

# Climate risk and food security in South Sudan: Analysis of climate impacts on food security and livelihoods

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*Report by:*

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## Executive Summary

Agriculture and food security are the most vulnerable and climate-sensitive sectors in South Sudan. The high level of food insecurity in the country is explained by a set of interrelated factors including climate change/variability, climate related disasters, conflict, food prices and market dynamics among others. Variability and extreme climatic events, decades of civil war and conflict, as well as environmental degradation, have contributed to increased vulnerability to food security. Natural and partly man-made disasters such as drought, land degradation, floods are some of the major contributing causes to food insecurity in the country. Conflict, displacement and food insecurity are three of the most pressing problems for South Sudan, which have often sparked international humanitarian aid effort. The linkages between climate on one hand and livelihoods together with specific vulnerabilities on the other have not been quantitatively and qualitatively studied in South Sudan.

Understanding the ways in which climate risks affect vulnerability and livelihoods is a critical step towards identifying the regions and communities that should be prioritized as well as the appropriate mechanisms for intervention. This analysis explores on some key drivers to food insecurity and ways in which livelihoods are affected by climate related risks. The method used consist of dynamic and descriptive analyses to evaluate the relationship between historic and current climatic variability and food security indicators using various layers. Finally, it uses this information to disaggregate food security and resilience patterns to the most vulnerable populations.

The following are highlights from this analysis:

**Climate:** Seasonal rainfall trends are highly variable across the country. Recent rainfall data show increasing trends particularly in the northern parts of the country and declining rainfall in the western and southern parts of the country. In addition, analyses suggest that there has been a shift in the start and cessation of rainfall, leading to more erratic and unpredictable rainfall patterns.

**Climate impacts on food production:** Rainfall is one of the main climatic determinants of food production in South Sudan. Good rainfall years are generally associated with higher food production. Grains and cereals – the main staple in the country – is especially sensitive to changes in rainfall, and almost 70% of the variability in their production can be explained by variations in rainfall.

**Climate impacts on food access:** Access to markets is critical for food security in South Sudan. This is especially the case in the agro-pastoralist and agricultural areas, where households depend heavily on markets during the agricultural lean seasons, despite poor roads infrastructure for market access. 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 flood limit physical access to markets.

**Climate impacts on livelihoods:** Food insecurity, particularly in the most vulnerable areas in almost all the country, is highly sensitive to climate trends. It is likely that climate change will exacerbate livelihood vulnerabilities and food insecurity trends in the most at-risk areas. Efforts to reduce the adverse impacts of climate on food security in South Sudan should therefore prioritize these livelihood zones. Climate impacts have also a bearing on conflicts, but this has not been included in this report, given that the major conflicts being faced in the country is political.

The following areas of intervention to enhance food security and climate adaptation are identified in the report:

- Adaptation to floods resulting from increased seasonal rainfall through flood management strategies. The agro-ecological zones in central and northern regions of the country are the most vulnerable to the negative impacts of more intense rainfall.
- Adaptation to drought through water management strategies, supported by introduction of drought-tolerant crops and crop varieties can play a critical role in reducing the vulnerability of at-risk populations.
- Adaptation to floods, drought and land degradation resulting from erratic (and potentially more intense) seasonal rainfall through water management. Strategies to ensure sustainable food security under a scenario of decreased rainfall should focus improving water management practices.
- Adaptation to climate-induced market risks. At-risk populations are also highly dependent on markets and vulnerable to volatile food prices. In this context, food market stabilization during shocks (through subsidies) and food stocks can provide a buffer against food insecurity. Improving the road infrastructure is also likely to enhance access to markets. The implementation of early warning systems can provide timely information about roads/routes that are unreachable due to climate-related disasters, ensuring that remote populations can access markets. Other innovative mechanisms such as insurance schemes can also help reduce some of the negative effects of climate on food security.
- Asset creation and disaster risk management. At the community level, conditional asset transfers 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 is also critical to enhancing resilience.
- Support to livelihood and income diversification. Given the high reliance on rain-fed agriculture, strategies for livelihood and income diversification are critical to ensuring resilience. 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.
- **Capacity building at government and community levels.** Efforts to reduce climate impacts should also incorporate a strong capacity building and resource mobilization component at government and community levels through awareness raising campaigns, as well as developing analytical tools to ensure that risks and vulnerabilities are identified and mapped.
- **Strengthening climate information for early warning systems.** An effective early detection and warning system for severe or abrupt climate variability is an important tool for climate risk management. Integrating this information into existing early warning systems for food security can provide an additional layer of information for better food security and adaptation planning.
- **Management of uncertainties associated with long-term climate change.** Adaptation options should also consider a range of uncertainties associated with climate variability and the timescales of climate impacts. In managing this type of uncertainties, multiple risks need to be considered simultaneously.
- **Management of land degradation and desertification.** This is brought about by human land-use pressures and recurrent drought affect large areas and threaten already vulnerable arable zones. Depletion of forests-primarily for household fuel consumption threatens biological diversity and human communities and reduces the other valuable products and services that forests provide.

It is hoped that this report will not only help advance the climate change and food security dialogue in South Sudan, but also provide concrete inputs for adaptation programming to build resilience in the most vulnerable communities in this youngest country.

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## 1. INTRODUCTION

South Sudan's population is overwhelmingly rural and primarily dependent on subsistence farming or animal husbandry for their livelihoods. The risk of food insecurity varies markedly with rainfall, conflict, soil types, topography, drainage and access to markets among other factors. The majority of rural population practice various combinations of agricultural types, animal husbandry and pastoralism/agro-pastoralism, gathering of wild plant foods, hunting, fishing, income sources from timber, gum Arabic and other natural resources. There is informal trade particularly in agricultural produce, livestock and timber across the country's borders. Staple foods, including food aid, accounts for the bulk of imports because of low production in some areas and because limited internal transport does not allow food to be brought from surplus to deficit areas and to Juba and other urban areas within South Sudan.

Livelihoods are largely differentiated according to topography. Those households living along rivers are mostly engaged in activities related to fishing. In low lying areas, households typically rely on agriculture and pastoralism. Households living in areas characterized by plains, highlands and mountains with equatorial rain forest do crop farming and livestock production supplemented by food obtained from hunting and wild foods, and food purchased with income from agricultural and casual labor. Households on highlands, plateau and foothills with a mixture of forest, bush shrubs and grasslands are endowed with some natural resources such as wild honey and shea butternut trees.

Households in vast plain and foothills of the mountainous ranges with vegetation characterized by dense forest with mahogany and bamboo trees, bush shrubs and savanna grasslands do livestock keeping. Some poor households are involved in the sale of products such as charcoal, firewood, poles, bamboo and ropes. Those in semi-arid do pastoralism. Those in flood plains characterized by swampy vegetation do fishing as well as agro-pastoralism.

Activities related to the oil mining and zinc sulphate industry forms economic activity of households in forest, bush scrub and grasslands in the western flood plain of the Nile. In the flat plains with low lying areas covered with grasslands, scanty shrubs, thorns, Balanites, bushes and other hardy plants and patches of forest are the agro-pastoralists communities.

Household incomes especially from the sale of surplus crops, livestock and natural products are heavily dependent on access to external markets.

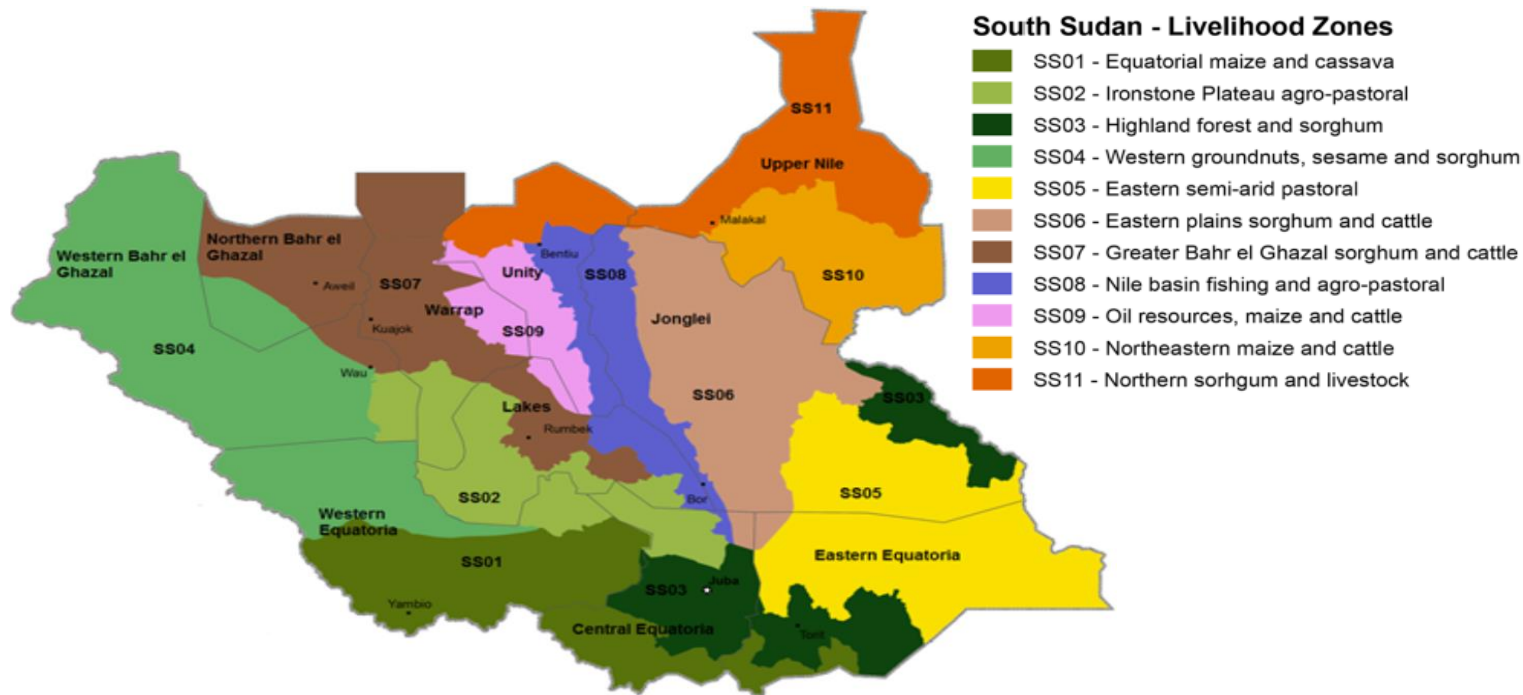
## 2. METHODOLOGY

### 2.1. Descriptive Data analysis

The aim of descriptive component of this analysis is to identify the potential vulnerabilities of food security to climate variability through overlaying of maps and other visual outputs. For the descriptive assessment, relevant variables that are climate sensitive are identified and major livelihood profiles across South Sudan examined. The relevant parameters from the secondary data and other sources are selected, and their specific vulnerabilities to climate variables described.

The majority of these data were obtained from an extensive literature review, combining with other sources of information from FEWSNET and WFP's previous assessments in the country.

**Figure 1. Livelihood Zones of South Sudan (FEWSNET 2013)**



*This livelihood zoning and profiling exercise aims to identify and describe generalizable trends and patterns in livelihoods that can then serve as a starting point for analyzing food security and vulnerability. It is based on the method used by both FEWS NET and the Household Economy Assessment (HEA) for livelihood assessment. The livelihood zone map and profiles used in this analysis was compiled largely on the basis of existing secondary data held by various*

## 2.2. Dynamic Data Analysis

The dynamic analysis is to evaluate the temporal relationship between historic and current climate and food security, and to further evaluate the correlations between climate and food production trends at national and sub-national scale. Most assessments of climate impacts on food security focus on production—the aim of this analysis is to analyze potential impacts on other food security indicators.

## 3. A RESILIENCE PROFILE

Resilience refers to the capacity of livelihood groups, households, communities and individuals to manage stressors and shocks with no long-lasting adverse effects on development. This analysis takes into account four important factors that contribute to resilience outcomes from a livelihoods perspective:

The four year average (2010 – 2013) food insecurity and current food security status of different livelihood groups are used to provide indication of the current vulnerabilities to future food insecurity in the event of a shock. For instance, livelihood groups that have been chronically food insecure for this period are exposed to high levels of poverty and in the face of regular shocks, their resilience capacity is reduced drastically.

Risk exposure to shocks reduces resilience among the vulnerable households. Livelihood groups that depend on climate sensitive activity may be unable to meet their livelihood needs when a significant climatic shock (such as bad season exacerbated by floods or dry spells) impacts their primary activity.

Conversely, livelihood groups that have a wide range of activities to fall back to can withstand the impact of certain climatic shocks. Poor households increase their reliance on fish, wild foods and, to some extent, labour, and petty trade to withstand the impact of drought. Some households have increased sales of honey, shea butter and cassava that increase their access to cash income, supplement income from labour, and increase resilience following drought years.

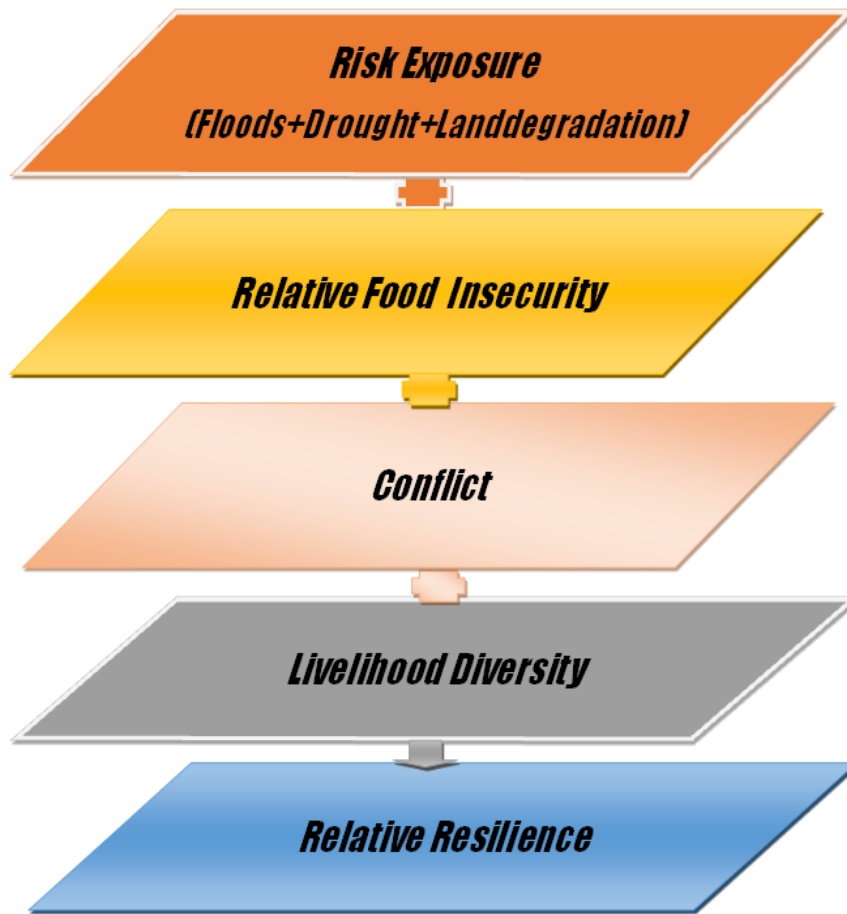
Conflict is the most damaging hazard for livelihoods and basic food security. Its attendant consequences have continually undermined access to markets and migration, and denied households the opportunity to effectively address structural seasonal food deficits.

It is upon use of these indicators that this analysis is able to identify livelihood-based resilience patterns that can help inform programmatic interventions.

## 4. RISK EXPOSURE

South Sudan is exposed to a number of climate-related hazards, including floods, droughts, land degradation, livestock diseases, crop pests among others. Extreme climate events have detrimental effects on livelihoods, for example, floods destruction of livelihood assets and destruction of agricultural land which may take several months or years to recover.

Figure 2: Conceptual framework used to develop a resilience profile

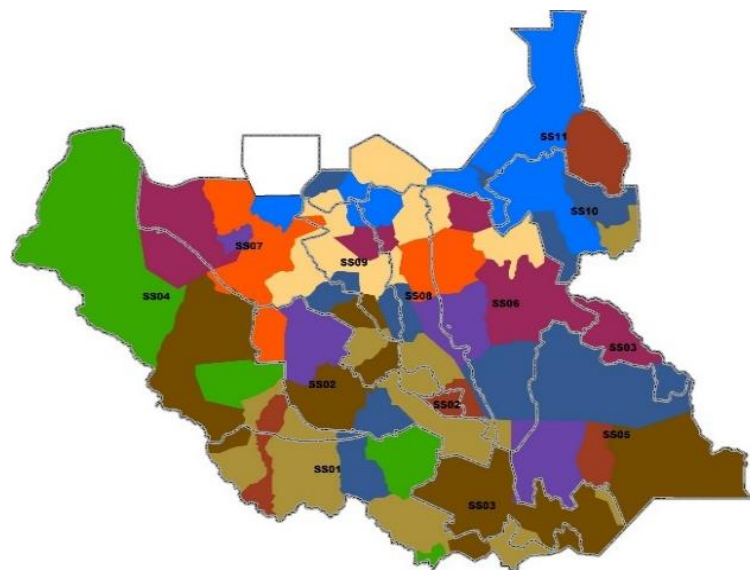












County level spatial integration of the land degradation, flood and drought is compiled using spatial analysis technique. Each of the factors considered are divided into thresholds such as high, medium and low exposure to floods, drought and land Degradation. These thresholds were thereafter combined according to the intensity or level of population exposure for each of the natural hazards. Floods have the worst devastating impact compared to other hazards and therefore given more weight in this analysis. In **figure 3**, the flood frequencies are categorized as 7 – 9 (low); 10 – 13 (medium) and 14 – 17 (high) in this analysis. These are the number of times some parts of the country had been exposed in the last two decades.

Ten category levels of exposure are identified for the three common natural hazards. **Figure 3** shows the spatial disaggregation of these hazards into the livelihood zones and Counties together with approximate number of people affected (**Table 2**). The most exposed livelihood zones to the three hazards is SS05 located in the semi-arid area, where dry spells occur more frequently. SS08 is highly exposed to flooding and land degradation. The least exposed livelihoods are SS04, SS02 and SS03 where households depend exclusively on crops and livestock and the poorest live off wage labour. The rich agro-ecological zones located in the western and southwestern parts of the country are generally exposed low floods, low drought with medium land degradation.



**Figure 3. Category of climate risks exposure**



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



**Photo 1: Impacts of floods**

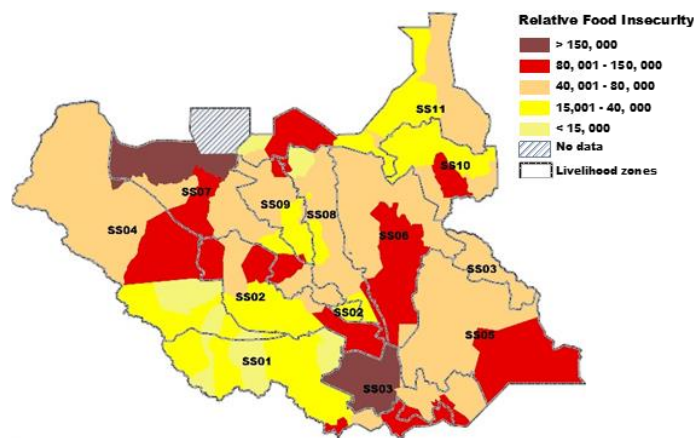


Multiple and frequent hazards combined with low household resilience, a heavy reliance on markets for food and difficulty with market access expose inhabitants in livelihood zone SS09 to a high risk of food insecurity. SS05 is a semi-arid livestock rearing area, with limited crop

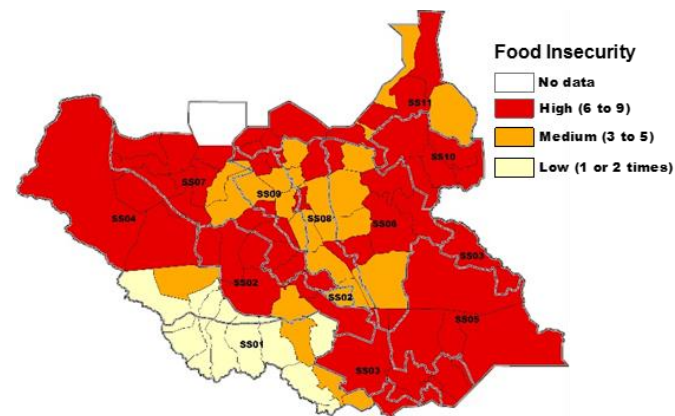
production. This zone is prone to prolonged drought, livestock losses from diseases and raiding, resource and political conflict. Conflict, livestock diseases and drought reduce impacts on livestock production and chiefly affect the poor who are least resilient.

## 5. FOOD SECURITY

**Figure 4a. Food insecure population in South Sudan (2010 – 2013 FSMS average)**



**Figure 4b: Recurrence of moderate-severe Food Insecurity by County (prevalence > 30%), from 2010 to 2013**



This analysis identifies areas where the level of food insecurity has been consistently high in the last three years versus areas where the prevalence of food insecurity has been consistently low. Based on the FSMS 2013 population projections<sup>1</sup>, more than 150, 000 people in parts of livelihood zones SS07 and SS03 are food insecure (**Figure 4a**).

On average, five zones are considered as highly food insecure: Agro-pastoralists (SS04); pastoralists (SS05); highland forest and sorghum farmers (SS03); northern maize and cattle farmers (SS10); greater Bahr el Ghazal sorghum and cattle farming communities (SS07). Poor households in some of these zones tend to experience lean season food insecurity and some resort to wild food gathering.

In SS01 and SS02, seasonal food insecurity is driven by prolonged dry spells and limited own production of food together with crops and livestock diseases. The risk of food insecurity is greatest in those areas in which there is a high risk of production failure, the poorest households have limited opportunities to obtain income and the greatest difficulties in accessing markets.

Livelihoods in SS11 depend mainly on sorghum production and rearing goats. Rainfall in the area is among the lowest and most unreliable within the country and frequent drought and crop failure, cattle raiding, political instability and insecurity, and changes in market conditions

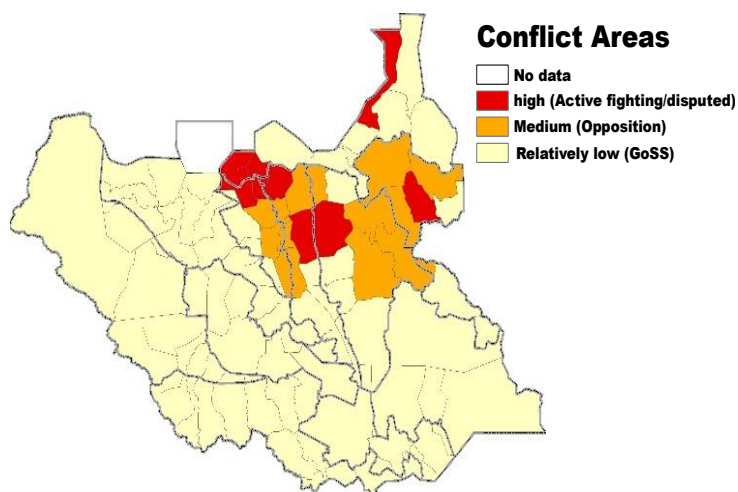
<sup>1</sup> South Sudan National Bureau of Statistics (NBS). The NBS applied a population growth rate of 2.052% to the 2008 census figures to project population figures for 2013. These figures have been adopted the UN County Team (UNCT)

due to its location along the border with Sudan, expose inhabitants to food insecurity. Livelihood zone SS08 is predominantly agro-pastoral farming and fishing zone. It is the least food insecure area among the five main zones. It is, however, prone to flooding that results in limited access to wild foods, crop destruction, particularly the short-term variety of sorghum which is known for its low resistance to flood water, and increases in other crop pests and livestock diseases, especially among goats and sheep.

SS07 is a predominantly agro pastoral economy occupying a flood plain. Floods exacerbate poor crop performance. Increased risk of livestock losses from disease, land degradation due to overgrazing and high levels of cattle rustling contribute to high food insecurity. There is over exploitation of the natural resources, especially fish, wild foods and bush products, communal conflicts over water and grazing, and the presence of Internally Displaced People (IDP) due to political conflicts along the border with Sudan. Rural to urban migration has also deprived households of productive labor.

## 6. CONFLICT

**Figure 5: Impacts of conflict on food insecurity (IPC 2014)**



Conflicts in South Sudan is attributed to political insurgency with isolated inter-communal and inter-ethnic clashes over cultural and dwindling resources exacerbated by climate variability and change.

Widespread communal conflicts cause human and livestock displacement and disruption of crop production activities.

The frequently conflict affected states include Jonglei, Unity and Upper Nile (**Figure 5**) making households in livelihood zones SS06, SS08, SS09, SS10 and SS11 perpetually food insecure with weak resilience. The impacts of conflicts overflow to neighbouring states causing reduced market functionality. SS05 is prone to livestock losses from diseases and raiding, resource and political conflict.

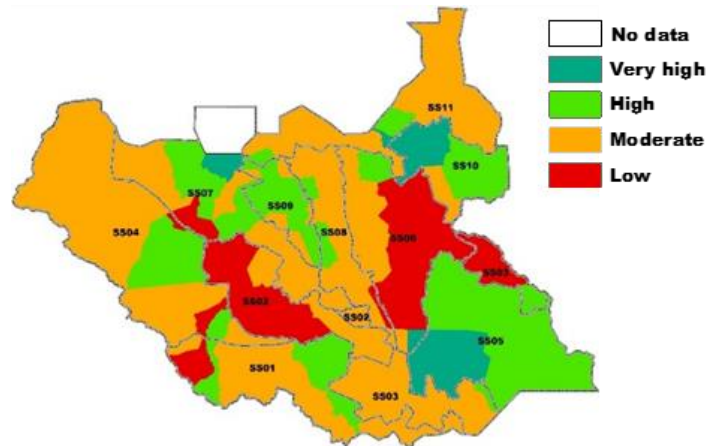
Markets and trade routes are disrupted and large portions of the population in the conflict affected states are either minimally or completely unable to undertake agricultural activities in a particular season due to displacement, violence and uncertainty. Severe challenges in protracted conflict areas include early depletion of household food stocks, dysfunctional markets, loss of livelihoods, and displacement.

The conflict states in most cases are inaccessible for the provision of humanitarian assistance resulting into weak resilience.

## 7. LIVELIHOOD DIVERSITY

Households with diversified livelihoods are likely to cope with climate risk. Livelihood zones SS02 and SS06 are relatively lowest in livelihood diversification. Livelihood in SS06 chiefly depend on livestock keeping with little agriculture.

**Figure 6: Relative Livelihood Diversification**

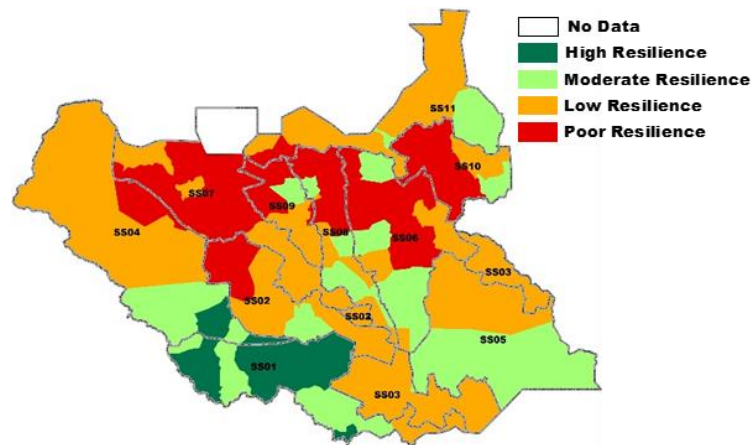


Households in the eastern semi-arid pastoral SS05 zone have relatively high levels of diversification, largely because a part from rain fed agriculture, alternative livelihood activities such as gold mining, charcoal and natural products trade are feasible. They also do gold extraction and sale of agricultural labor together with sale of local brew. Traders travel to sell maize grain and vegetables locally and in turn trade livestock to Ethiopia and Uganda.

The very high diversified livelihood are located in zones SS05 and SS07. In SS05, there is sale of natural products, i.e. charcoal, bamboo, grass, wild game, honey, shear butter nut oil etc. while in SS07 a part from livestock and crop farming, they do oil mining and fishing.

### 7.1. Overall Resilience

**Figure 7: Overall Relative Resilience**



All the indicators used i.e. conflict, floods, drought, land degradation, livelihood diversification and food insecurity are weighted based on the estimated 2013 population for the three years period. Most parts of South Sudan are between poor to low resilience considering the overall relative resilience (**Figure 7**). The most resilient livelihood groups based on this analytical approach are those in the Equatorial maize and cassava, and partly in the western groundnuts, sesame and sorghum.

Households that depend on pastoralism in the northern part of the country (zone SS06) have poor resilience as they have limited livelihood diversity and are often hit by livestock disease and cattle rustling.

Most of the poor households in the central parts of the country who depends on rain fed agriculture and related activities have poor resilience due to chronic poverty and very low diversity of livelihoods.

This is largely due to a combination of access to a diversity of income and food sources, low inter-communal and political conflicts, relative low food insecurity levels, relatively good access to markets and economic centers, and little risk exposures with manageable shocks impact. However, climate change and other socio-economic dynamics may challenge this resilience in the future as was the case in the recent weather patterns and political situation of 2013/14. Households that depend on pastoralism in the northern part of the country (zone SS06) have poor resilience as they have limited livelihood diversity and are often hit by livestock disease and cattle rustling.

Most of the poor households in the central parts of the country who depend on rain fed agriculture and related activities have poor resilience due to chronic poverty and very low diversity of livelihoods. Furthermore, since they do not have access to different livelihoods, they may be unable to manage the impacts of large-scale shocks such as floods and market access. These zones, spread over the eastern and western flood plains, and wet climatic zones, are also highly sensitive to climate variability given the high reliance of households on rain-fed agriculture.

## 8. IMPACTS OF CLIMATE



In light of a projected long-term increase in rainfall variability and the accompanying intensity and frequency of floods and droughts, as well as hazards such as animal diseases, conflicts and land degradation, water management and climate adaptation strategies are becoming ever more necessary. Developing appropriate climate adaptation efforts will also be necessary to avoid detrimental effects on livelihoods.

### 8.1. Past climate variability

The past climate of South Sudan has been characterized by high spatial and temporal variability in precipitation.

On average, most of the annual precipitation falls between May and November (**Figure 8**). This is determined by the passage of the rain belt i.e. the Inter Tropical Convergence Zone (ITCZ) between the northern and southern spheres. This determine land use patterns of cultivation, livestock grazing and fisheries.

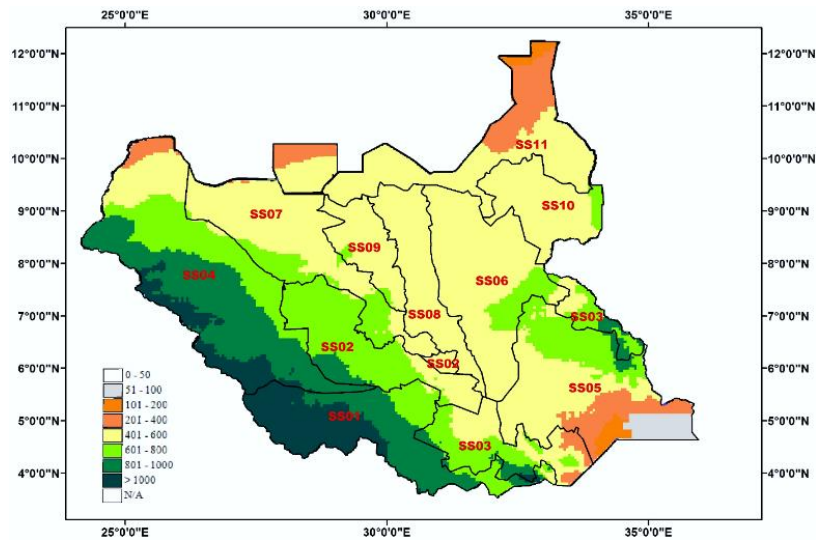
The figure highlights the semi-arid areas of the south-eastern and northern regions of South Sudan receive the least rainfall. In contrast, the area around the greenbelt of south-western region tends to receive more rainfall.

Climate risk is one of the key challenges to ensuring food and nutrition security in South Sudan. Climate variability and change disproportionately affect the poorest and most food insecure through a combination of decreasing crop production, increasing human and animal diseases, flooding, inter-communal conflicts over resources, dry spells and unpredictable weather.

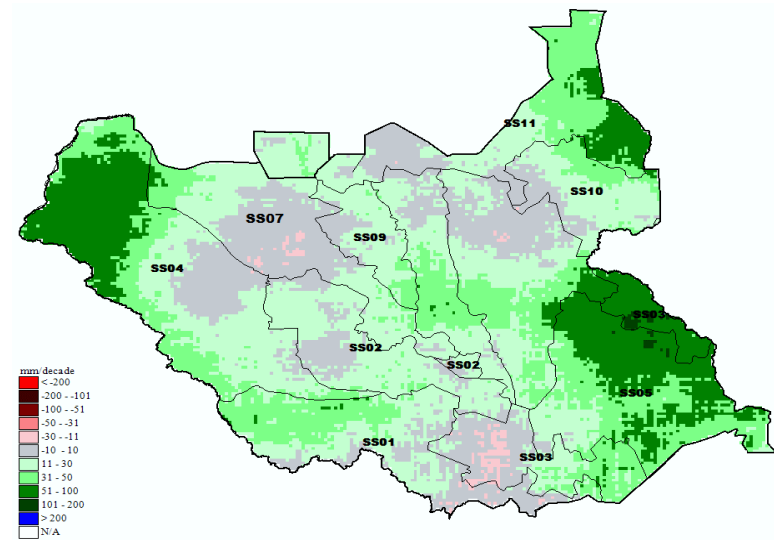
Recent events such as floods (2013, and 2014), droughts (2008, 2010 and 2011), inter-communal conflicts, civil war (2013/2014) and cattle rustling, combined with increasingly erratic weather all highlight the sensitivity of livelihoods to climate related risks.

Rainfall is the key climatic variable influencing food security in South Sudan. Reliable rainfall is needed

**Figure 8: Distribution of key livelihood systems overlaid with rainfall climatology (Base period 1971 to 2000)**



**Figure 9: Rainfall trend overlaid with livelihood zones (grey areas are decreasing in trend while green areas increasing trend)**



**Figure 9** gives spatial rainfall trends analysis over the 11 livelihood zones for the period 1961 to 2013. Climate change analysis manifested itself in a noticeable decreasing trend in livelihood zones SS03, SS06 and SS07. It is ironical that the rainfall trend in the rich agricultural green belt is slightly decreasing while increasing in the semi-arid. It should be noted, however, that in a semi-arid area, an increase of 1mm of rainfall would still exaggerate the trend upwards.

Rainfall decrease in the central parts of the country is remarkable yet it supports crop farming. Combined with observed increases in temperature, this trend can significantly reduce water availability for agriculture and therefore reduce the suitability of certain areas for crop production.

There is also evidence of frequent increasingly high rainfall leading to flooding in some agriculturally productive areas in the country. Some traditionally dry areas are getting drier noticeably in the south-eastern and northern semi-arid areas.

## 8.2. Rainfall Trends

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 (**Figure 9**). The seasonal rainfall causes seasonal flooding of the floodplains. The driest part of the country includes the semi-arid areas of the south-eastern region, coinciding with the highest food insecurity levels (**Figure 4b**).

A trend of decreasing annual rainfall is contributing to drought conditions in many parts of South Sudan. This is evident from the coefficient of variability of rainfall that shows an overall increasing trend, suggesting greater rainfall unreliability.

## 8.3. Seasonal variability

Rainfall patterns in South Sudan vary in seasonality, duration, and regularity both in latitude and longitude. **Figure 10** shows that on average, the seasonal rainfall starts in April/May and ends in October/November. The long rains occur between May to November across most of the country except in the south-eastern parts of the country which has bimodal rains.

The variability in rainfall is high in the semi-arid northern and eastern parts of the country. Changes in climatic patterns, both long-term and seasonal, have a detrimental effect on livelihoods that depend on climate-sensitive income, such as seasonal or daily agricultural labour, sale of rain fed crops, and fishing.

Most of the country has a semi-humid climate, with annual rainfall ranging from 200 mm in the southeast (Eastern Equatoria) to 2200 mm in the forest zone in Western Equatoria and the Equatoria highlands. Western Equatoria and the highland parts of Eastern Equatoria receives 1,200-2,200 mm of rainfall annually. The lowland areas of Eastern Equatoria, Jonglei, Upper Nile and Bahr el Ghazal receive between 700 and 1,300 mm of rainfall per year. The southeastern tip of Eastern Equatoria receives the least annual rainfall at about 200 mm (**Figure 11**).

Most of the annual precipitation falls between May and November. This is determined by the passage of the rain belt, Inter Tropical Convergence Zone (ITCZ) between the northern and southern spheres.

The seasonal climate patterns cause cyclic relations in the ecosystem and hence determine land use patterns of cultivation, livestock grazing and fisheries. Annual mean precipitation decreases from south-west/west to eastern/north-eastern, from about 1000 to 200 mm/year (**Figure 11**).

Figure 10: Mean annual rainfall cycle for El Renk, Malakal, Juba, Raga and Wau. The 2013 actual rainfall is shown in grey bars, and the mean annual cycle (1971-2000) is shown in the blue line.

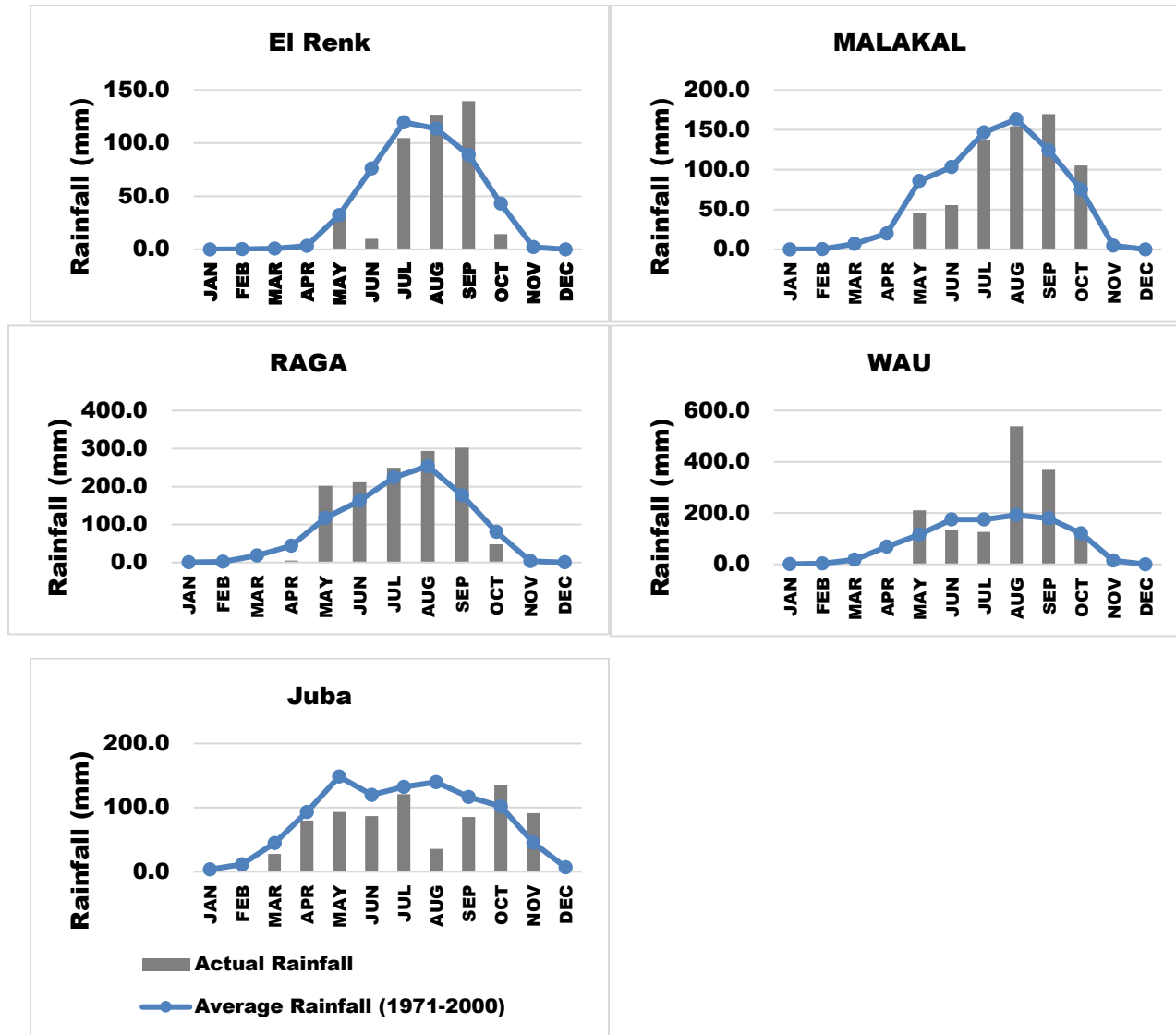




Figure 11: Spatial aggregation of monthly rainfall (Data from TAMSAT)

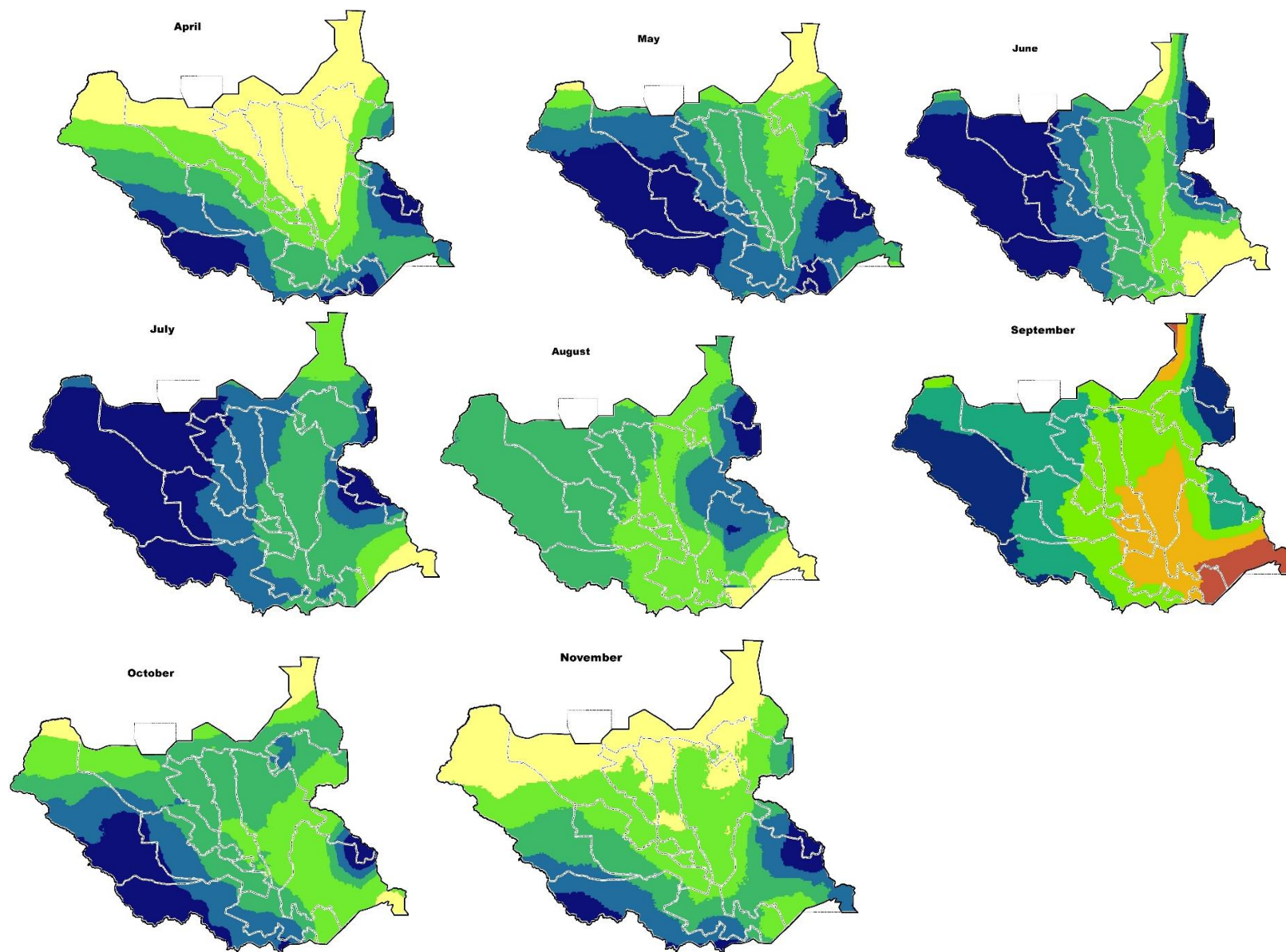
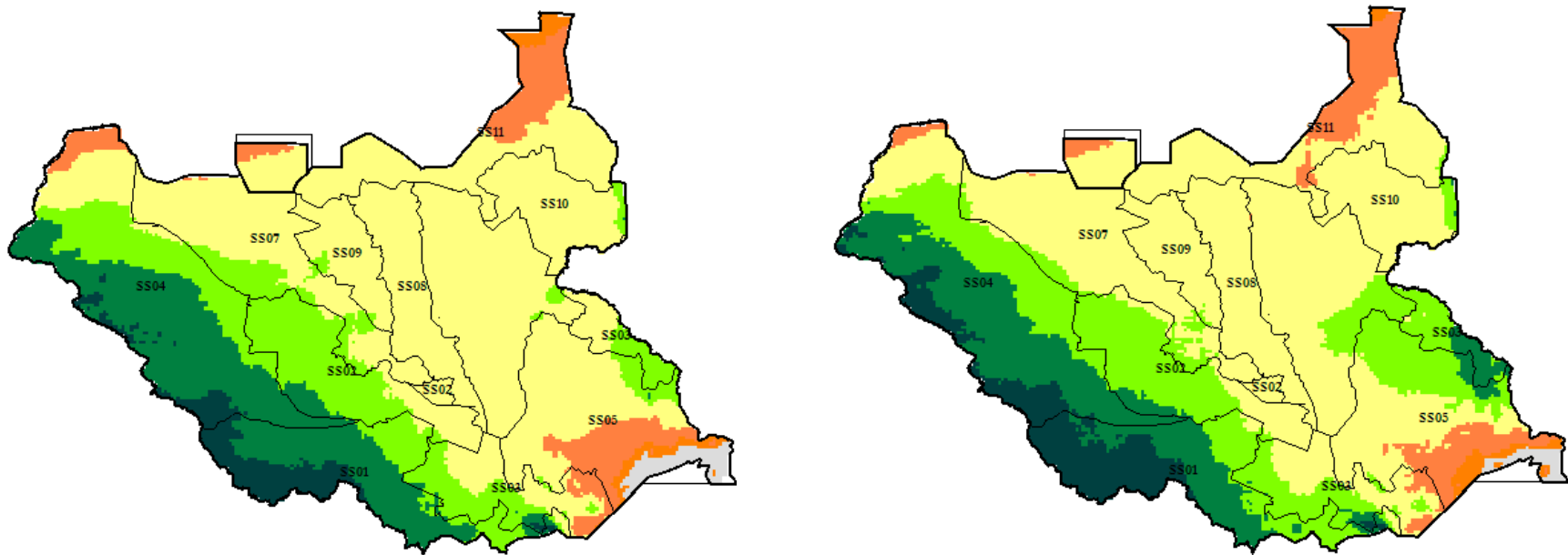


Figure 12: Mean annual rainfall from 1981-2001 (left) and 2003-2013 (right)



Mean annual rainfall from 1981-2001 (left) and 2003-2013 (right) shows a gradual westward increase, particularly in the agro-ecological zones 03 and 05. The agro-ecological zones within the forest zone in Western Equatoria and the Equatoria highlands also show some spatial increase in wet areas. This trend can have a positive effect on rain-fed cropping systems in the country.

Climate variability over the past 20 years has manifested itself in a noticeable increasing trend in rainfall across most of the greenbelt area. Mean annual rainfall has increased by 9% of the annual total (108 mm) compared to the period 1982-2002 in the eastern sector covering zone 03 and some parts of zone 05.

As livelihoods in these zones depend solely on seasonal rains, the increased amount could be positive to farming but could as well promote increased animal and crop diseases as well as flooding areas. Late seasonal rainfall onset, distribution in space and time, erratic patterns are some of the concerns different farmers have noted to impact on their livelihood activities.

A reduction in rainfall in combination with increasing temperatures could result in more intense or longer dry spells, as well as consecutive droughts as seen in the semi-arid agro-ecological zones.

#### 8.4. Rainfall and Crop Production Relationship

Quantifying the relationship between cereal yields and climate is challenging. Given the importance of non-climatic variables including, among others, sub-national differences in farm inputs such as choice of fertilizers, irrigation techniques and seeds, as well as economic changes influencing agricultural management techniques are also very important.

The impact of seasonal rainfall on the estimate for the weighted average yield of cereals in each state is built up from disaggregated data compiled at county level (WFP-FAO 2014). Estimates of 2009 - 2013 cereal production in the traditional sector, disaggregated by states and counties, are presented in **Annex 1**. For this analysis, focus is given to state-level trends.

Using first-differences time series for rainfall and cereals production (i.e. the difference in values from one year to the next), the relationship between climate and crop production is evaluated (**Figure 13**).

The analysis shows that wetter years are associated with higher crop production although too much rainfall could lead to flood events and consequently to lower crop production or destruction (**Photograph 1**).

The correlation between mean seasonal precipitation and crop production in the period 2009-2013 is 0.73 to 0.97 – this suggests that the relationship between rainfall and crop production has been larger during the last five years compared to the long-term mean. Other factors that affect yields within a season, such as seed supply, cultivation and weeding (timing and methods), use of inputs, pest and disease challenges, local security conditions and access to credit for mechanized farming are not considered yet they play major role in any crop production.

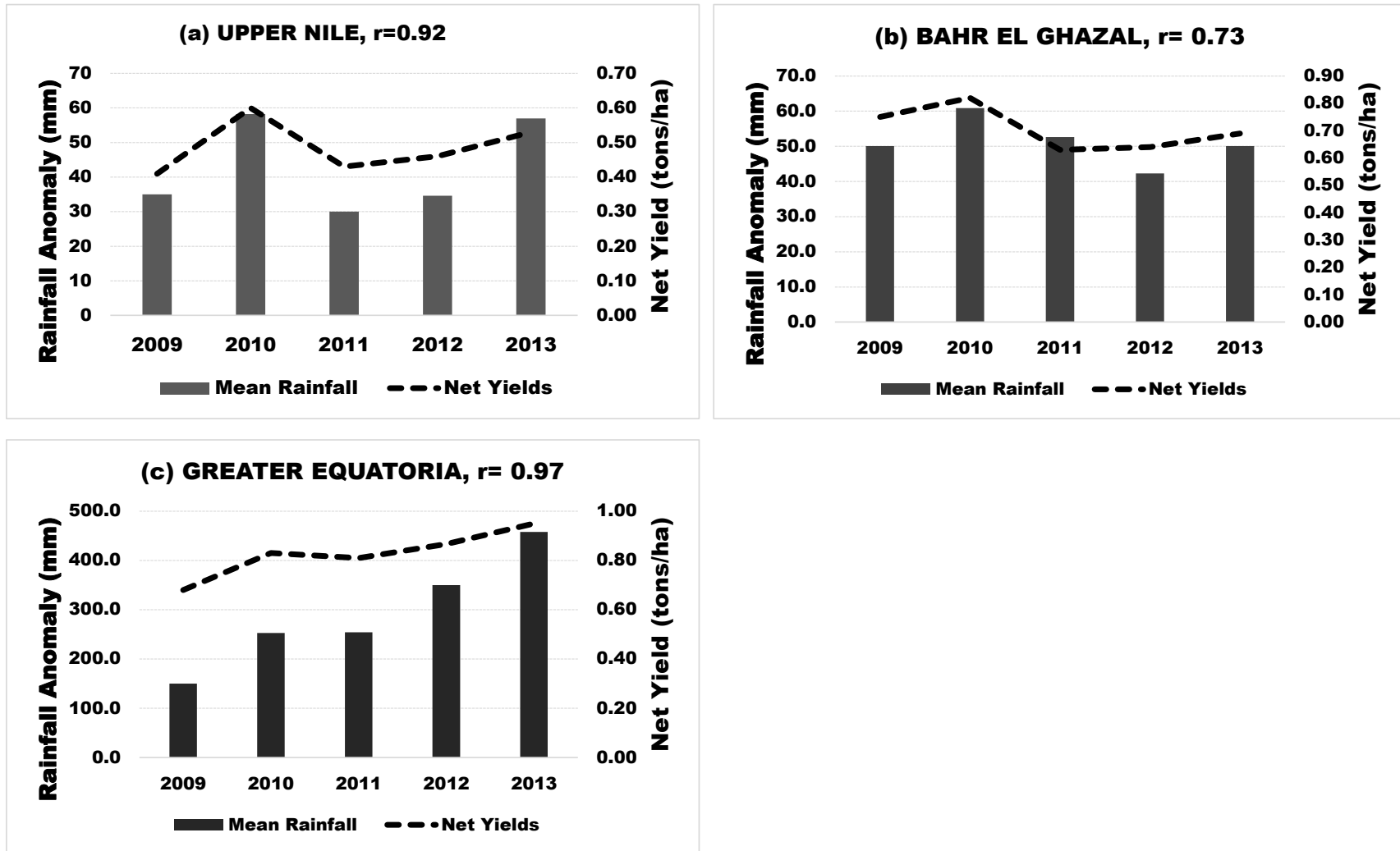
#### 8.5. Climate impacts on livelihoods

Livelihoods in South Sudan are complex due to the varied differences in topography, rainfall patterns, conflicts, displacements and population density. Despite the complexity of livelihood systems in the country, it is possible to understand risks and vulnerabilities by focusing on three main livelihood zone types: cropping (mostly located in the northern and western parts of the country), pastoral (mostly located in the eastern and southeastern parts of the country), and agro-pastoral (mostly located at the margin between the two) (**Figure 8**).

The hot, dry conditions trigger human and livestock migrations to more permanent water sources, which serve as dry season grazing and fishing areas. The general onset of the main rains in most areas over South Sudan is in April/May. Most people and their animals return to upland in wet season when cultivation begins in the agricultural season. Seasonal movements are less pronounced in the more agricultural zones, such as the Hills and Mountains Zone, and almost non-existent in the exclusively agricultural Greenbelt Zone. The Hills and Mountains zones have two rainy and cropping seasons in April-July and August-December.

**Figure 14** depicts relationship between cereal harvested net production in the traditional sector of Upper Nile, greater Equatoria and Bahr el Ghazal regions against mean seasonal rainfall for the period 2009-2013. The analysis show close correction between net production and seasonal rainfall. It is observed that the 2010/2011 drought that ravaged nearly all the GHA region resulted into low cereal production in all the rich agricultural areas.

Figure 13: Relationship between precipitation and crop yield first differences



## 8.6. Future climate

According to the latest IPCC report<sup>2</sup>, Climate change will interact with non-climate drivers and stressors to exacerbate vulnerability of agricultural systems, particularly in the semi-arid areas.

Key Highlights from IPCC 2014 for the horn of Africa sub-region: -

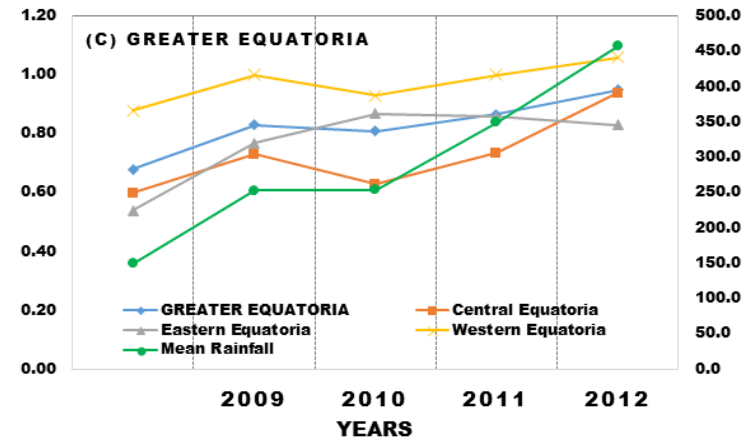
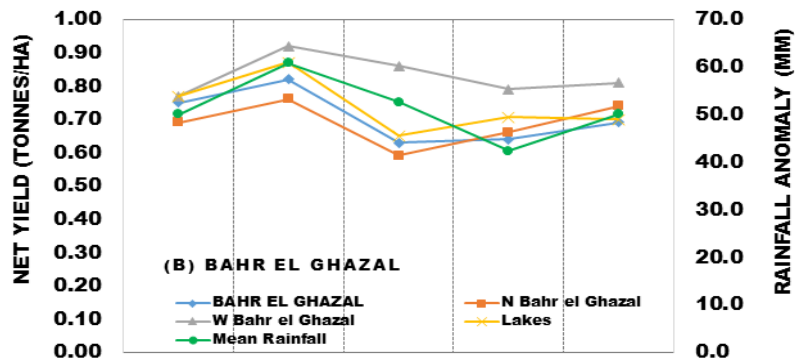
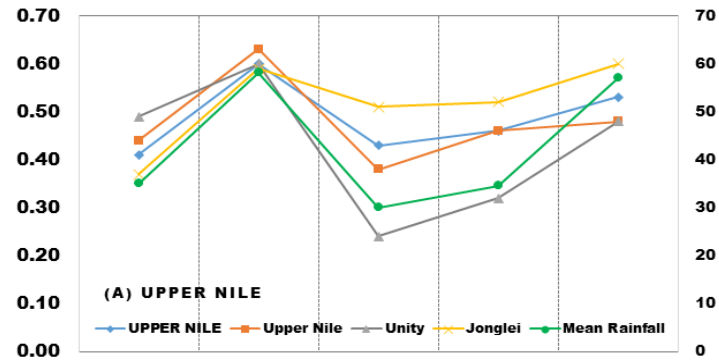
- Increasing temperatures and changes in precipitation are very likely to reduce cereal crop productivity with strong adverse effects on food security.
- Pest, weed, and disease pressure on crops and livestock is expected to increase as a result of climate change combined with other factors.
- Regional climate model studies suggest drying over most parts of Uganda, Kenya, and South Sudan in August and September by the end of the 21st century as a result of a weakening Somali jet and Indian monsoon (Patricola and Cook, 2011).
- Suitable agro-climatic zones for growing economically important perennial crops are estimated to significantly diminish, largely as a result of the effects of rising temperatures.
- Under an A2 scenario, by mid-century suitable agro-climatic zones that are currently classified as very good to good for perennial crops may become more marginal, and what are currently marginally suitable zones may become unsuitable; the constriction of crop suitability could be severe in some cases
- Multiple stressors faced by livestock systems in South Sudan (land degradation; increased variability in access to water; fragmentation of grazing areas; in-migration of non-pastoralists into grazing areas; lack of opportunities to diversify livelihoods; conflict and political crisis; weak social safety nets; and markets, and other resources) will interact with climate change and variability to amplify the vulnerability of livestock keeping communities (Dougill et al., 2010).
- Climate change impacts on fisheries can be linked to exposure to the physical effects of climate change and two-thirds of the most vulnerable countries are in Africa. The annual landed value of fish is estimated to decline by 21% in the region.
- Recent spike in global food prices can be attributed to a convergence of several factors, the intensification of climate change impacts could become more important in the future in terms of exerting upward pressure on food prices of basic cereals (Hertel et al., 2010), which would have serious implications for Africa's food security.

Rainfall is already highly erratic, shifts in the timing and amount thus it is likely to become more so in the future, particularly during the long rainy season. At present, erratic rainfall patterns have a more direct effect on livelihoods in many of the agro-ecological zones particularly rain-fed small scale farmers. A continuation of this trend in the next few decades would render rain-fed agriculture unsustainable.

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<sup>2</sup> IPCC 2014

Figure 14: Cereal harvested net production and mean seasonal rainfall in the traditional sector (2009-2013)



**Photograph 2: Flooded Jonglei's swampy areas**



**Photograph 3: Sorghum crop**



Decreasing rainfall trend in combination with increasing temperatures could result in more intense or longer dry spells, as well as consecutive droughts. The impact on food security would be significant, as a large proportion of the crops produced and consumed in the country originates from rain sensitive areas and production could be limited with insufficient rains.

Long-term climatic shifts in the major agro-ecological zones could have an impact on the suitability of agricultural production in those areas. Notable concern is the reduction in rainfall in semi-arid areas which may result in shrinking of the productive agricultural zones. A continuation of this trend would especially affect households' livelihood zones SS01, SS03, SS06, SS08 and SS07 (**Figure 12**). Rain fed agriculture may no longer be feasible under erratic rainfall patterns.

## 9. LIVELIHOOD ZONE PROFILES

National Livelihood Zone Map shows the division of southern Sudan into relatively homogeneous zones, defined according to a livelihood framework (FEWSNET 2013). The main function of a Livelihood Zone Map is to provide geographic disaggregation for food security monitoring, analysis and decision support. On the other hand Livelihood Zone Profile describes the major characteristics of each zone, including a brief differentiation of different wealth groups. The major hazards and the relative capacity of different types of households in different places to withstand these hazards are also identified.

The highly diverse livelihood zones in South Sudan are categorized into eleven and households within a zone may engage in a variety of activities depending on their access to resources. These are comprised of various combinations of agricultural types, and animal husbandry and pastoralism/agro-pastoralism. Driving factors for production are linked to the rainy seasons be it for agricultural production or pasturelands and these will vary throughout the year depending on geographical location.

Understanding the different livelihood characteristics provides useful information to better identify food security and resilience patterns and inform programmes to support the most vulnerable populations. The negative consequences on food security and livelihoods of these long-term climate projections are discussed in the next section.

### SS01: Equatorial and maize cassava



#### Overview

#### Risk Exposure level

■ Moderate

#### Food Insecurity level

■ Low

#### Conflict

■ Low

#### Livelihood diversity

■ Moderate

#### 9.1. Resilience Profile

This livelihood zone is considered to have high resilience due to moderate exposure to hazards and low food insecurity level. Although most household's income is highly climate-sensitive, seasonal rains rarely fail in this greenbelt zone.

Poorer households subsist from their own crop and livestock production supplemented by food obtained from hunting and fishing and wild foods, and food purchased with income from agricultural and casual labor.

The better off are largely self-sufficient in food with saleable surpluses in years of good rainfall and do not purchase staples from the market.

#### Risk exposure

The main hazards are prolonged dry spells, crop pest, livestock diseases and localized seasonal floods and because of poor market access a limited ability to compensate for this by trade. Generally the zone is low in exposure to floods with low to medium drought and land degradation.



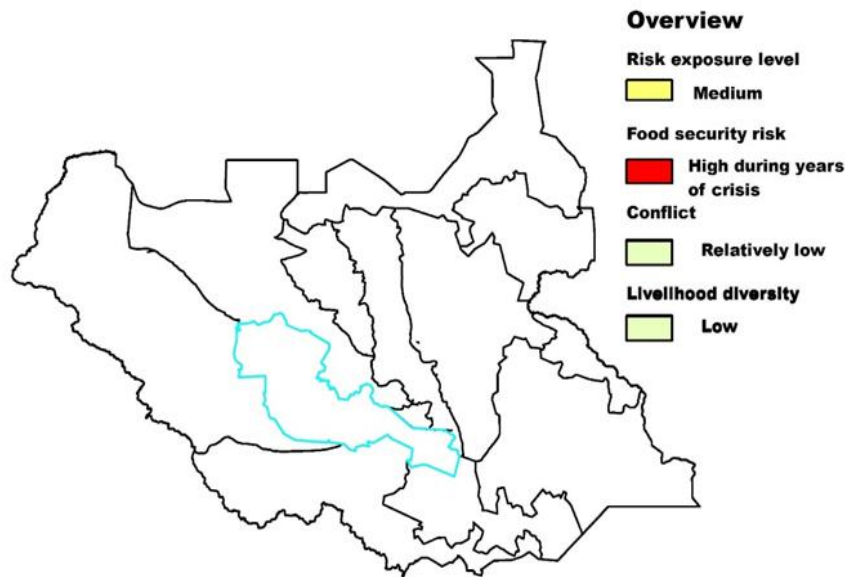
## Markets

The main sources of cash income during the lean season are sale of natural products, agricultural and non-farm labor employment such as construction. Most cash income is used to purchase staple foods. Vital trade links with neighboring countries of Uganda, Central Africa Republic (CRA) and Democratic Republic of Congo (DRC) provide the much needed strategic access to external markets outside the zone. The main constraints to market access include long distances, poor road conditions, seasonal flooding and insecurity.

### Future Climate Change Impacts on Wealth Group in Zone 01

	Livelihood activities	Income sources	Food sources	Climate change impacts
Poor households	Subsist from their own crop and livestock production supplemented by food obtained from hunting and fishing and wild foods, and food purchased with income from agricultural and casual labor.	Crop sales constitute the main source of income among poor In addition to staple crop sales, sale of labor, poultry, honey and fruit (including mangoes, oranges, pineapples and lemons) provide additional sources of income	Maize, Sorghum, Groundnuts, Soya beans, Cassava and sweet potatoes, Vegetables, Wild foods	Reduction in rainfall in combination with increasing temperatures could result in more intense or longer dry spells, as well as consecutive droughts, thereby impacting on rain-fed agriculture.  Reliance on rain-fed agriculture may no longer be feasible under erratic rainfall patterns. The impact on food security would be significant, as a large proportion of the crops produced may be limited if there is insufficient rainfall.
Better off households	Largely self-sufficient in food with saleable surpluses in years of good rainfall and do not purchase staples from the market.	Crop sales constitute the main source of income among better-off group.	Maize, Sorghum, Groundnuts, Soya beans, Cassava and sweet potatoes, Rice, Vegetables	

## SS02: Ironstone Plateau agro-pastoral



### Resilience Profile

Low resilience livelihood zone since income and food sources are highly rainfall dependent yet in the recent past, rainfall and production have been relatively poor.

Poorer households subsist from their own crop and livestock production with other income sources from agricultural and casual labor.

The better-off group have saleable surplus (sorghum, millet and vegetables). The livelihood diversity is very low and when dry spell is prolonged, the poor household's resilience is greatly undermined.

### Profile

Livelihoods in this zone depend chiefly on crop cultivation with livestock production being of lesser importance. Cultivation occurs on the plateau in the wet season with movement of livestock in the dry season to the wetter areas. Shea butternut, mahogany and bamboo are the main source of natural products available.

The most important food crops are sorghum, millet, cow peas, green gram, groundnut, sweet potatoes, and vegetables such as okra. Maize, cassava and other crops such as pumpkins are grown on a small scale in specific areas. Cattle, goats, and a few sheep are the main livestock reared in this zone. Some poultry is also kept, but in very small numbers, for household consumption. Seasonal livestock movement into the lowlands in search of pasture and water is during the dry season, returning to the highlands when the rain season starts.

### Risk exposure

Generally this livelihood zone is low in exposure to floods (between September and October) but high to drought on average low to medium drought and land degradation. Drought conditions normally occur after every twelve years. Crop pest and diseases occur on annual basis during the rainy season. Livestock diseases occur on annual basis in both the dry and rainy/wet seasons. The livestock sector, especially cattle has been severely undermined by tsetse fly infestations and trypanosomiasis. Inter communal conflicts and cattle raiding occur on annual basis during dry season.

## Markets

Household incomes especially from the sale of surplus crops and natural products are heavily dependent on access to external markets. Improvements in the road network since the comprehensive peace agreement, particularly to Rumbek, Juba and Uganda high way have made it possible for people to travel long distances to the regional markets such as Uganda to purchase grain.

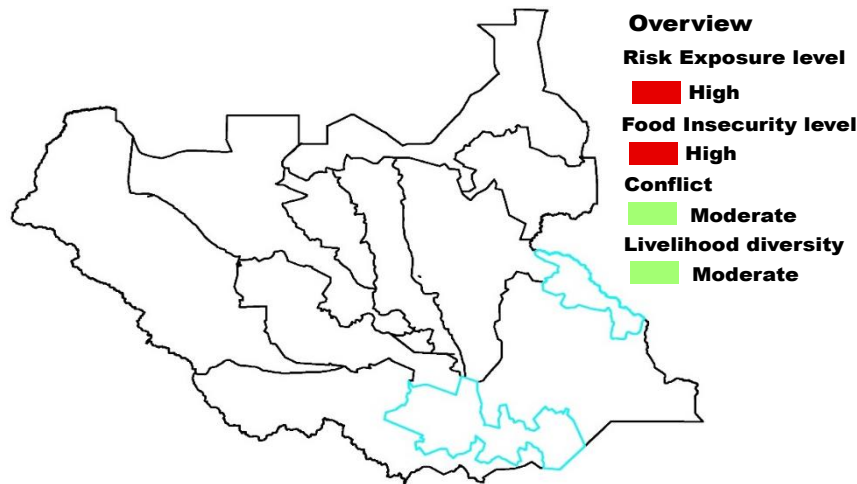
Bordered by the surplus crop-producing Greenbelt Zone to the south, the Ironstone Plateau depends on exchange relations with its more agriculturally suited neighbour.

Large amounts of commercially viable shea butter oil, fruit and honey production occur in this zone, and sale of these products constitutes an important component of cash income. Household incomes especially from the sale of surplus crops and natural products are heavily dependent on access to external markets.

### Future Climate Change Impacts on Wealth Group in Zone 02

	Livelihood activities	Income sources	Food sources	Climate change impacts
Poor households	Livelihoods in this zone depend chiefly on crop cultivation (by hand) and livestock production to a lesser extent. Shea butternut, mahogany and bamboo are the main source of natural products available.	Obtain most of their income from the sale of natural products (fire wood, charcoal, grass, mats, poles, shea butternut oil) and from agricultural and casual labor within and outside the zone.	Sorghum, Millet, Maize, Groundnut, Sesame, vegetables, Cassava, Sweet potatoes, Dried fish, Wild foods	Increased movement in search of browse and water for livestock exacerbating inter-communal conflicts over limited resources.  Increasing temperatures and decline in precipitation are very likely to reduce cereal crop productivity with strong adverse effects on food security.
Better off households	Livelihoods depend chiefly on cultivation (by use of animal traction) with livestock production being of lesser importance.	Sale of sorghum, millet, vegetables, tobacco, cattle, honey	Sorghum, Millet, Maize, Groundnut, Sesame, vegetables, Cassava, Sweet potatoes, Dried fish, Wild foods	

### SS03: Highland forest and sorghum



#### Resilience Profile

This livelihood zone is low in resilience due to over reliance on rain fed crop farming and sedentary cultivation with less reliance on livestock.

Due to favorable climatic conditions, this zone usually has good harvest, but lacks access to local markets but have good trade linkages with neighboring zones.

#### Risk exposure

The main areas of this livelihood zone is categorized as under medium exposure to floods and land degradation but high in drought. The common hazards include dry spells, mudslides and floods causing crop failure. There is no seasonal livestock movement in this highland zone leading to minimal animal diseases, however, livestock-keeping households face continuous conflicts over cattle and associated resources. Conflict and insecurity can occur at any time of the year.

#### Markets

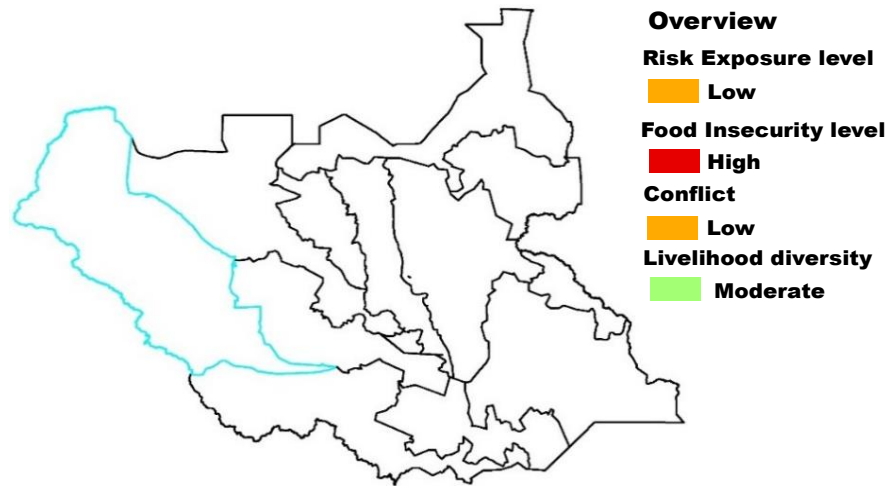
The main markets for the sale of local products, including labor are in the eastern part of the country; people in the central parts of the zone can access the main regional markets at Juba and Torit. In the eastern part of the zone there is some trade with Ethiopia. The long distant trade with Ethiopia expands during the dry season.

Household incomes are constrained by a lack of roads, hilly and mountainous terrain and poor road conditions, which limits access to markets.

### Future Climate Change Impacts on Wealth Group in Zone 03

	Livelihood activities	Income sources	Food sources	Climate change impacts
Poor households	Complementary sources of livelihood include hunting and seasonal fishing	Mainly depends on cash income from labor and natural products such as charcoal and bamboo. Relies mainly on market purchases	Maize, mainly in the eastern parts of the zone, short and long-term varieties of sorghum, millet, sesame, cow peas/green grass. Other crops grown on a smaller scale include sweet potatoes and cassava and groundnut. The livestock kept are mainly goats, a few sheep and poultry	<p>The most direct effect of increased temperature would there be on cereals production.</p> <p>Maize and sorghum will not thrive under these conditions and new varieties need to be developed.</p> <p>This would result into increased conflicts over natural resources exacerbated by climate change.</p>
Better off households	Maize farming, sorghum and millet farming	Chief source of income is from the sale of Maize, followed by sorghum and millet, wild foods and dry fish. Some income is also obtained from retail sales and the sale of timber outside the zone.	The livestock kept are relatively few cattle. Wild food plants including roots, fruits, berries and leafy vegetables	

## SS04: Western groundnuts, sesame and sorghum



### Resilience Profile

The resilience in this livelihood zone is classified as moderate. Although this zone is regarded a food sufficient area, the reliance on rain fed crop production, the low level of income diversification and restricted access to reliable markets means that there is a risk of food insecurity in years of low production. Highly productive crop farming zone, with less risk to food insecurity.

### Risk exposure

The main areas of this livelihood zone is categorized as under low exposure to floods drought and land degradation. However, some portions are exposed to medium drought and high land degradation. Crop pests and diseases are also common.

### Markets

Access to markets is seasonal and limited by poor roads and insecurity. Access to markets is on foot or by bicycle. Surplus food and cash crops produced in the zone are sold in permanent rural markets.

## Future Climate Change Impacts on Wealth Group in Zone 04

	Livelihood activities	Income sources	Food sources	Climate change impacts
<b>Poor households</b>	crop production, livestock keeping (milk and meat) and seasonal fishing	Cash crops include sesame, tobacco and groundnuts Depend on agricultural labor, natural products such as charcoal, thatching grass, wild honey and shea butternuts for income	Depend on the purchase of staples for part of the year and practice hunting with some in-kind payment of labor to maximize access to food. Own crop production Sorghum, cassava, and groundnuts together with fishing	Increasing temperatures and changes in precipitation are very likely to reduce cereal crop productivity with strong adverse effects on food security.  Rainfall is already highly erratic and likely to become more so in the future. At present, erratic rainfall patterns have a more direct effect on livelihoods.
<b>Better off households</b>	crop production, livestock keeping (milk and meat)	Sales of crops production and livestock products (milk and meat) and fish. sale of high value natural products including timber and bamboo	Sorghum, cassava, groundnut, cow peas, sweet potatoes and vegetables.	A continuation of this trend in the next few decades would render survival on rain-fed agriculture and food sources such as sorghum, cassava, and groundnuts in this livelihood unsustainable.

## SS05: Eastern Semi-Arid Pastoral



### Resilience Profile

The resilience in this livelihood zone is low. Income is highly climate-sensitive with many poorer households unable to secure steady income due to periodic conflicts with other pastoral groups in seasonal movements in search of water and pasture. Cattle raiding and poor relations with neighbour zones, civil insecurity and the unreliability of markets contribute to the low resilience.

### Profile

Households are mostly nomadic pastoralists who depend on livestock for grain exchange, livestock products and wild foods. The poor group produces approximately two months of their staple foods from their own crop production, the better-off group slightly more and all households depend for food on market purchases of staple foods, supplemented by milk, meat and animal blood especially during the rainy season.

The main food crops produced are sorghum and on a small scale okra and other vegetables. The livestock kept include cattle, camels, goats, and sheep and to a lesser extent poultry, mainly for household consumption. In the dry season the inhabitants normally move in search of water and pasture into Ethiopia and Kenya.

The poor group produces approximately two months of their staple foods from their own crop production, the better-off group slightly more and all households depend for food on market purchases of staple foods, supplemented by milk, meat and animal blood especially during the rainy season.

### Risk exposure

The livelihood zone is categorized as under high exposure to drought, low exposure to floods but low exposure to floods but moderate land degradation. High food security risk area, due to semi-arid conditions, livestock diseases and periodic conflicts with other pastoral groups. Inter communal conflict and cattle raiding mainly during dry seasons, floods and livestock diseases. Inter communal conflict and cattle raiding occur mainly during dry season and livestock diseases are endemic across the zone.



## Markets

Trade is conducted chiefly at the local market although access is limited due to poor road conditions both within and outside the zone, cattle raiding and poor relations with neighbour zones, civil insecurity and the unreliability of markets. External traders also travel to sell maize grain and vegetables locally and in turn trade livestock to Ethiopia and Uganda. Households also exchange livestock for grain and other household items with Murle cultivators in zone 3 (Highland Forest and Sorghum) with whom they have strong economic links.

### Future Climate Change Impacts on Wealth Group in Zone 05

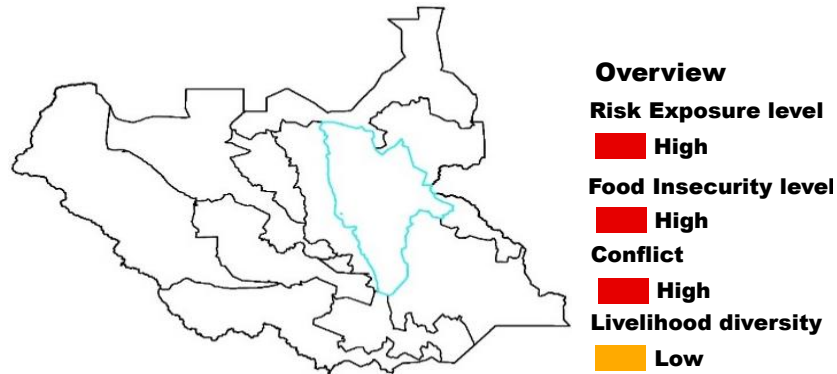
	<b>Livelihood activities</b>	<b>Income sources</b>	<b>Food sources</b>	<b>Climate change impacts</b>
<b>Poor households</b>	Mainly pastoralism with very limited crop production	Sale of goats, sheep, herding Domestic work, gold, natural products including charcoal and wild foods. Sorghum, Milk meal, animal blood meal, Meat, Vegetables, Wild foods.	Sorghum, Milk meal, animal blood meal, Meat, Vegetables, Wild foods.	Like in other semi-arid zones, multiple stressors faced by livestock will interact with climate change and variability to amplify the vulnerability of livestock keeping communities.
<b>Better off households</b>	Mainly pastoralism with very limited crop production	Sale of cattle, goats, sheep Gold extraction,/sale of gold Sale of milk, ghee and yoghurt	Sorghum, Milk meal, animal blood meal, Meat, Vegetables, Wild foods.	In other words; pest and disease pressure on livestock is expected to increase as a result of climate change combined with other factors.

## SS06: Eastern Plains sorghum and cattle

### Resilience Profile

This is one of the zones with relatively poor resilience. The poor resilience stems from being highly exposed to hazards, high food insecurity with low livelihood diversity.

Being one of zones prone to civil unrest with inter-communal conflicts, livelihood activities are adversely affected.



### Profile

The economy is agro-pastoral. Crop farming and livestock rearing are both important sources of livelihood. The main crops grown by both poor and better-off group are sorghum, millet, groundnut, sesame, pumpkins and some vegetables. The livestock reared in this zone are cattle, goats, sheep and to a lesser extent poultry, especially chicken mainly for household consumption.

### Risk exposure

Hazards are from inter communal conflicts and cattle rustling, floods, livestock diseases, pests and drought which reduce crop and livestock production and chiefly affect the poor who are least resilient.

Flooding occurs on an annual basis during seasonal rainfall period. Livestock diseases and crop pests and diseases common from June to September.

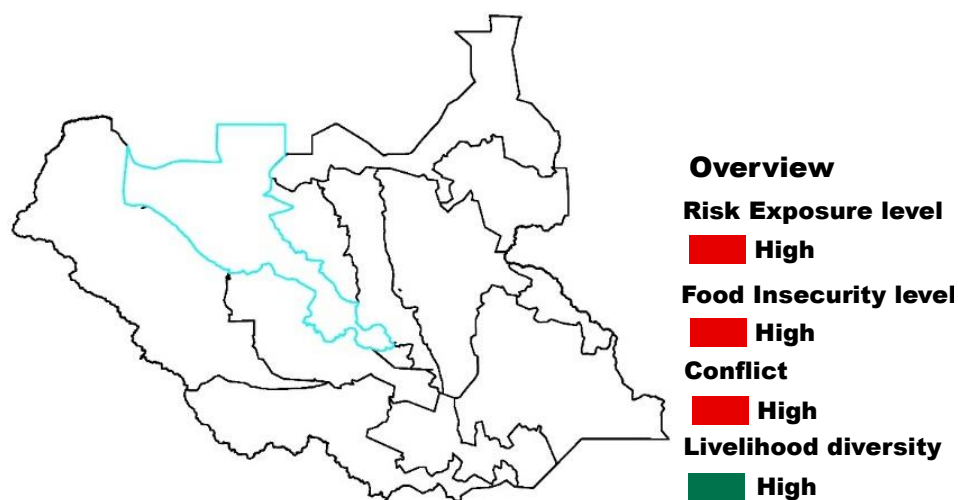
### Markets

Market access in this zone is relatively good due to improvements in road communication with Bor and Juba. The constraints to market access in the zone are insecurity, livestock diseases and a lack of feeder roads in the most rural parts of the zone.

### Future Climate Change Impacts on Wealth Group in Zone 06

	<b>Livelihood activities</b>	<b>Income sources</b>	<b>Food sources</b>	<b>Climate change impacts</b>
<b>Poor households</b>	Households mainly depend agriculture and livestock keeping	The main income sources of the poor group are from the sale of firewood, charcoal, construction poles, goats and brewing.	Sorghum, millet, groundnut, sesame, pumpkins and some vegetables. Livestock reared here are cattle, goats, sheep and to a lesser extent poultry, especially chicken mainly for household consumption.	Pest, weed and disease pressure on livestock and crops is expected to increase as a result of climate change combined with other factors reducing further resilience in livelihood.
<b>Better off households</b>	Households chiefly depend agriculture and livestock keeping	on sale of surplus crop harvest, cattle and milk	Sorghum, millet, groundnut, sesame, pumpkins and some vegetables.	

## SS07: Greater Bahr el Ghazal Sorghum and Cattle



### Resilience Profile

This livelihood zone is considered to have low resilience due to vulnerability to typical flood and drought hazards and because survival options have become increasingly dependent on fish and wild foods due to the impact of prolonged conflict.

The zone is characterized by small holder rain fed agriculture with high diversification into other livelihood activities. The poor households face seasonal food insecurity during bad years due to climate-sensitivity to crop farming.

### Profile

Crop production is mainly rain fed. The livelihood is mixed agro-pastoral and livestock rearing, with all wealth groups cultivating crops as well. Households in this zone generally depend on livestock, crops, wild foods and fish as their main food sources.

### Risk exposure

Floods, livestock diseases, dry spells, inter communal conflicts and cattle rustling during dry season. High risk food insecurity area caused by recurring hazards, shocks and diminishing natural resources.

### Markets

Physical access to the markets is fairly good although sometimes limited by floods and inter communal conflicts and by livestock quarantines due to disease.

## Future Climate Change Impacts on Wealth Group in Zone 07

	Livelihood activities	Income sources	Food sources	Climate change impacts
Poor households	Households depend on sale of labour	Sale of goats and sheep; natural products such as grass, firewood, charcoal. Sale of labor, wild foods/fish and local brew labor migration across into Sudan	Depend on livestock, crops, wild foods and fish as their main food sources.	Long-term changes in rainfall could also have an indirect effect on livelihood activities. Reduction in rainfall in combination with increasing temperatures could result in more intense or longer dry spells, as well as consecutive droughts, thereby impacting on rain-fed agriculture. Reliance on rain-fed agriculture may no longer be feasible under erratic rainfall patterns. The impact on food security would be significant, as a large proportion of the crops produced may be limited if there is insufficient rainfall.
Better off households	Households chiefly depend on livestock keeping and farming	Sale of cattle, sorghum, maize, timber and fish Retail trade	Depend on livestock, crops, wild foods and fish as their main food sources.	

## SS08: Nile Basin Fishing and Agro Pastoral



### Resilience Profile

This livelihood zone is considered to have low resilience due to vulnerability to multiple hazards and civil unrest.

The zone is predominantly occupied by agro-pastoralists while crop production is rain fed. It has moderate diversification into other livelihood activities such as fishing.

Food secure zone with surplus maize production sold in external markets during good years.

### Profile

Crop production is mainly rain fed. The livelihood is mixed agro-pastoral and livestock rearing. The primary source of food for consumption for poorer households is from fishing, their own crop production milk and the collection of wild foods. Fishing using nets, lines, spears and hooks takes place throughout the year and is a source of both food and cash income for all wealth groups. Access to natural products is normally constrained by excessive flood water.

### Risk exposure

Exposed to multiple hazards but mainly floods which tend to limit fishing activities, reduce crop and livestock and wild foods production and cause a loss of income for the better off and put the poor group at greater risk of food insecurity. Inter communal conflicts/ cattle raiding occur annually during the dry season.

### Markets

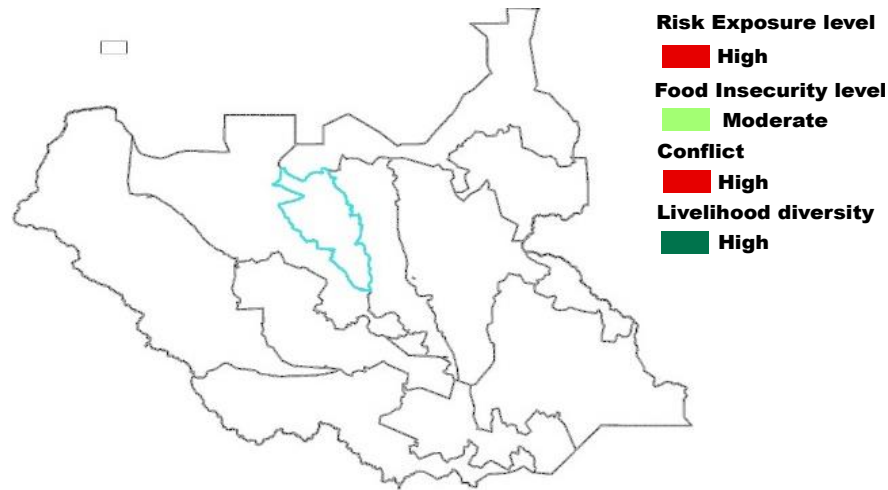
This zone has limited physical access to markets due to poor road conditions especially when excessive flooding takes place during the rainy season. This is despite its strategic location on the main road linking the four states of Upper Nile, Unity, Jonglei and Lake. Market access is also constrained by insecurity because of its close proximity to the border with Sudan. This zone, however, enjoys exclusive access to five

major ports along the Nile River which provide the opportunity for better-off group to sell their products and fish to external traders. It was one of the zones impacted negatively by spate of recent civil unrest as it is mostly occupied the opposition.

**Future Climate Change Impacts on Wealth Group in Zone 08**

	<b>Livelihood activities</b>	<b>Income sources</b>	<b>Food sources</b>	<b>Future climate change impacts</b>
<b>Poor Households</b>	Engaged as daily labourers, catching fish, and selling small quantities of natural products.	Sale of goats, sheep, vegetables, natural resource products including grass, charcoal, firewood and domestic work	Maize, Sorghum, Cow peas, Pumpkins, Okra, Milk, Fish, and Wild foods	With more and erratic rains, this livelihood zone will be bear the consequences of increased flooding with high food insecurity.  Surplus maize usually produced and sold in external markets will no longer be feasible. Production of sorghum could stop at 2o C increase of temperature.
<b>Better off Households</b>	Are often fishing equipment owners who rent them to poorer households and sell larger amounts of fish. They often have small businesses.	Sale of cattle, maize, sorghum and fish. Retail trade and formal employment	Maize, Sorghum, Cow peas, Pumpkins, Okra, Milk, Fish, and Wild foods	

## SS09: Oil resources, cattle and maize



### Resilience Profile

This livelihood zone is considered to have majorly low resilience high exposure risk and conflicts.

The zone is predominantly occupied by agro-pastoralists while crop production is rain fed.

Although it has high livelihood diversification, conflicts and exposure to multiple hazards impacts on livelihood activities.

Moderately food insecure zone with surplus maize production sold in external markets during good years.

### Profile

The area also has natural resources including oil, zinc sulphate, timber, gum Arabic, fish, special grasses suitable for thatching. Compared with its neighbors, this zone is more densely populated with households primarily involved in selling livestock (especially goats, sheep and cattle). Own crops, milk and fish are the main food sources in this zone. In addition, the poor group sells charcoal, firewood, grass and does some domestic work to supplement their income. The better-off sell surplus maize, engage in retail trade and some are engaged in formal employment.

### Risk exposure

The zone is categorized under high exposure to floods, medium to high drought and land degradation. Other hazards include reduced crop and livestock production from flood, drought, bird attack, plant and animal diseases, conflict and livestock raiding and low livestock and high food prices. Poor households cope through increased reliance on wild foods, migratory labor and in some cases external food assistance. The better-off group normally increases livestock sales.

### Markets

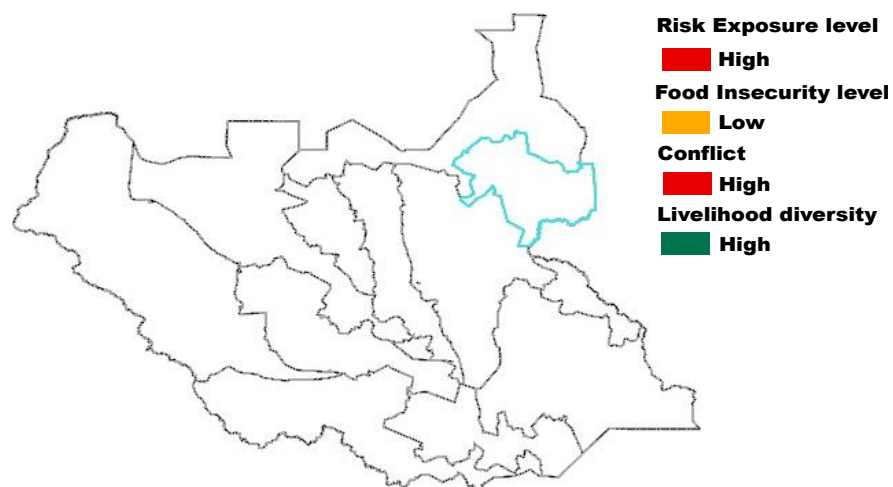
Market access is as in other zones limited by poor roads, flooding and insecurity.



### Future Climate Change Impacts on Wealth Group in Zone 09

	<b>Livelihood activities</b>	<b>Income sources</b>	<b>Food sources</b>	<b>Future climate change impacts</b>
<b>Poor Households</b>	Engaged as daily labourers, farming and selling small quantities of natural products.	Sale of goats, sheep, vegetables, natural resource products including grass, charcoal, firewood and domestic work	Maize, Sorghum, Cow peas, Pumpkins, Okra, Milk, Fish, and Wild foods	In years of excessive floods, this zone produces surplus maize for sale but with increase 2° C in temperature, new maize variety that withstands high temperature should be invented.
<b>Better -off Households</b>	Do retail trade and farming	Sale of cattle, maize, sorghum and fish. Retail trade and formal employment	Maize, Sorghum, Cow peas, Pumpkins, Okra, Milk, Fish, and Wild foods	Fishing will be favoured by flooding conditions but people would not access the fishing areas.

## SS10: North Eastern Cattle and Maize



### Resilience Profile

This livelihood zone is moderately resilient since the majority poor are self-sufficient only for about 6 months of the year and rely on staple purchase for the remainder.

Although low risk food insecurity with much diversified sources of livelihood, inter-communal conflicts and civil unrest together with yearly flooding erodes their resiliency.

### Profile

This is an agro-pastoral area, with a majority of households practicing agriculture, livestock and fishing. Livelihood patterns in this area are largely determined by the annual distribution of rainfall and water courses, including the River Sobat and tributaries running from Ethiopia into South Sudan. Natural resources include oil, with the nascent oil industry already providing some employment, gum Arabic, fish and wild game. Low risk food insecurity zone, the area has very diversified sources of livelihood.

### Risk exposure

The zone is categorized under high exposure to floods, low to medium drought and land degradation. The major hazards are from floods, drought and pest damage to crops and inter communal conflict. Although a low food security risk area, excessive and recurring floods can negatively affect crop production and livestock rearing, the main sources of livelihood of the inhabitants of this zone.

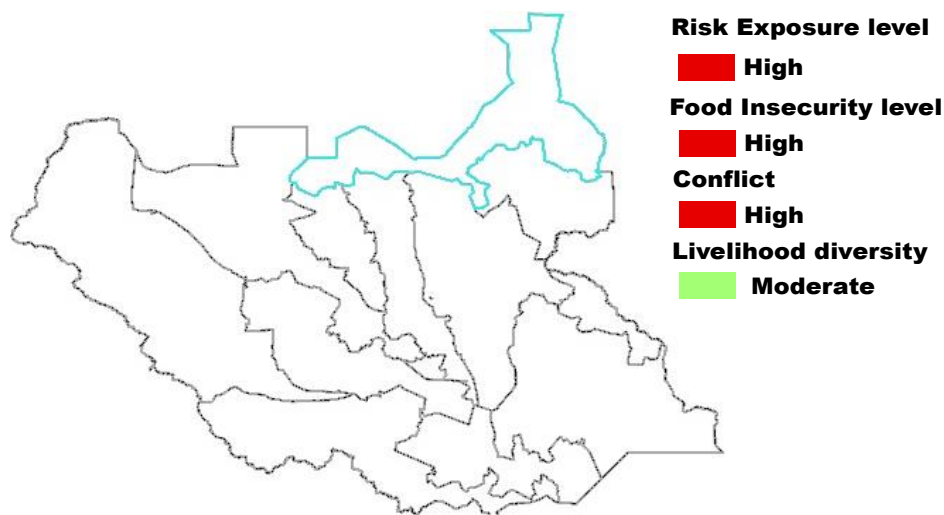
### Markets

Trade in this zone is mainly within South Sudan. The good physical access to Ethiopia also allows this zone to trade surplus maize and livestock.

**Future Climate Change Impacts on Wealth Group in Zone 10**

	<b>Livelihood activities</b>	<b>Income sources</b>	<b>Food sources</b>	<b>Future climate change impacts</b>
<b>Poor Households</b>	agro-pastoralism with a majority of households practicing agriculture, livestock and fishing	Sale of goats, charcoal, firewood, grass, labor. In good years sale fish while bad ones do wild food collection, migratory labor and the sale of some goats and sheep.	Maize, sorghum, cow peas, pumpkins and green vegetables such as okra. Livestock rearing	Pest, weed, and disease pressure on crops and livestock is expected to increase as a result of climate change combined with other factors (IPCC 2014).
<b>Better off Households</b>	Animal and crop farming supplemented with retail trade	Sale of cattle, goats and maize, supplemented with retail trade. A few households rely on formal employment	Food self-sufficient. Produce a surplus of maize for sale	Increasing temperatures and decline in precipitation are very likely to reduce cereal crop productivity with strong adverse effects on food security.

## SS11: North Eastern Cattle and Maize



### Resilience Profile

This livelihood zone is low in resilience due to high risk food insecurity with semi-arid conditions and frequent flooding in every rainfall season.

Seasonal movements are the source of frequent conflict over pastures, waters and cattle raiding.

### Profile

This is an agro-pastoral area with relatively low rainfall that restricts crops mainly to drought resistant sorghum and some gum Arabic production. The main activity is rain fed food crops production and livestock rearing. The main livestock reared are goats and to lesser extent sheep and cattle. There are seasonal livestock movements to Greater Bahr El Ghazal, with frequent inter marriages and other exchanges between communities in these areas.

Hand tilling is the main means of ploughing, although mechanized and irrigated crop production is also carried out in some areas by a few commercial farmers and the government.

### Risk exposure

The zone is categorized under high exposure to floods, low drought and land degradation. Floods and crop pests and diseases normally compound the problem of low crop harvests in this zone and increasing reliance particularly by the poor group on the market for food.

### Markets

This zone has exceptional access to markets within South Sudan and with Sudan. The main goods traded include cattle, goats and grain.

### Future Climate Change Impacts on Wealth Group in Zone 11

	Livelihood activities	Income sources	Food sources	Future climate change impacts
<b>Poor Households</b>	agro-pastoralists	Agricultural and other casual labor, brewing and the sale of goats, thatching grass, wild foods and other natural products	Sorghum, cowpeas, pumpkins and okra, Wild foods and other vegetables. Reliance on the market for food purchase	Increasing temperatures in the semi-arid areas together with decline in precipitation are very likely to impact on crop production adverse effects on food security.
<b>Better-off Households</b>	agro-pastoralists and retail trade	Sale of livestock supplemented by retail trade Some household's engage in formal employment	Sorghum, Cow, peas Pumpkins, Fish, Meat, Vegetables and Milk	

## References

- Dougill, A.J., E.D.G. Fraser, and M.S. Reed, 2010: Anticipating vulnerability to climate change in dryland pastoral systems: using dynamic systems models for the Kalahari. *Ecology and Society*, 15(2)
- Hertel, T.W., M.B. Burke, and D.B. Lobell, 2010: The poverty implications of climate induced crop yield changes by 2030. *Global Environmental Change*, 20(4), 577-585.
- IPCC, 2014: Summary for policymakers. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1-32.
- Patricola, C.M. and K.H. Cook, 2011: Sub-Saharan Northern African climate at the end of the twenty-first century: forcing factors and climate change processes. *Climate Dynamics*, 37(5-6), 1165-1188.