

## Climate Change Technical Note

South Sudan Health Sector Transformation Project (HSTP) (P181385)

1. **The project has been screened for climate disasters and risks and been found to be highly impacted with a high risk to project activities as a function of routine annual flooding and intense dry seasons, which are becoming more extreme and are coupled with a virtual absence of adaptive capacity.** Flooding occurs routinely every year, primarily between July and September, when heavy rains fall in most parts of the country, leading to the flooding of the Nile River tributaries. Since the 1900s, flooding has contributed to about 55% of natural hazards in the country. Mean annual precipitation is projected to increase by 4% by mid-century. The country is projected to become wetter and rainfall intensity is expected to increase. Between 2019 and 2022, longer and more intense rainy seasons debilitated the country, destroying already seriously limited critical infrastructure and crippling movement. These record-setting rainy seasons are in line with the trend towards heavier rainy seasons. Mean average temperature is 25°C, with highs exceeding 35°C, particularly during the dry season (January to April). Mean annual temperature in the country has increased by 1.3°C per century for the period 1951-2000. Mean annual temperature is projected to increase by 1° C by 2060.
2. **Health in South Sudan is intricately intertwined with climate, as both a function of the impact of climatic patterns on diseases and the impact of climate shocks on the health system.** South Sudan experiences flooding on an annual basis. Given the country's very limited infrastructure, this flooding is debilitating every year, disrupting health service delivery as supplies, health workers and supervisors cannot easily reach facilities by road or air as roads become impassible and airstrips are flooded, foot travel is further complicated by large flowing rivers and swamps. Simultaneously, transmission of water and vector borne diseases increase annually during this period. Malaria, which accounts for 8.07 percent of South Sudan's burden of disease spikes during rainy season as floods spread through much of the country.<sup>1</sup> Diarrheal diseases, which account for 8.59 percent of South Sudan's burden of disease, and are inclusive of cholera also increase during this period.<sup>2</sup> Very limited availability of safe drinking water sources lead people to use the abundant unsafe surface water sources that are present during the rainy season, perpetuating the spread of waterborne disease. Because access to health services is so severely limited during rainy season, all health services are fundamentally impacted by the floods, every year. Flooding between 2019 and 2022 was particularly debilitating, displacing people, and destroying the already limited schools and health facilities.<sup>3</sup> The floods destroyed farmland and livestock and were directly linked to food insecurity and increases in malnutrition.<sup>4</sup> As of August 2023, 7.7. million people in the country were estimated to be food

<sup>1</sup> UNICEF. Malaria Season: <https://www.unicef.org/southsudan/stories/malaria-season>

<sup>2</sup> WHO, Aiming for Zero Cholera in South Sudan: <https://www.afro.who.int/news/aiming-zero-cholera-south-sudan>

<sup>3</sup> CARE, South Sudan: Climate crisis transforms annual floods into catastrophe for hundreds of thousands, <https://reliefweb.int/report/south-sudan/south-sudan-climate-crisis-transforms-annual-floods-catastrophe-hundreds>

<sup>4</sup> World Food Program, <https://www.wfp.org/emergencies/south-sudan-emergency#:~:text=Four%20consecutive%20years%20of%20record,fuel%20prices%20and%20ongoing%20conflict.>

insecure and 2.9 million people severely food insecure.<sup>5</sup> The World Food Program (WFP) directly links food insecurity and undernutrition in the country with the impacts of climate change.<sup>6</sup> See Table 2 for further information on the climate change and health links in South Sudan.

3. **South Sudan is comprised of riverine basins, with debilitating annual floods for approximately eight months a year.** With climate change, these already extreme climactic patterns are expected to become worse. Delivering health services in the country is a practice of delivering services on a flood plain. During dry season, the country becomes very hot and is drought prone. High heat further complicates service delivery as travel to health facilities during the day is inhibited by the high temperatures and in many parts of the country much of the population moves from their home villages to areas closer to water sources. The country has no adaptive capacity. Climate adaptation measures have been built into all aspects of project design to both improve the health system's adaptive capacity and deliver services in the project.
4. The project intends to adapt to climate change while employing measures to mitigate greenhouse gas emissions.

**Table 1: Climate Adaptation and Mitigation Activities in the Project**

Subcomponent	Climate Activity
<b>Component 1: Provision of Essential Health Services Nationwide (UNICEF and competitively selected pharmaceutical procurement and logistics will implement; US\$330.77 million: US\$10 million equivalent from Government contribution; US\$100.71 million equivalent IDA [including US\$90.49 million WHR] and US\$220.06 million Trust Funds [US\$23.14 million SDTF and US\$196.92 million MDTF])</b>	
<b>Subcomponent 1.1: Delivery of high impact essential health and nutrition services Nationwide through Health Facilities (US\$273.73 million: US\$10 million equivalent from Government contribution, <u>US\$62.67 million equivalent IDA</u> [WHR] and US\$201.06 million Trust Funds [US\$21.14 million SDTF and US\$179.92 million MDTF])</b>	<p><b>Climate Sensitive Planning and data use:</b> The subcomponent will use climate sensitive planning and data use to ensure continuity of health service delivery during seasonal floods. This will include focused use of data to look at seasonal trends in health conditions; assessment of activities based on needs; and planning to maximize access to people during seasonal flooding and high heat. <b>(adaptation)</b></p> <p><b>Climate Sensitive Service Delivery:</b> service delivery will be adjusted to seasonal patterns to maximize delivery during flooding and high heat. Embedded approaches that will be utilized include, but are not limited to: outreach visits (the purchase and use of all terrain vehicles, boats, and camping equipment as well as outreach visit costs); dry season service delivery campaigns to maximize reach of people during accessible periods (transport costs; accommodation costs; logistics costs); air travel costs to transport staff and move supplies during rainy season; and costs for porters to move supplies locally during rainy season. <b>(adaptation)</b></p>

<sup>5</sup> World Food Program,  
[https://api.godocs.wfp.org/api/documents/08d6c0680d194cbd90827fef9b9f14c1/download/?\\_ga=2.43959341.924412022.1692894756-2046979839.1691780832](https://api.godocs.wfp.org/api/documents/08d6c0680d194cbd90827fef9b9f14c1/download/?_ga=2.43959341.924412022.1692894756-2046979839.1691780832)

<sup>6</sup> Hunger and malnutrition being driven by climate crisis and conflict in South Sudan, November 3, 2022  
<https://wfp.org/news/hunger-and-malnutrition-being-driven-climate-crisis-and-conflict-south-sudan>

	<p><b>Delivery of Services for climate sensitive conditions:</b> the package will finance delivery of services for water and vector borne diseases, as well as undernutrition, which are highly climate sensitive in South Sudan's context. Overlay of climactic data will be used to inform delivery of services for these conditions to support adaptation to the health impacts of climate change. <b>(adaptation)</b></p> <p><b>Pharmaceutical procurement for climate sensitive conditions:</b> This subcomponent will finance pharmaceuticals and supplies for climate sensitive conditions in South Sudan: water and vector borne diseases and undernutrition. Seasonal data will be used to inform the procurement of these pharmaceuticals. This will help treat climate sensitive diseases to reduce the health impacts of climate change. <b>(adaptation)</b></p>
<p><b>Subcomponent 1.2: Boma Health Initiative (US\$12.41 million: <u>US\$3.41 million equivalent IDA</u> [WHR IDA] and US\$9.0 million Trust Funds [US\$0.95 million SDTF and US\$8.05 million MDTF])</b></p>	<p><b>Community level service delivery to reach the population during flooding and high heat:</b> the expansion of the Boma Health Initiative is largely fueled by the need to ensure continuous service delivery to the population during annual flooding, in light of the extreme flooding of recent years which has destroyed health facilities. The BHI was found to be a core approach to reach communities regardless of climactic conditions. Climate sensitive service delivery will be guided by the County level climate emergency preparedness and response plans which will include specific planning for the BHI as a mechanism to ensure service delivery continuity during flooding and high heat. <b>(adaptation)</b></p> <p><b>Delivery of Services for climate sensitive conditions:</b> the package will finance delivery of services for water and vector borne diseases, as well as undernutrition, which are highly climate sensitive in South Sudan's context. Overlay of climactic data will be used to inform delivery of services for these conditions. Community level malaria diagnostic and treatment as well as treatment of diarrheal diseases are core services to be delivered at the community level and estimated to comprise at least one third of the services offered by BHWs. <b>(adaptation)</b></p>
<p><b>Subcomponent 1.3: Pharmaceutical and Medical Supply Procurement and Last Mile Delivery (US\$13.41 million: <u>US\$3.41 million equivalent IDA</u> [WHR] and US\$10.0 million Trust Funds [US\$1.05 million SDTF and US\$8.95 million MDTF])</b></p>	<p><b>Climate Sensitive pharmaceutical planning and distribution:</b> to ensure continuity of services throughout rainy season, pharmaceuticals need to be prepositioned ahead of the rainy season in most locations. This involves developing detailed seasonal plans and consolidated shipping during the country's limited dry season from January to March. This subcomponent will also finance as needed air shipments of pharmaceuticals to fill gaps when these occur. <b>(adaptation)</b></p>
<p><b>Subcomponent 1.4: Climate Resilient Health Service Delivery (<u>US\$31.22 million equivalent IDA</u> [including US\$21.00 million WHR])</b></p>	<p><b>This entire subcomponent finances climate activities, focusing on adaptation and incorporating targeted mitigation activities,</b> to support sustained health service delivery given the enormous impact of seasonal flooding and high heat on health service delivery in the country. The subcomponent will finance:</p> <p><b>Climate adaptive and energy efficient health facility and pharmaceutical store rehabilitation guidelines:</b> these guidelines will identify and outline (i) rehabilitation measures that can be taken to reduce the impact of flooding and high heat on health facilities in</p>

	<p>South Sudan. These measures will both go beyond standard practice and be locally tailored to reduce the impacts of flooding and high heat, which debilitate service delivery. Measures are expected to include innovative flood control and passive cooling measures; and (ii) energy efficiency guidelines for health facilities and pharmaceutical store rehabilitation, aligned with Criteria 9.1 of the ‘Buildings, public installations and end-use energy efficiency’ section of the of the Multilateral Development Bank Mitigation Finance Methodology,<sup>88</sup> the Project commits to developing energy efficiency health facility rehabilitation guidelines that will substantially reduce net energy consumption, resource consumption, and CO<sub>2</sub>e emissions of health facilities and pharmaceutical stores. These guidelines will ensure at least 20 percent energy efficiency in comparison with standard practice. The activity will finance i) technical assistance to develop the guidelines; ii) development of the guidelines including consultations; and iii) guidelines dissemination. The content and impetus of the guidelines is entirely climate related. <b>(adaptation and mitigation)</b></p> <p><b>Climate adaptive pharmaceutical stores:</b> heavy annual flooding, combined with very limited infrastructure, make pharmaceutical deliveries to rural parts of the country where 80 percent of the population lives very difficult. Access is more problematic during the extreme flooding of recent years. As a result, it is necessary to preposition pharmaceuticals to ensure service continuity during the rainy season. This subcomponent will finance rehabilitation of stores for dry season prepositioning for continuous availability of pharmaceuticals during rainy season. Rehabilitation will finance measures to ensure stores are not impacted by flooding or high heat. Measures will be based on the climate adaptive and energy efficient health facility and pharmaceutical store rehabilitation guidelines. Energy efficiency measures will be employed in electrified stores, which are a subsection of stores anticipated to be rehabilitated. The activity will finance: i.) technical assistance for implementation of the national climate adaptive and energy efficient health facility and pharmaceutical store rehabilitation guidelines; ii.) climate adaptive rehabilitation of pharmaceutical stores; and iii) energy efficiency measures in electrified pharmaceutical stores. <b>(adaptation and mitigation)</b></p> <p><b>Climate adaptive health facility rehabilitation:</b> health facilities have been substantively impacted by flooding in recent years, stalling health service delivery. In complement to rehabilitation of flood damaged facilities financed by the CERHSSP, this activity will finance climate adaptive rehabilitation of health facilities that are at risk of flood damage to prevent future damage. The activity will target climate vulnerable health facilities. The health facilities will be identified by implementing partners and UNICEF, with community consultations, based on: i) exposure to flood waters over the past four years; ii) proximity to known flood plans; iii) vulnerability of infrastructure to floods. The activity will utilize the national climate adaptive health facility and pharmaceutical store rehabilitation guidelines to be developed through this component, which will go beyond standard practice and will finance: i.) technical assistance for implementation of</p>
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	<p>the national climate adaptive health facility and pharmaceutical store rehabilitation guidelines; and ii.) climate adaptative health facility rehabilitation. This activity intends to make health facilities resilient to climate shocks and climate is the main driver the entire activity, including sanitation rehabilitation, which intends to ensure safe water supply and sanitation systems in flood prone conditions. <b>(adaptation)</b></p> <p><b>Energy Efficient Health Facility Rehabilitation:</b> aligned with Criteria 9.1 of the 'Buildings, public installations and end-use energy efficiency' section of the of the Multilateral Development Bank Mitigation Finance Methodology,<sup>88</sup> the Project commits to adopting measures that substantially reduce net energy consumption, resource consumption, and CO<sub>2</sub>e emissions of the municipal hospitals, guided by the building standards developed under this Subcomponent for the rehabilitation of energy-efficient health facilities. The project will finance: i) technical assistance for the implementation of energy efficient rehabilitation; and ii) energy efficient rehabilitation of health facilities ensuring at least 20 percent greater energy efficiency in comparison to standard practice. <b>(mitigation)</b></p> <p><b>County level multi-hazard emergency response plans with a focus on climate emergency preparedness and response:</b> this activity will finance the development of health sector climate emergency preparedness and response plans for each county. The plans will outline service delivery provision for routine and extreme climactic events, primarily flooding and high heat, focusing on sustaining health service delivery and other health sector activities. Contingency plans and preparatory actions will be incorporated. Detailed mechanisms for the role of the BHI in delivering services to climate vulnerable populations will be a focus of the document and closely linked to BHI service delivery under subcomponent 1.2. The County level guidelines will be closely linked with National and State level plans developed in subcomponent 2.1. The activity will finance: i.) staff time and technical assistance for the development of the climate emergency preparedness and response plans; and ii) the printing and dissemination of the plans. Climate change is the entire impetus for inclusion of these plans in the project. Multi-hazard response plans are being supported as this aligns with the existing emergency preparedness and response planning structures in the country and developing broader emergency preparedness and response plans will benefit the country. <b>(adaptation)</b></p> <p><b>Training on climate emergency preparedness and response plans and climate and health adaptation:</b> This subcomponent will train health workers and CHD staff on the country level climate emergency preparedness and response plans as well as the health and health system impacts of climate change and adaptation measures. The activity will finance: i) technical assistance for the development of training materials; ii) execution of the trainings. <b>(adaptation)</b></p>
<b>Component 2: Health Systems Strengthening (US\$15.00 million: <u>US\$5.50 million equivalent IDA</u> [including US\$3.72 million WHR] and US\$9.50 million Trust Funds [US\$1.0 million SDTF and US\$8.50 million MDTF])</b>	

<p><b>Sub-component 2.1: Health emergency preparedness and response, laboratory strengthening, and disease control (US\$5.5 million: <u>US\$2.04 equivalent million IDA</u> [including US\$1.38 million WHR] and US\$3.46 million Trust Funds [US\$0.36 million SDTF and US\$3.10 million MDTF])</b></p>	<p><b>Development, dissemination, and training on national and state level climate and climate health emergency preparedness and response plans:</b> The subcomponent will finance the development of national and state level climate emergency preparedness and response guidelines, which will be aligned with county level plans developed in subcomponent 1.4. The plans will include actions to prepare for and respond to health emergencies and risks to health systems and service delivery activities from the National through the community levels and will outline actions for PHEOCs. Climate change is the entire impetus for inclusion of these plans in the project. Multi-hazard response plans are being supported as this aligns with the existing emergency preparedness and response planning structures in the country and developing broader emergency preparedness and response plans will benefit the country. <b>(adaptation)</b></p> <p><b>Operational Costs for PHEOCs:</b> PHEOCs will be operationalized to respond to climate and health emergencies, including climate sensitive diseases, guided by the national and state level climate and climate health emergency preparedness and response plans. Staff will be trained on the plans. This will support the PHEOC's response to health emergencies and adaptation to the health impacts of climate change. <b>(adaptation)</b></p> <p><b>Laboratory Guidelines:</b> laboratory guidelines will include specific sections for the testing and transfer of samples for climate sensitive diseases (water and vector borne diseases) and ii) guidelines for the transfer of samples during floods and high heat. Staff will be trained on these with specific modules on climate sensitive diseases and sample transfer during floods and high heat to ensure the continuity of laboratory sample testing and support adaptation to the health impacts of climate change. <b>(adaptation)</b></p> <p><b>Laboratory accreditation:</b> laboratory accreditation will include assessments of laboratories for (i) resilience to climate shocks, primarily flooding and high heat; and (ii) energy efficiency. Specific measures on each of these will be in the assessment. The energy efficiency assessment will outline steps to meet energy efficiency requirements based on South Sudan's energy efficient rehabilitation guidelines to be developed through subcomponent 1.4. Similarly, resilience to climate shocks will assess if resilience measures developed in the climate resilient health facility rehabilitation guidelines. This will help ensure that laboratories are able to adapt to the health impacts of climate change and contribute to greenhouse gas emissions reductions. <b>(adaptation and mitigation)</b></p>
<p><b>Sub-component 2.2: Blood Banking and Transfusion (US\$2.50 million: <u>US\$0.93 million equivalent IDA</u> [including US\$0.64 million WHR] and US\$1.57 million Trust Funds [US\$0.17 million SDTF and US\$1.40 million MDTF])</b></p>	<p><b>Blood Transfusion Transfer Guidelines:</b> blood transfusion transfer guidelines will include specific contingency plans for delivery of blood supplies during flooding and high heat. This will help ensure the continuity of services in climate shocks, enabling climate change adaptation. <b>(adaptation)</b></p>

<p><b>Sub-component 2.3: Health Service Quality Improvement (US\$2.50 million: <u>US\$0.83 million equivalent IDA</u> [including US\$0.53 million WHR] and US\$1.67 million Trust Funds [US\$0.17 million SDTF and US\$1.50 million MDTF])</b></p>	<p><b>Health Worker Training Curriculum on Climate and Health:</b> Specific modules on climate emergency preparedness and response and climate and health adaptation will be included in the health worker training curriculum to be developed under this subcomponent. This will help the health workforce adapt to the health impacts of climate change. <b>(adaptation)</b></p>
<p><b>Sub-component 2.4: Health Management Information Systems (US\$2.50 million: <u>US\$0.93 million equivalent IDA</u> [including US\$0.63 million WHR] and US\$1.57 million Trust Funds [US\$0.17 million SDTF and US\$1.40 million MDTF])</b></p>	<p><b>Meteorologic and Health Data Use:</b> this subcomponent will finance the use of health data against meteorologic data to better understand the relationship between climate change and climate sensitive diseases as well as service delivery, given the major impact of climate shocks on health service delivery. This activity will finance technical assistance for the Ministry of Health to conduct and develop capacity for this analysis. The data will be used to understand the impacts of flooding and high heat, including changes in flood and heat levels, on health conditions (climate sensitive diseases and other health conditions) as well as health service delivery, to help the MoH and partners adapt health service prevention, response, and treatment activities to the health impacts of climate change. This will help the health system to more effectively respond to the health impacts of climate change. <b>(adaptation)</b></p>
<p><b>Subcomponent 2.5: Health Sector Stewardship and Financing (US\$2.00 million: <u>US\$0.77 million equivalent IDA</u> [including US\$0.54 million WHR] and US\$1.23 million Trust Funds [US\$0.13 million SDTF and US\$1.10 million MDTF])</b></p>	<p><b>Climate sensitive health sector operational plans:</b> the subcomponent will finance technical assistance for planning to ensure continuity of health services during floods and high heat. This will include plans to maximize population reach during dry season, staffing plans, supervision plans with attention to climactic conditions, ensuring budgets are available to support intensive activities during dry season, etc. These plans will be used to implement other activities financed in this project under component 2 and component 1. <b>(adaptation)</b></p>
<p><b>Component 3: Monitoring and Evaluation and Project Management (US\$23.73 million: <u>US\$10.79 million equivalent IDA</u> [WHR] and US\$12.94 million Trust Funds [US\$1.36 million SDTF and US\$11.58 million MDTF])</b></p>	
<p><b>Subcomponent 3.1: Third Party Monitoring (US\$13.75 million: <u>US\$6.15 million equivalent IDA</u> [WHR] and US\$7.6 million Trust Funds [US\$0.8 million SDTF and US\$6.8 million MDTF])</b></p>	<p><b>Climate Measures in Monitoring:</b> third party monitoring will include specific climate measures, including (i) questions to patients on the impacts of climate shocks on health service access; (ii) analysis of TPM results by season as well as across years and locations to understand the impacts of climate shocks on health service delivery; (iii) assessment of health facility climate resilience in health facility functionality; and (iv) focused climate measures in the two household surveys. These measures will include: (i) assessment of the prevalence of climate sensitive conditions including vector and water borne diseases, with data analysis against location and seasonal data as well as questions on related exposures including types of water source access and sanitation access as well as proximity to stagnant water; (ii) measures on exposure to climate shocks, to be triangulated against other indicators; and (iii) questions on the impact of climate shocks (primarily floods and high heat) on health service access. <b>(adaptation)</b></p>
<p><b>Subcomponent 3.2: Data analysis and visualization platform (US\$0.73 million: <u>US\$0.30 million equivalent IDA</u> [US\$0.0 million IDA Grant and US\$0.30 million WHR] and US\$0.43 million Trust Funds</b></p>	<p><b>Overlay of Climate and Health Data:</b> the data visualization platform will include seasonal analysis and the overlay of meteorologic and health data to better understand the impact of climate change on health and health services. <b>(adaptation)</b></p>

[US\$0.05 million SDTF and US\$0.38 million MDTF])	
<b>Subcomponent 3.4: Project management</b> (US\$5.81 million: <u>US\$2.80 million equivalent IDA [WHR]</u> and US\$3.01 million Trust Funds [US\$0.31 million SDTF and US\$2.7 million MDTF])	This subcomponent will manage the project's other climate activities and so should be assessed at the same rate as the project's overall climate activities.



**Table 2: South Sudan Climate and Health Risks and Links**

Health Risks		Evidence of climate Change link
Vector-borne diseases (VBDs)	Malaria	Malaria is one of the leading causes of poor health/ illness and deaths in South Sudan disproportionately affecting children and pregnant women. Malaria is endemic in South Sudan with a year-round disease burden. According to the Malaria Consortium South Sudan, 95% of the South Sudan population is at risk of malaria which accounts for 60% of all health facility visits (out-patient visits and admissions). <sup>7</sup> In 2019 alone, malaria incidence was estimated at 246 cases per 1,000 people per year. <sup>8</sup> Evidence shows malaria transmission in South Sudan is significantly related to climatic conditions particularly temperature and rainfall. <sup>9</sup> Stagnant water caused by heavy rainfall induced flooding coupled with warm water temperatures increase the suitability of <i>Anopheles gambiae</i> mosquito bleedings. Projected high increase in climate change particularly temperature in South Sudan of 2.5°C and 3°C by the 2050s and 2080s respectively — except northern South Sudan showing uncertainty in temperature — are predicted to considerably increase malaria transmission and other vector-borne diseases in the country. <sup>10</sup>
	Diarrheal diseases	Acute watery diarrhea is the leading cause of under-five mortality/ deaths responsible for an estimated 42.9% of the annual mortality rate in South Sudan. <sup>11</sup> Drinking water pollution; and poor sanitation and hygiene are key risk factors in the spread of acute diarrheal illnesses in South Sudan. According to a World Bank report, only 10% of the households in South Sudan have access to sanitation facilities while 75% practice open defecation; about 21% of schools have no access to sanitation facilities; while 33% schools do not have access to drinking water services. <sup>12</sup> Recent increases in climate change induced floods in South Sudan has greatly contaminated water sources resulting from flood damaged sewage systems, wash off of human excretes and waste into water sources elevating the risk of diarrheal diseases and other water-borne diseases.
	Cholera	Evidence shows that in South Sudan, heavy rainfall and related strong flooding events trigger cholera outbreaks resulting from increased exposure to contaminated water (especially by human

<sup>7</sup> <https://www.malariaconsortium.org/where-we-work/south-sudan.htm>

<sup>8</sup> Pasquale, H. A. (2020). Malaria prevention strategies in South Sudan. *South Sudan Medical Journal*, 13(5), 187-190.

<sup>9</sup> Mukhtar, A. Y., Munyakazi, J. B., & Ouifki, R. (2019). Assessing the role of climate factors on malaria transmission dynamics in South Sudan. *Mathematical biosciences*, 310, 13-23.

<sup>10</sup> Leedale, J., Tompkins, A. M., Caminade, C., Jones, A. E., Nikulin, G., & Morse, A. P. (2016). Projecting malaria hazard from climate change in eastern Africa using large ensembles to estimate uncertainty. *Geospatial health*, 11(1 Supp), 102-114.

<sup>11</sup> William, G. B., Kariuki, J. G., & Kerochi, A. (2023). Risk Factors for Acute Watery Diarrhea among the Under Five in Bentiu Protection of Civilian's Site, Unity State, South Sudan. *Journal of International Business, Innovation and Strategic Management*, 7(1), 1-17.

<sup>12</sup> Borgomeo, E., Chase, C., Godoy, N. S., & Kwadwo, V. O. (2023). *Rising from the Depths: Water Security and Fragility in South Sudan*. World Bank Publications.

		excretes) due to wide spread open defecation practices in communities. For example, in 2015, in Juba, an intra-seasonal double peak of cholera cases was reported in the aftermath of heavy rainfall events. <sup>13</sup> Projected increase in rainfall intensity across South Sudan mid-century is expected to increase the risk of floods and frequency of cholera outbreaks.
<b>Heat-related risks</b>	Heat- related mortality and morbidity	Climate change is increasing temperatures across South Sudan exposing the population particularly in urban centers to extreme heat. With temperatures of 26-32°C, Juba has the highest population at greater risk of heat-related morbidity and mortality largely due to increasing population and poor city planning. <sup>14</sup> Children, pregnant women, and the poor are disproportionately affected by heatwaves with increased rates of miscarriages and still births. <sup>15</sup> South Sudan is projected to experience an increase in average annual temperature of 1-1.5°C by 2060 with significant impacts on extreme heat days elevating the risk of heat stress and other heat-related health risks. <sup>16 17</sup>
<b>Food insecurity and malnutrition</b>		Evidence from South Sudan show that significant increases in daily maximum temperature, increased intensity per rainfall event, and increases in mean annual rainfall has significantly led to a decline in crop yields impacting food security and increasing malnutrition in the country. Currently, South Sudan is experiencing the worst food crisis triggered by a combination of climate hazards (floods, drought, extreme heat) and conflict. While South Sudan has one of the richest agricultural areas in Africa, climate change variability is expected to negatively impact agriculture and further increase food insecurity in the country. <sup>18</sup> For example projected increases in temperature are predicted to significantly reduce average primary food crop yields including cassava (16-24%), groundnuts (19-30%), maize (9-18%), and sorghum (12-23%) by the mid-century. <sup>19</sup> The IPC notes that areas impacted by climactic shocks are those most impacted by food

<sup>13</sup> Lemaitre, J., Pasetto, D., Perez-Saez, J., Sciarra, C., Wamala, J. F., & Rinaldo, A. (2019). Rainfall as a driver of epidemic cholera: comparative model assessments of the effect of intra-seasonal precipitation events. *Acta tropica*, 190, 235-243.

<sup>14</sup> Lamanna, C. (2019). Too hot to handle? Heat resilience in urban South Sudan. *South Sudan Medical Journal*, 12(1), 24-27.

<sup>15</sup> <https://www.businesslive.co.za/bd/world/2023-10-10-extreme-heat-in-south-sudan-puts-lives-of-and-pregnant-women-and-babies-at-risk/>

<sup>16</sup> Lamanna, C. (2019). Too hot to handle? Heat resilience in urban South Sudan. *South Sudan Medical Journal*, 12(1), 24-27.

<sup>17</sup> Asefi-Najafabady, S., Vandecar, K. L., Seimon, A., Lawrence, P., & Lawrence, D. (2018). Climate change, population, and poverty: vulnerability and exposure to heat stress in countries bordering the Great Lakes of Africa. *Climatic Change*, 148, 561-573.

<sup>18</sup> <https://climateknowledgeportal.worldbank.org/country/south-sudan>

<sup>19</sup> Ulimwengu, J. M., Thomas, T. S., Marivoet, W., & Benin, S. (2022). *Determinants of resilience for food and nutrition security in South Sudan* (Vol. 2117). Intl Food Policy Res Inst.

		insecurity <sup>20</sup> and that undernutrition is directly linked with food insecurity in the country <sup>21</sup> .
<b>Climate change impacts on the health system and infrastructure</b>	Impacts on health infrastructure, health service access and delivery	Extreme flooding caused by frequent heavy rains have damaged health infrastructure, roads, and reduced access to health services in South Sudan. For example, in 2019, South Sudan faced heavy rainfall and associated flooding across 40 counties that caused damage to health facilities, roads, school buildings, homes and destroyed WASH infrastructure contaminating drinking water sources. The floods increased the disease burden from climate sensitive diseases (diarrheal, malaria, malnutrition) overwhelming the capacity of the already fragile health facilities. As a result of the rising water levels, the floods made access to health facilities and access to communities by health service providers challenging. <sup>22</sup> This was also the case in 2021, when seasonal heavy rains caused flooding that damaged health facilities and roads hindering health service providers extending health service delivery to affected communities. <sup>23</sup>

<sup>20</sup> IPC. South Sudan: Acute Food Insecurity Situation October - November 2022 and Projections for December 2022 - March 2023 and April - July 2023 <https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1155997/?iso3=SSD>

<sup>21</sup> IPC. South Sudan: Acute Malnutrition Situation July - October 2022 and Projections for November 2022 - February 2023 and March - June 2023 <https://www.ipcinfo.org/ipc-country-analysis/details-map/en/c/1155999/?iso3=SSD>

<sup>22</sup> World Health Organization South Sudan (November 13, 2020) Increasing access to life-saving primary healthcare services in South Sudan's flood-affected areas. <https://www.afro.who.int/news/increasing-access-life-saving-primary-healthcare-services-south-sudans-flood-affected-areas>

<sup>23</sup> OCHA (September 15, 2021) South Sudan: Flooding Situation Report Inter-Cluster Coordination Group. [https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/south\\_sudan\\_flooding\\_situation\\_report\\_1.pdf](https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/south_sudan_flooding_situation_report_1.pdf)