(Crop Classification using Sentinel-2 Satellite imagery)– Case Study: Agricultural Scheme in the Sudan (Gezira) – EARTH OBSERVATION EXAM 2022

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1. INTRODUCTION

Crop classification is one of the most important agricultural applications of remote sensing. It provides relevant information for crop management, food security assurance, and agricultural policy design. The availability of Sentinel-2 images time series, with a very short revisit time and high spatial resolution and it has excellent potential for crop classification in regions. Dense image time series enable the implementation of supervised crop classification schemes based on the comparison of the time series of the element to classify with the temporal signatures of the considered crops. (Department of Engineering, 2020)

The main objective of this study is to classify the crops (Cotton, Sorghum) from a portion area in Agricultural scheme in Gezira state (Sudan) and calculate the cultivated area of each crop. Sentinel-2 Satellite imagery in (July, August, October, December) in 2016 was used to emphasize healthy and unhealthy vegetation using color infrared band combination for (B8, B4, B3) (VNIR, Red, Green) and then apply supervised classification by using QGIS plugin (Dzetsaka). (gisgeography, 2022)

2. MATERIALS AND METHODS

2.1. STUDY AREA:

The study area covers the agricultural areas of the state of Gezira (Sudan). This area has an extension of 67.919 km2. Different types of crops are grown in this region, but the main crops are Cotton, Sorghum and Peanuts.

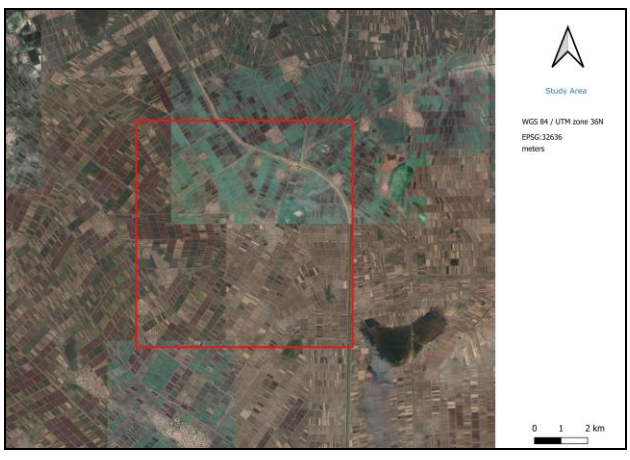

Figure 1. Area of interest.

2.2. Materials:

The Sentinel-2 imagery were chosen in this project. The choosing was based on the preference in terms of:

1. The **temporal resolution** of a satellite in orbit is the revisit frequency of the satellite to a particular location. The revisit frequency of each single SENTINEL-2 satellite is 10 days and the combined constellation revisit is 5 days. (AGENCY, 2022)

2. The **spatial resolution** of an instrument is the *at-ground* representation of an individual detector in a satellite sensor array. Details on the spatial resolution of the MSI instrument resolution are provided in the Spatial Resolution section. (AGENCY, 2022)

Also, it incorporates two new spectral bands in the red-edge region, which can be used to derive red-edge type of vegetation indices. (Clevers, 2012)

Band	Properties	
	Wavelength (nm)	Resolution(m)
Blue (Band2)	490	10
Green (Band3)	560	10
Red (Band4)	665	10
Visible and Near Infrared (VNIR) (Band8)	842	10

Table 1. Sentinel-2 Bands Properties (system, 2022)

Dates of sentetinal-2 imagery:

- 22/07/2016
- 30/09/2016
- 20/10/2016
- 29/12/2016

Ground points -for validation processes- was obtained from a geographical database of the project “SPACE MONITORING OF SUMMER AGRICULTURAL SEASON & YIELD ESTIMATION FOR EASTERN AND CENTRAL SUDAN " that done by MIERAG SPACE TECHNOLOGIES COMPANY in 2016. This information was collected from the field and saved as shapefile containing points and crops type.
Crop calendars show the life span of major crops within study area including early sowing & late harvest.

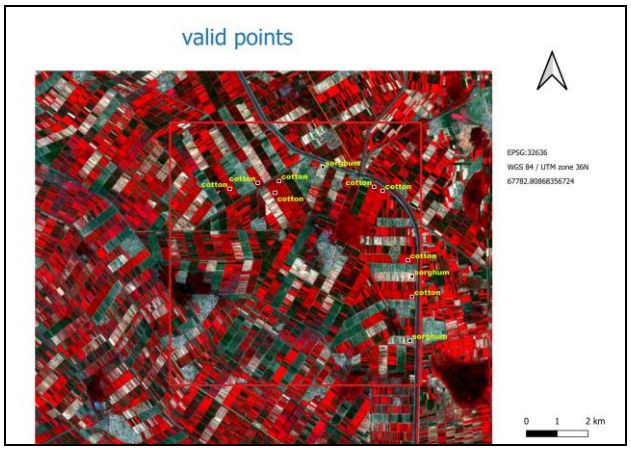

Figure 2. Valid points.

2.3 Method:

Four Sentinel-2 imagery (level 1C) on different months was downloaded from Copernicus open access hub and Atmospheric correction was applied by using Sen2cor which is a processor for Sentinel-2 Level 2A product generation and formatting; it performs the atmospheric-, terrain and cirrus correction of Top-Of- Atmosphere Level 1C input data. Sen2Cor creates Bottom-Of-Atmosphere, optionally terrain- and cirrus corrected reflectance images; additional, Aerosol Optical Thickness-, Water Vapor-, Scene Classification Maps and Quality Indicators for cloud and snow probabilities. Its output product format is equivalent to the Level 1C User Product: JPEG 2000 images, three different resolutions, 60, 20 and 10 m. (system, 2022)
A virtual raster's was created with the exact AoI for visualization & clipping purposes.

A supervised classification algorithm based on crops calendar was applied. The basic concept behind this classification algorithm is that crops exhibit physical differences during the growing season due to their phenological development, which leads to different backscatter time series. Therefore, A training sample was created by distinguish between two different crops. Cotton is planted at the beginning of August and harvested at the end of January so at the end of December, Cotton looks red on the color infrared band combination view while, sorghum is planted at the mid of July and harvested at the end of November so at end of October, Sorghum looks red on color infrared band combination view, and it looks Gray on December. The supervised classification was performed by using (Dzetsaka plugin) in QGIS. to define the performance of the classification. (Richards)

Figure 3. classified raster

4 class of supervised map:

1. COTTON
2. SORGHUM
3. UN_FARMED
4. URBAN

NDVI maps was created to differentiate vegetation from other types of land cover, hence, it used to define urban areas and unfarmed areas. This step performed by using the raster calculator which the tool used to perform the algebraic operation on the images. The indices were built by using equation 1 bellow:

$$NDVI = \frac{NIR - Red}{NIR + Red} \quad (1)$$

where *NDVI* = Normalized Difference Vegetation Index
NIR = Near-Infrared band
R = Red band

Figure4. NDVI (July, September, October, December)

A Confusion matrix (error matrix) was computed by QGIS which defined as the quantitative method of characterising image classification accuracy. It is a table that shows correspondence between the classification result and a reference image. (METHOD, 2016)

660	2	3	0
0	388	0	0
13	0	839	1
1	0	3	405

Table 2. Confusion matrix obtained by QGIS

3. RESULTS DISCUSSION

The result shows the crops type on the study area. The main crops were Cotton and Sorghum (figure.5). the classification was based on supervised classification algorithm. However, figure.6 show that on study area Cotton was the most cultivated crop compared with sorghum. The unfarmed area was 28857600 m2.

In conclusion, after compare the result with validation point that collected from the field, the supervised classification showed success in determining the crops type and calculate the agricultural areas and each crops area. this can be used on Crop productivity estimation.

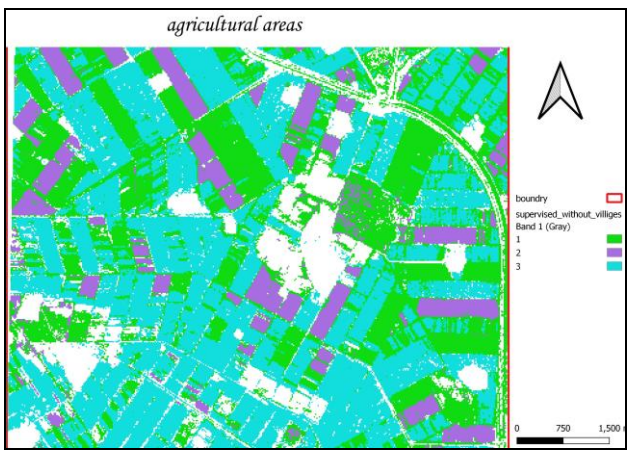

Figure 5. Agricultural areas

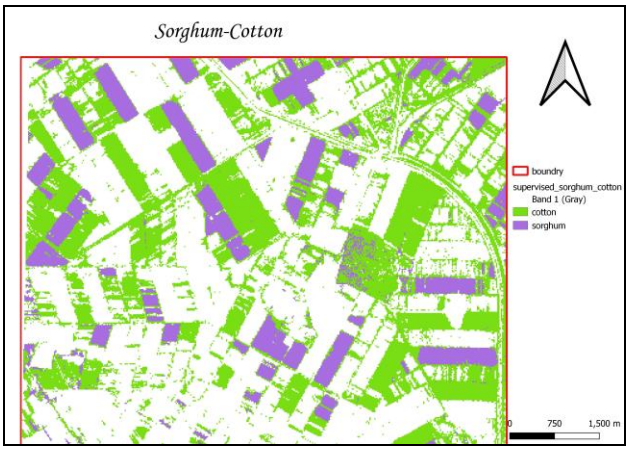

Figure 6. Sorghum-Cotton

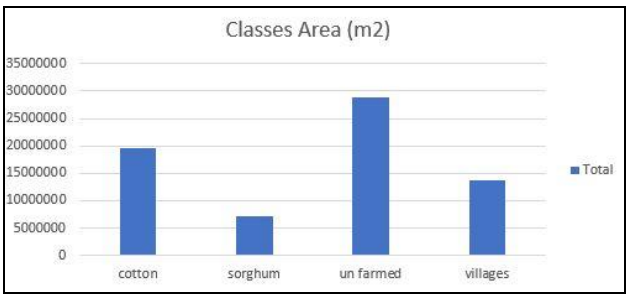

Figure 7. Classes area.

4. REFERENCES

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