Population Movement Environmental Impacts Assessment Using Remote Sensing and GIS Case Study South Kordofan–Sudan

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Abstract: Statement of the problem: Population movements caused by natural disasters such as floods and drought etc. and non-natural disasters (man-made) such as conflicts and war. Challenges related to migration and the environments include rapid urbanization sprawl, deforestation, unsustainable agricultural and production systems, and the effects of migrants on source and destination communities and ecosystems. Climate change poses risk to human security, principally through its potentially negative effects on people's livelihoods. The aim of this paper is to assess the changes over the years 2015, 2016 and 2017. There is increasing in the NDVI value in 2016 but still close to the normal average value in the area which it couldn't be called as a highly significant increase, then a high decrease in 2017 due to high rainfall at the time due to floods at this period. NDVI also correlated positively with temperature and negatively with precipitation in summer, mostly in the broad-leaved savanna woodland Acacia Seyal which cover South Kordofan. Annual rainfall ranges from less than 50mm on the northern border to more than 800mm on the southern border. The rainy season varies from three months or less in the north to five months in the south, with rains occurring between May and October. It is concluded that there is significant change (increase) in the land cover in the urban areas & the crop land areas as indicators of the growth of the livelihood. There is a high significant decrease in the closed areas, herbaceous vegetation and sparse vegetation cover over the last three years. It could be associated with human activities and the population growth. Low NDVI value and decrease in the crop land area in 2017 due to the high amount of the rainfall caused floods caused light damage, numerous road closures, numerous creeks and streams flooding classifies as minor –moderate.

I. Introduction

Population movements cause by natural disasters such as floods and drought etc , and non-natural disasters (man-made) such as conflicts and war . Challenges related to migration and the environment include rapid urbanization and sprawl, deforestation, soil erosion, agro-chemical pollution, water shortages, abandonment of rural areas, declining health and physical resilience, unsustainable agricultural and production systems, difficulties in building effective governance systems and the effects of migrants on source and destination communities and ecosystems. Climate change poses risk to human security, principally through its potentially negative effects on people's livelihoods. However, caution should be used in linking environmental change to conflict and forced migration. Substantially more research is needed on the environmental change–conflict–migration nexus and the ways it may undermine human security.

A. Objectives

The aim of the study is to assess the changes over the last years 2015,2016 and 2017 according to the event to the event in 2011 when the civil war started

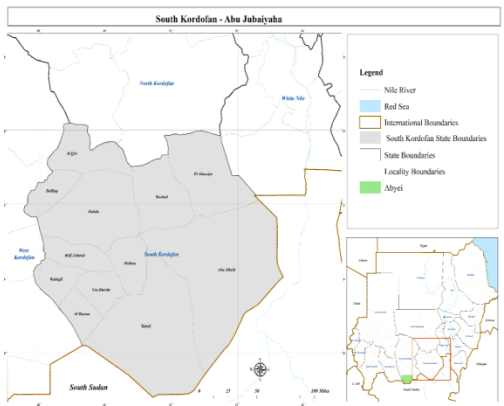
and during the time at 2013 the South Sudan civil war also has started, and assess the environmental impacts of the population movements (Refugees & IDPs) on our study area Abu Jubaiyaha, as well to highlight the areas affected by developing risk map.

B. Study Area

Abu Jibaiha lies on the coordinates 11.4562° N 31.2285° E on the twelve localities in South Kordofan state, away from Khartoum the capital of

Sensor	Date
Landsat 8	26.12.2015
Landsat 8	28.12.2016
Landsat 8	22.12.2017

the Sudan at 481 km (298.8 miles) is located at a height of 679 meters (2,228 feet) above the surface. The area is wealthy with natural resources Is one of the important cities located on the gum belt, which it considered for most of world production of Arabic gum. The population of the Abu Jubaiyah is about 21,790 people representing different ethnic groups and Sudanese tribes, the main ethnic groups in are the Nuba, Misserya and Hawazma, Kawahla , Flata , awlad Hamid , Kenana and others .Tribal conflict between the Misserya and Nuba has displaced many . The livelihood activities vary from cultivation and grazing to light industry and retailing. Agriculture and grazing are the most important economic activities of the population. The agricultural sector is concentrated on the production of traditional rain-fed agriculture crops, which are locally known as "fire cultivation", where weeds and grass are burned to prepare the ground, and the machine farming is used in most stages of the production process. The most important crops are: fruit, mainly mango, which is famous for the city in Sudan, and gum arabic, where the city is one of the largest production areas in Sudan, sesame, corn, peanuts



and vegetables such as beans. Soils suitable for the cultivation of the basic food staples of the Nuba Mountains are limited. They are divided broadly by local people into the fertile clay soils of the plains (known as hadaba in Arabic), the sandy/clay pediment soils found at the foot of the mountains (known as gardud) and the rocky soils found in the mountains (karkar).

II. Material and Methods

A. Materials

- Rainfall data
  Monthly Precipitation Data Using Giovanni
  http://giovanni.gsfc.nasa.gov/giovanni
- Temperature data
  Temperature data extracted from the satellite images (Landsat 7 and Landsat 8) .
  Date of satellite data.
- Landsat 8
- GIS Data (Shape files)
  - Sudan admin boundaries (Country – states – Localities)
  - Area of study layer (Camps Locations)
- Tables
  - IDPs & Refugees population figures (2011, 2015,2016,2017)
  - Market price data for 2011, 2015, 2016 and 2017

B. Methods

- Software used
  - ArcMap 10.5 to display the geospatial data, generate spatial indexes, overlay the spatial layers
  - ERDAS 2014
  - Excel to generate tables and charts

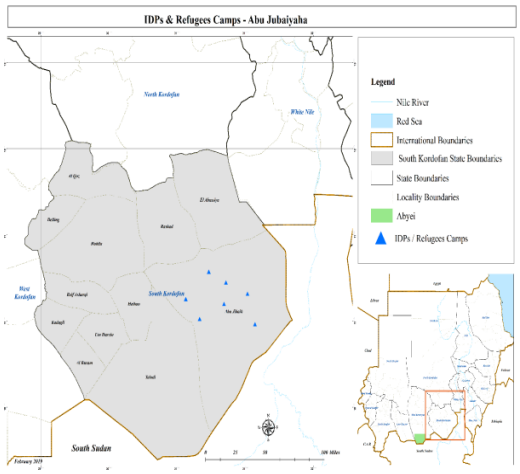
  Google earth pro for locations verification

C. Methodology

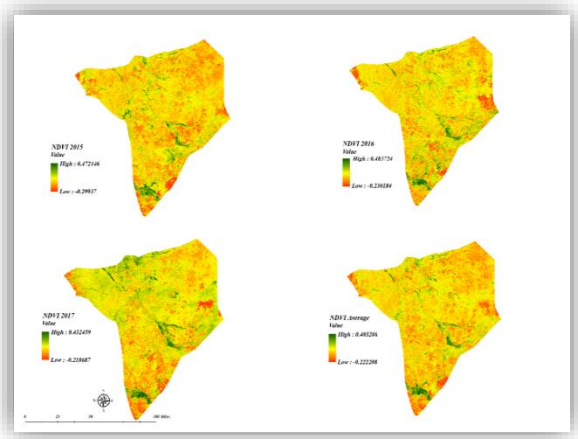
The data was collected from the different sources and then through the software it was analyzed to achieve the results.

III. Results

IDPs/ Refugees Camps

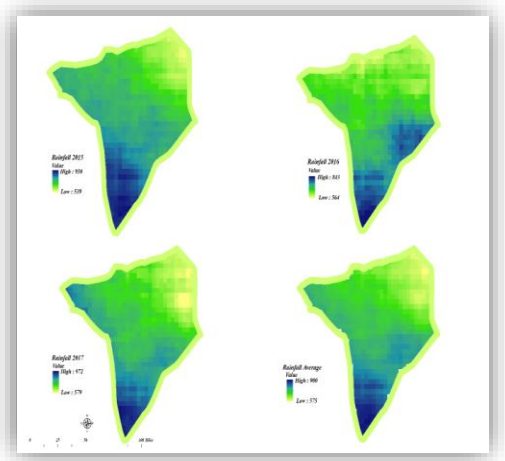


A. NDVI



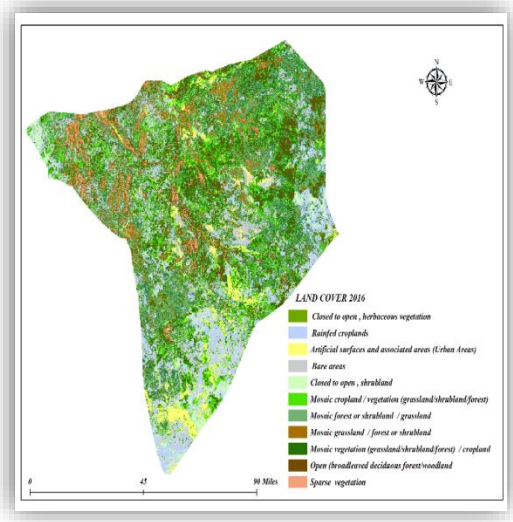
There is increasing in the NDVI value in 2016 but still close to the Normal Average value in the area which it couldn't be called as a highly significant increase, then a high decreasing in 2017 due to high rainfall at the time due to floods at this period. NDVI also correlated positively with temperature and negatively with precipitation in summer, mostly in the broad-leaved savanna woodland Acacia seyal and Balanites aegyptiaca which is covered South Kordofan and the clay soil .

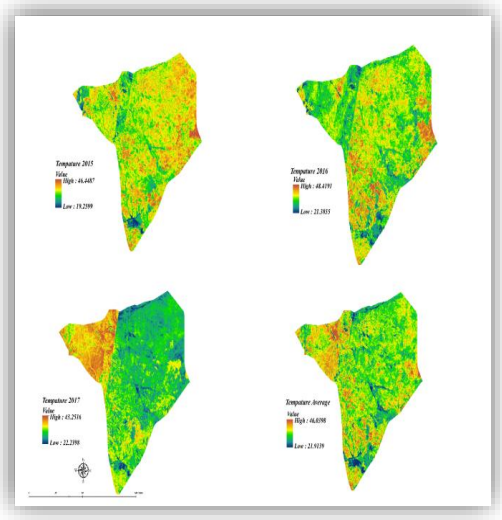
B. Rainfall



As shown 2016 has the lowest Rainfall Value, while 2015 has the Highest rainfall, in 2017 there's significant increase in the rainfall after a significant decrease. The Rainfall Average Value will be classified in order to be one of the contribution parameters to assess the high-risk areas. The region has a varying climate, ranging from desert and semi-desert in the north, to rich savanna in the south. Arid and semi-arid zones cover the largest part of this region. Annual rainfall ranges from less than 50mm on the northern border to more than 800mm on the southern border. The rainy season varies from about three months or less in the north to about five months in the south, with rains occurring between May and October.

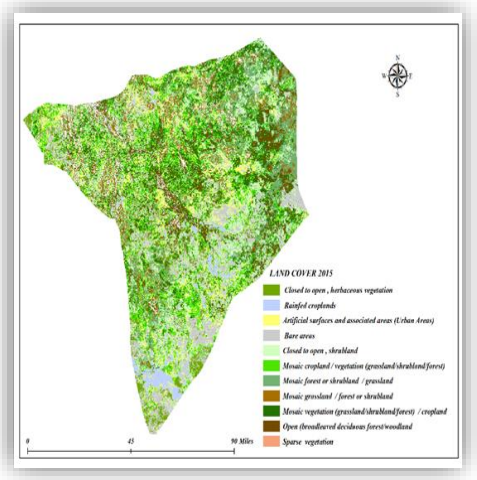
C. Temperature





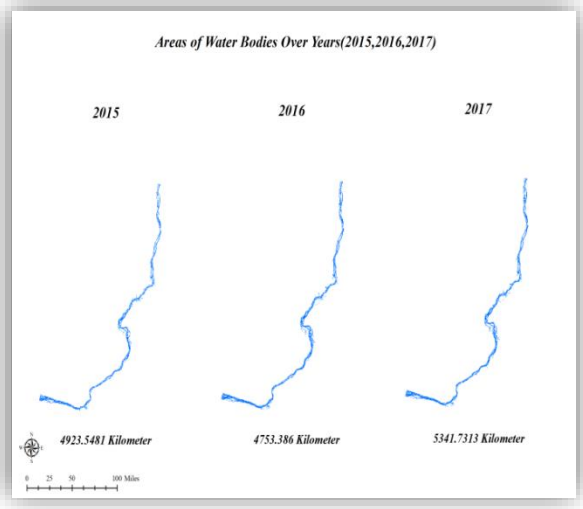
D. Land Cover

Land cover 2015



E. Land cover 2017

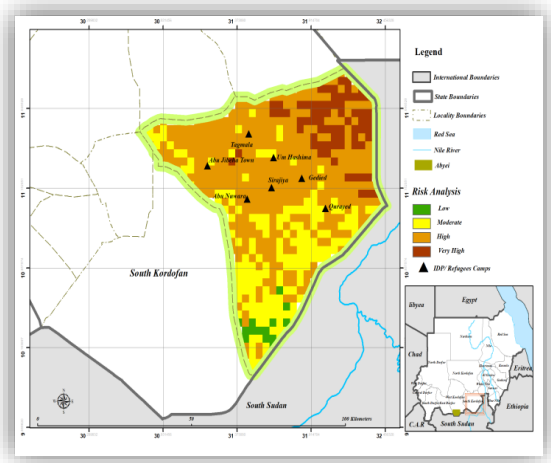
F. Water bodies



G. Risk Map

The Risk analysis performed based on specific criteria for the input factors, the Rainfall, Temperature and NDVI, each factor contributed in the result based on their weight.

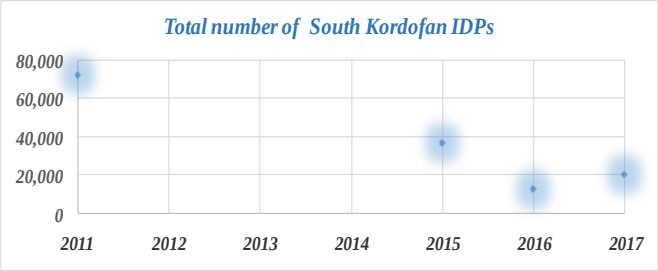
All the average result of the factors are reclassified and the weights assigned to, reclassified into four classes, the lowest rainfall class, the highest temperature value class and the lowest NDVI value class has the highest weight assigned into it. Then the weighted overlay analysis performed based on the given weights, for each factor influence on the result to determine the risk, the Rain fall has the 45 % weight value, temperature 35% and the NDVI 20%. The result shows the ranking risk areas and overlaid the camps layers over in order to see where the camps are located



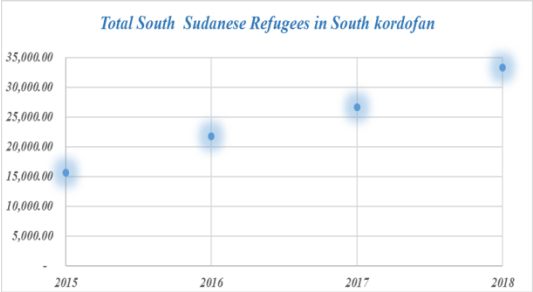
IV. Tables

IDPs & Refugees Population figures

A. South Kordofan IDP



The highest IDPs number is in 2011 in South Kordofan state due to the civil war in South Kordofan and Blue Nile at that time, While the noticeable decrease in the IDPs number after 2011 due to the separation of South Sudan, the South Sudanese returned to South Sudan (as they) while they represented a part of the IDPs. In South Sudan, the humanitarian situation has become increasingly precarious during the first half of 2011 due to increasing conflicts and the deteriorating situation in Abyei and South Kordofan. By mid-June 2011, more than 300,000 IDPs have returned to South Sudan. A second peak in returns is taking shape and may increase rapidly and continued.

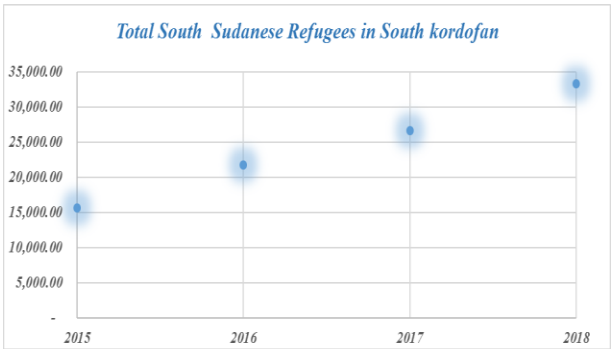


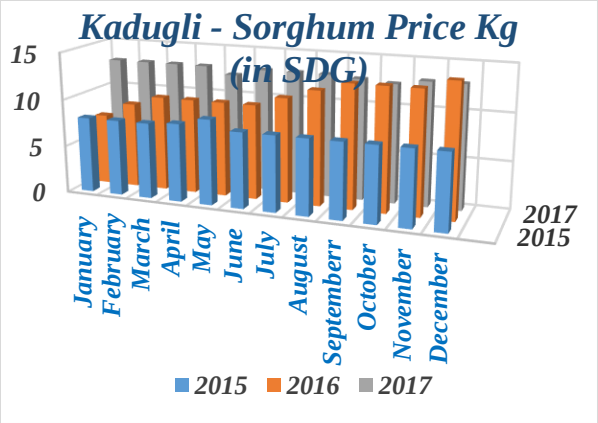
B. South Kordofan Refugees

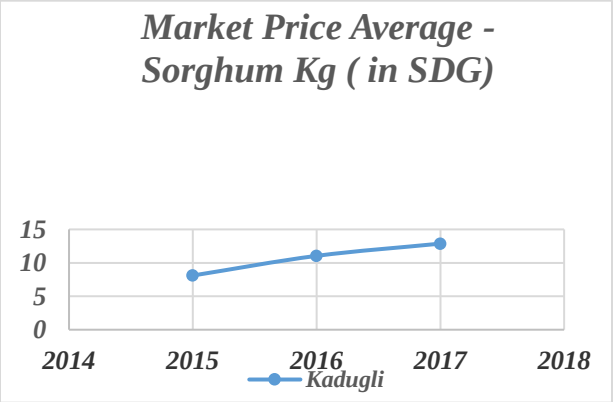
The history of the Sudan was characterized by population movements both into and out of it. The geographical factor of kordofan region in general and in addition it has been home for the South Sudanese before the separation in 2011, which the region becomes one of the big the settlement for South Sudanese refugees, as well as the South Kordofan refugees are still seeking safety in neighboring South Sudan When the war in the Nuba Mountains in Sudan's South Kordofan state began in 2011 Five years of war, thousands of Nuba people fled to neighboring South Sudan. They settled close to the border in Yida where they built a market, workshops, houses and schools. Yida lies just inside South Sudan, just 15 kilometers (9 miles) from the border with Sudan. The border is controlled by the SPLA (the army of South Sudan) and rebels from SPLM-North (a banned militant organization opposed to the government of Sudan). The rebels fought alongside the SPLA during the South Sudanese struggle for independence from Khartoum. When South Sudan finally ceded from Sudan in 2011, their new common border left the Nuba Mountains on the Sudanese side. Since then Khartoum has sought to flush out the rebels with aerial bombing raids. Hundreds of civilian targets, schools, homes and hospitals, have been hit. All these events in Sudan and South Sudan makes south kordofan as a witness and at some point, it was the safety settlement for south Sudanese as well the South Sudan for the South Kordofan refugees. Abu Jubaiha is a key settlement area for new arrivals in South Kordofan. In 2017, an estimated 40% of new arrivals crossed through Gedeid, Sirajiya and Quaryd (camps).

C. Market Price

Is one of the indirect impacts in the area is the arket price South Kordofan Market Price Average (Kadugli) We used the Market Price average of the sorghum which is the main crop in the state of Kadugli i the State capital of South South Kordofan for the last three years -2015,2016 and 2017 for the availability but in can be used for generalizes the whole state .







V. Conclusion and Recommendations

- The significant change (increase) in the land cover in the urban areas increase & and the crop land areas as indicators of the growth of the livelihood, Which the two factors are significant indicators of the population growth.
- High significant decrease in the Closed to open, herbaceous vegetation and Sparse vegetation cover over the last three year. It could be associated with human activities and the population growth.
- Highly significant expand of the Rainfed croplands area which is associated with increase of the agricultural livelihood due to the population increase.
- High Market price of Sorghum due to market reported significant monthly increases of 32 percent between August and September as a result of increased demand for local consumption and reduced market supplies with depleted grain stock of the above average season.
- Environmental Changes in the landcover and the other environmental indicators such as the NDVI, Rainfall and Temperature associated with the population movements due to conflicts event and natural events such as floods.
- The low NDVI value and decrease in the crop land area in 2017 due to the High amount of the rainfall caused floods caused Light Damage, Numerous road closures, numerous creeks and streams flooding classifies as Minor -moderate.
- Positive significant Correlation between the water bodies and rainfall.
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- Positive significant Correlation between the water bodies and rainfall.
- Recommendation

- Lack of Availability of Satellite imagery data of 2011 and 2013 for the comparison between the time of the events and after .
- High Resolutions for farther study of camps expedition.
- Lack of Availability Market Price of Abujibeha.
- Annually monitoring using Satellite imagery to assess the impact level and to avoid the risk in the future.

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