant impacts to ecosystems and biodiversity will result from unchecked human interventions, which can exacerbate climate change impacts.

Hydrographic integrity is crucial to maintaining flooded grasslands and savannahs, as "many species track flooding patterns and seasonal abundance of resources" (WWF, n.d.). However, human interventions such as diversion and channeling of water can cause habitat loss and degradation, particularly when coupled with pollution, eutrophication, and changes in natural fire regimes (WWF, n.d.). The Jonglei Canal in its current incomplete form (75m wide, 360 km long, and 4-8 meters deep) already acts as wildlife trap (Seymour, n.d.). If it is complete, the resulting drainage could have severe impacts to biodiversity, including degrading fish habitats, and wildlife migration and grazing areas (UNEP 2018; WWF, n.d.). The canal could also act as a barrier to movement between the east and west banks of the Nile that could impact the movement of wildlife, as well as people and livestock (UNEP 2018). Further, draining part of the Sudd would likely increase development in the region, which could open up new areas of land for poaching and bushmeat hunting, as well as impact critical wildlife corridors. Other developments, such as mineral exploration, could also impact the Sudd's seasonal flooding and hydrology, although limited data makes these impacts difficult to understand (UNEP 2018).

Any loss in ecosystems equates to a loss in ecosystem services, which will negatively impact communities that rely on the Sudd and could contribute to conflict over resources. USAID (2016a) explains, "…degradation of ecosystem services, in part caused by climate change, causes friction between competing forms of land use and competition for resources within land use sectors, which often leads to social conflicts and instability." In addition to conflict created by climate change and human intervention, existing conflict also impacts ecosystems and biodiversity. Seymour (n.d.) cited the civil war in South Sudan as one of the largest threats to conservation. The Sudd is home to three protected areas (Zeraf Island, Shambe National Park and north Meshra Game Reserve) and parts of two others (Boma and Badingilo National Parks) (UNEP 2018; WWF n.d.). However, conflict has led to a lack of effective management and protection in these parks, leading to uncontrolled poaching (Ginsberg, 2001 via WWF, n.d.) The tiang antelope is particularly vulnerable to conflict as their migration route passes through some of the conflict zones (UNEP 2018).

HEALTH

Climate change can have various direct and indirect impacts to human health, particularly as communities living in the Sudd already have limited access to clean drinking water, sanitation, and health services (Reach, 2017). Many of the potential impacts from climate change discussed above in relation to water resources, ecosystems, and agriculture will have negative impacts to the health of communities living in the Sudd. For example, reduced access to sanitation, water resources and degradation in water quality will affect local communities, many of whom rely on swamp water for drinking water. Food security is also likely to be impacted by climate change and human intervention, as habitat loss in the Sudd's wetlands will reduce fish populations while agriculture is vulnerable to reduced and/or extreme rainfall, as well as drought (UNEP, 2011). Food insecurity leads to reduced health outcomes in the form of acute malnutrition, famine, and death. Further, an expected increase in the number of extreme heat days can cause heat stress, while extreme precipitation can increase flooding and limit access to healthcare and other services (UNEP 2018).

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 (WFP, 2014).

Climate change also influences the range and spread of vector-borne diseases, such as malaria, which is common in South Sudan (UNEP 2018). While there is limited data available for the region, rainfall and temperature influences occurrence of both water and vector borne disease, both of which are common in the region (WHO, n.d., UNEP 2018). Both climate change, particularly increased temperatures and increase in extreme rainfall events, and drainage of the Sudd (which plays an important role in filtering water), along with contamination from other pollution sources, such as oil exploration, could increase the likelihood of gastrointestinal diseases.

RECOMMENDATIONS TO IMPROVE CLIMATE RESILIENCE:

- ***Additional research:*** Climate impacts in the Sudd and existing adaptation methods are poorly understood. Support additional research into climate change and variability impacts to the Sudd wetland and the climate regulation capacities of the Sudd itself to improve the quality of information available for management and decision making about the areas. Research should include data collection with local communities to understand perceived historical climate changes to date at the local level, as well as existing adaptation strategies that could be utilized or scaled-up. Climate services are most effective when actively developed as a partnership between users and providers of information.

- ***Local capacity building:*** Promote capacity building for Sudd communities to raise awareness of climate change impacts to livelihood activities and provide training on climate resilient agriculture and livelihood practices.

- ***Improve conservation policies and practices:*** Promote and support policies that maintain the integrity of the Sudd Wetland and its ecosystem services, including additional protected area designations such as the tentative UNESCO World Heritage Site listing. This may include encouraging sustainable wildlife and ecotourism in the Sudd to socialize its value as a potential contributor to economic growth, emphasizing the importance of its protection.

- ***Alternative Livelihoods.*** Given that the majority of the population depends on forest resources, adaptation priorities should include forest governance, reducing over-reliance on forest products by providing alternative income generating activities, and encouraging re-afforestation programs. Agroforestry can diversify land production systems while forest reserves and forest management plans can protect watersheds, establish water points for wildlife, and improve fire management.

6. POTENTIAL AREAS OF INVESTMENT

The analysis above identified many sector and regional specific climate vulnerabilities and recommendations to improve climate resilience. Below are broad recommendations for areas of investment to improve resilience across sectors and prepare South Sudan for projected climate change and variability.

- ***Improved sector specific, local, climate services:*** Invest in improved climate information and delivery of information at a sector-specific and local scale to improve community's decision making and understanding of the impacts of climate change and variability. For example, seasonal forecasts for farmers with suggestions on how seasonal climate conditions will impact certain crops, water resources, and grazing lands for pastoralists. Furthermore, this type of information should be distributed in a useful way for local communities, such as on a mobile/cell phone platform.

- ***Improved research, including local knowledge, on the role of climate change and variability in migration and conflict:*** Currently, lack of knowledge about the relationship between climate change, migration, and conflict make it difficult to decrease the potential impact of climate change and variability as threat multiplier to migration and conflict. Improved research, including local oral history, community engagement, and working across communities, to improve understanding of challenges and solutions to limit the impacts of climate change and variability on migration and conflict could contribute to local and national resilience efforts.

- ***Community level resilience efforts:*** Focus on improving resilience at the local level, including improved understanding of how climate change impacts various sectors using local knowledge and oral historical information. Identify resilience building actions at the community level that could be scaled up when the current crisis in South Sudan ends. For example, this may include obtaining information during household surveys about the role of climate and weather in overall resilience and integrate this data into effective resilience building efforts. Furthermore, it is important to understand that South Sudan traditionally has a decentralized government with local traditional leaders often the most important community decision makers. This context should also be considered for the role of women, who are often not treaty equally in the decision-making process, and how to create gender-equality in climate related decision making. (UNEP, 2018).

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