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Using remote sensing imagery and geographic information systems for mapping vegetation indices in Iraq

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Abstract

One of the parts of land cover is the vegetation cover. The changes in land cover are due to man-made of natural with the time. The vegetation indices are used in remote sensing for long time to monitor changes in vegetation. Remotely sensed data is considered as an important source of information. For particular area, the vegetation can be considered as a source to collect information about soil, or water table, and to delineate potential zone of ground water. Landsat 7 image is used to identify the land cover and to monitor the vegetation indices in the area under investigation. There are many indices in remote sensing. In this paper I used NDVI and SAVI for the study region and I produce Maps for these two indices using ArcGIS 10.2.2 software.

Keywords: Landsat7 images, Mapping, ArcGIS, Vegetation indices, Iraq

1. Introduction

The reflectance in the visible and infrared parts of the electromagnetic spectrum is used to calculate the Normalized Difference Vegetation Index (NDVI). Healthy vegetation have reflectance that is low in visible portion of the EMS because the chlorophyll and the pigment absorption occur in this region, while the reflectance is high in the infrared region due to tissue of green leaf. For more information, the interested reader should consult [2, 6, 13].

The following equation is used to calculate the index:

$$\text{NDVI} = (\text{Reflectance(NIR)- Reflectance(VIS)})/\ (\text{Reflectance(NIR)+ Reflectance(VIS)})$$

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The values of this index is between −1 and +1 always. The large values are for healthy vegetation. Low values 0.1 and lower represent barren areas of rock, sand and snow. While the values for grassland and shrub are in the range of 0.2 to 0.3. There are many spectral vegetation indices to

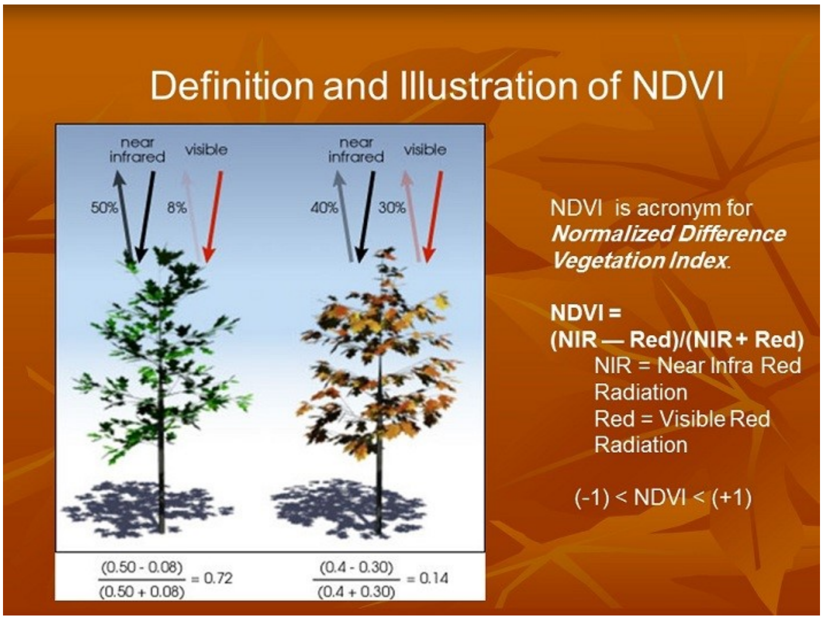

Figure 1: Normalized Difference vegetation Index.

describe vegetation, like normalized difference vegetation Index (NDVI), and soil adjusted vegetation index (SAVI). In figure2 water and soil and vegetation absorb and reflect in a different way. This represent the signature of these materials. More information on indices and spectral signatures can be found in [4, 7, 14, 5, 12, 9].

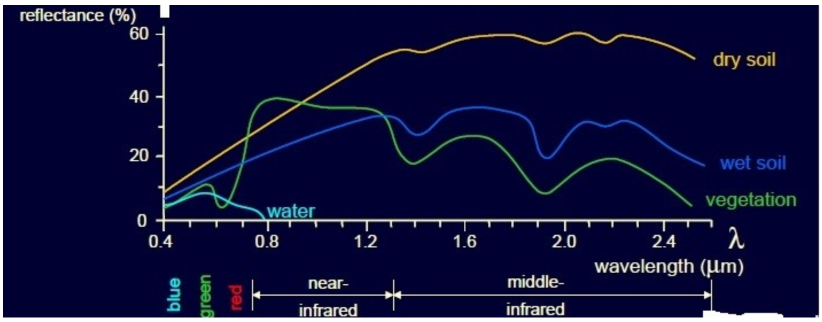

Figure 2: Typical spectral signatures.

2. Study area

In this study, I'm using a Landsat-7 image using an Enhanced Thematic Mapper Plus (ETM+) sensor. The path number is 168, and the row number is 37, both of which were gathered on March 8, 2003. For zone N38, the projection is Universal Transverse Mercator, and the datum is WGS84.

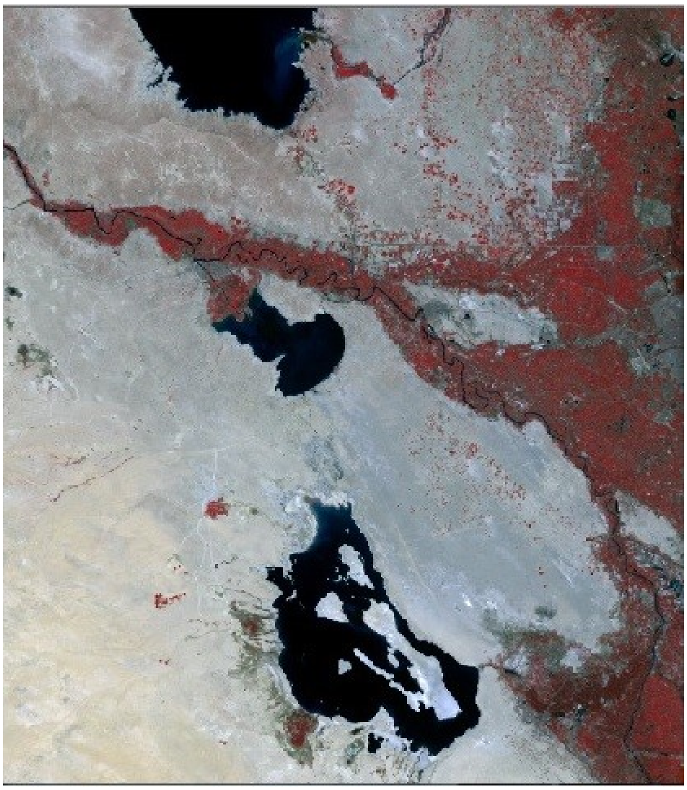

Figure 3: Depicts the remotely sensed data that was used in the investigation.

3. Methodology

Figure 4 indicate the steps used to calculate the surface reflectance from digital numbers (DN) of the image.

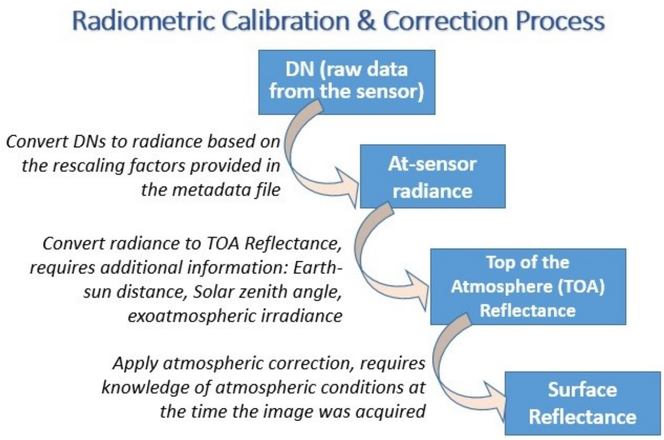

Figure 4: Steps required to calculate surface reflectance.

These steps are important to get a physically meaningful radiometric scale [3, 11]. Equation(1) is used to convert the digital numbers into radiance.

$$L_\lambda = \frac{(LAMX_\lambda - LMIN_\lambda)}{(Q_{calmax} - Q_{calmin})} \times (Q_{cal} - Q_{calmin}) + LMIN_\lambda \tag{1}$$

The spectral radiance is denoted by the letter L.
The digital number or pixel value is represented by Qcal.
LMIN's minimum pixel value is represented by Qcalmin.
LMAX's maximum pixel value is represented by Qcalmax.
As shown in Table, LMIN and LMAX are the radiance values (1).

Table 1: ETM+ Spectral Radiance.

	Before July 1,2000				**After July 1,2000**			
Band	**Loe Gain**		**High Gain**		**Loe Gain**		**High Gain**	
Number	**LMIN**	**LMAX**	**LMIN**	**LMAX**	**LMIN**	**LMAX**	**LMIN**	**LMAX**
1	-6.2	297.5	-6.2	194.3	-6.2	293.7	-6.2	191.6
2	-6.0	303.4	-6.0	202.4	-6.4	300.9	-6.4	196.5
3	-4.5	235.5	-4.5	158.6	-5.0	234.4	-5.0	152.9
4	-4.5	235.0	-4.5	157.5	-5.1	241.1	-5.1	157.4
5	-1.0	47.70	-1.0	31.76	-1.0	47.57	-1.0	31.06
6	0.0	17.04	3.2	12.65	0.0	17.04	3.2	12.65
7	-0.35	16.60	-0.35	10.932	-0.35	16.54	-0.35	10.80
8	-5.0	244.0	-5.0	158.40	-4.7	243.1	-4.7	158.3

The following equation is used to calculate the reflectance:

$$R_\lambda = \frac{\pi . L_\lambda . d^2}{E_{sun,\lambda} . sin\vartheta_{SE}} \tag{2}$$

Where:
R: is the reflectance (unitless ratio) referred to the wavelength range of the specific band;
L: is the radiance calculated by formula 1;
d: is the earth-sun distance (in astronomical units);
E: is the mean exoatmospheric solar irradiance at the specific band;
Sin: sine of solar elevation angle
The parameters of equation(2) can be found in Table 2, and (3).

Table 2: Earth – Sun Distance in Astronomical Units.

Julian Day	Distance	Julian Day	Distanc	Julian Day	Distanc	Julian Day	Distanc	Julian Day	Distanc
1	0.9832	74	0.9945	152	1.0140	227	1.0128	305	0.9925
15	0.9836	91	0.9993	166	1.0158	242	1.0092	319	0.9892
32	0.9853	106	1.0033	182	1.0167	258	1.0057	335	0.9860
46	0.9878	121	1.0076	196	1.0165	274	1.0011	349	0.9843
60	0.9909	135	1.0109	213	1.0149	288	0.9972	365	0.9833

Table 3: E_{sun} for wavelength of Band 3 and Band 4.

Spectral Band	**Sun Radiance** $\mathbf{E_{sun,\lambda}}$**[Watts/(sq.meters.** μ **m)]**
Band 3	15533
Band4	1039

4. Results

NDVI = (Reflectance(NIR)- Reflectance(VIS))/ (Reflectance(NIR)+ Reflectance(VIS))

I use the raster calculator in ArcGIS to calculate the indices in this paper.

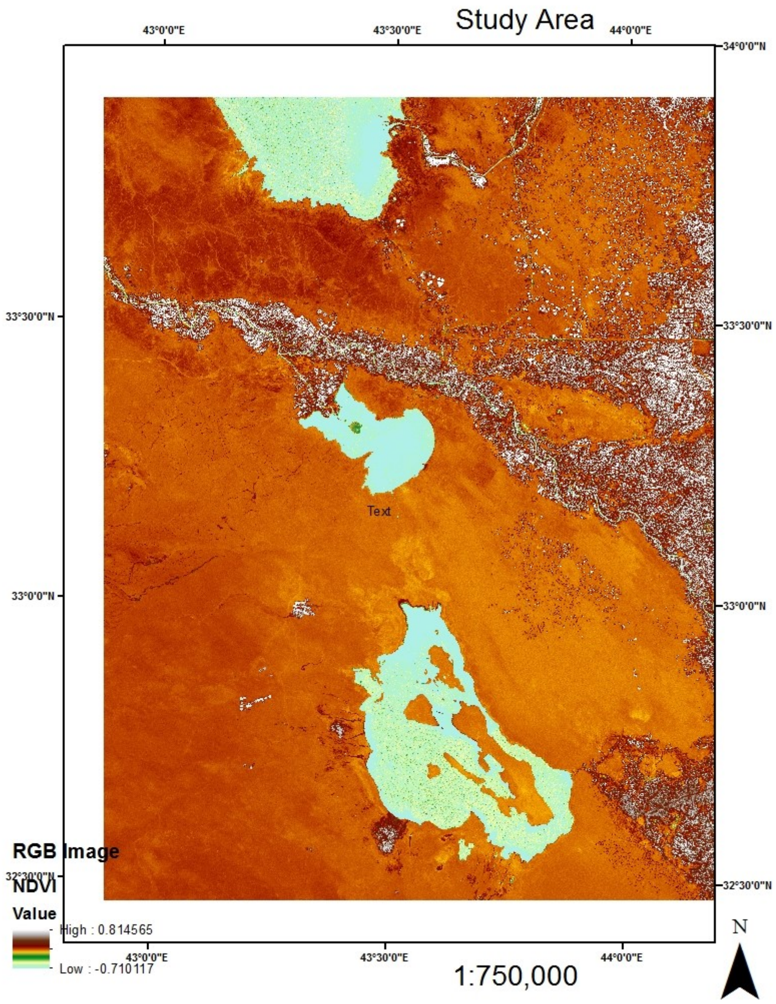

Figure 5: NDVI result of the study area.

The NDVI and SAVI values range from -1 to 1, with negative values indicating water and positive values indicating vegetation, while rock and bare soil areas gives us values near zero. SAVI is same as NDVI, but its include background soil conditions.

SAVI = (1+L) * (band4-band3) / (band4+band3)

Each band's reflectance is taken into account, and L is a soil brightness correction factor. From Huete [7], L=0.5.

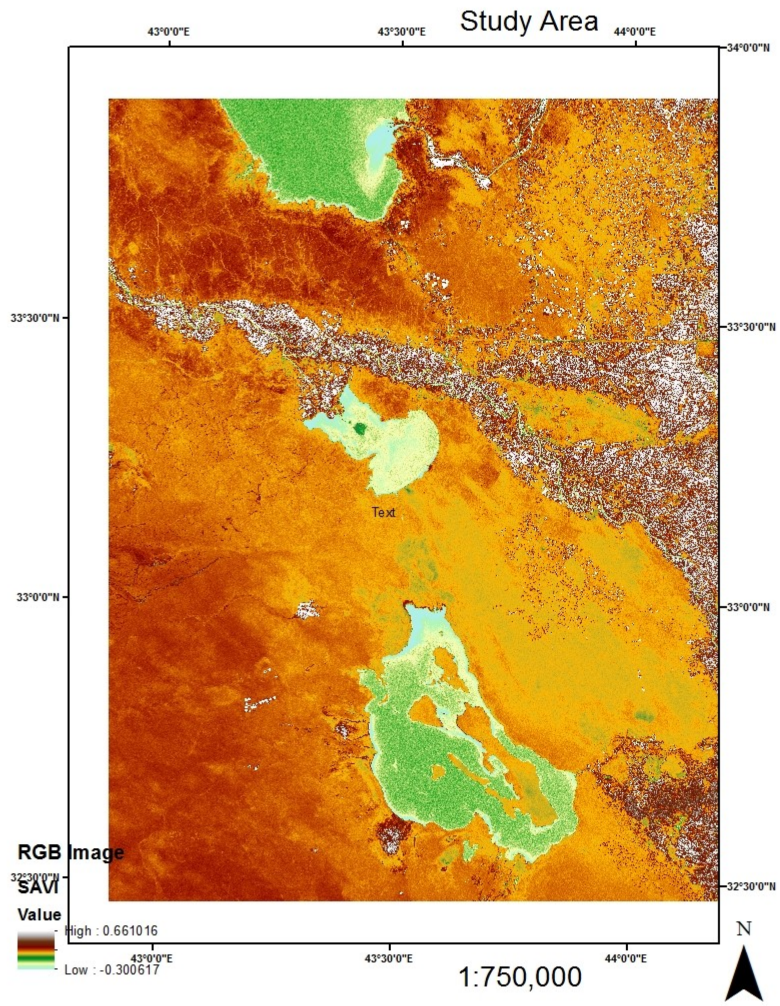

Figure 6: SAVI result of the study area.

Because photosynthesis absorbs in the visible spectral area, live green plants look dark in the visible region and luminous in the near infrared. Leaves, on the other hand, reflect sun light in the near infrared.

The work currently under way may be further examined as future work by internet of things, cloud computing or also e-government. Arduino and ZigBee technologies can also enhance the work currently underway [10, 1, 8].

5. Conclusions

In order to calculate NDVI and SAVI there should be two images for the same scene acquired at the same time. These indices are widely used by ecologists and agriculturalists. The idea behind using two bands is to to make the variability les because of soil background reflectance, and also the illumination, and the variation of view angle.

References

[1] T. Abd, Y. S. Mezaal, M. S. Shareef, S. K. Khaleel, H. H. Madhi and S. F. Abdulkareem. I*raqi e-government and cloud computing development based on unified citizen identification.*, Periodicals of Engineering and Natural Sciences, 7 (4) (2019) 1776-1793.

[2] W. Abdul, E. Salik and A. Karacabey, *Application of Landsat 8 Satellite Image – NDVI Time Series for Crop Phenology Mapping: Case Study Balkh and Jawzjan Regions of Afghanistan*, Journal of Graduate School of Natural and Applied Sciences, 5 (1) (2019) 49-62.

[3] G. Chander, B. L. Markham and D. L. Helder, *Summary of current radiometric calibration coefficients for Landsat MSS, TM, ETM+, and EO-1 ALI sensors*, Remote Sensing of Environment, 113 (2009) 893-903.

[4] W. B. Cohen and S. N. Goward, *Landsat's role in ecological applications of remote sensing*, Bioscience, 54 (6) (2004) 535545.

[5] J. Environ, *Assessing Spectral Indices for Detecting Vegetative Overgrowth of Reservoirs*, 28 (6)(2019), 4199-4211.

[6] J. Hill and B. Sturm, *Radiometric Correction of Multitemporal Thematic Mapper Data for Use in Agricultural Land-cover Classification and Vegetation Monitoring*, International Journal of Remote Sensing 12(7) (1991) 1471-1491.

[7] A. R. Huete, *A soil-adjusted vegetation index (SAVI)*, Remote Sensing of Environment, 25 (1988) 295-309.

[8] Z.K. Hussein, H.J. Hadi, M.R. Abdul-Mutaleb and Y.S. Mezaal, *Low cost smart weather station using Arduino and ZigBee.*, Telkomnika , 18 (1) (2020)282-288.

[9] K. Lavanya, A. J Obaid, I. Sumaiya Thaseen, K. Abhishek, K. Saboo and R. Paturkar, *Terrain Mapping of LandSat8 Images using MNF and Classifying Soil Properties using Ensemble Modelling*, International Journal of Nonlinear Analysis and Applications, 11(2020) 527-541. doi: 10.22075/ijnaa.2020.4750.

[10] A.A.H. Mohamad, Y. S. Mezaal and S. F. Abdulkareem, *Computerized power transformer monitoring based on internet of things*, International Journal of Engineering & Technology 7, (4) (2018) 2773-2778.

[11] A. NASA, *Landsat 7 Science Data Users Handbook*, (2003).

[12] E. Patil Manoj and A. Bhole Snehal, *A Comparative Study of Vegetation Change Detection Methods NDVI and LULC with use of Satellite Images*, International Journal of Engineering and Innovative Technology (IJEIT), 2 (3) (2012).

[13] A. Sahrish, *Vegetation Index Based Coefficients to Estimate Crop Evapotranspiration of Wheat in Punjab, Pakistan*, International Journal of Academic and Applied Research (IJAAR), 2 (9) (2018) 8-13.

[14] D. Thi Loi, T. Chou and Y. Fang, *Integration of GIS and Remote Sensing for Evaluating Forest Canopy Density Index in Thai Nguyen Province, Vietnam*, International Journal of Environmental Science and Development, 8 (8) (2017).