Application of Hyperion data for investigating agriculture field stress to drought conditions

Soghra Andaryani, Dennis Trolle and Abolfazl Mokhtari Asl

December 31, 2019

Application of Hyperion data for investigating agriculture field stress to drought conditions

S. Andaryani[1], D. Trolle[2], A. Mokhtari asl[3]

[1]Department of Remot sensing and Geomorphology, faculty of planning and environmental science, Tabriz University, Iran (s.andaryani@gmail.com)

[2]Department of Bioscience, Aarhus University, Vejlsøvej 25, 8600 Silkeborg, Denmark

[3]Expert of Natural Resources and Watershed Management Administration of Estern Azarbyjan, Iran

I. INTRODUCTION

Hyperspectral remote sensing has been considered as one of the most important sources of data collection in recent years. Remote sensing is used to monitor environmental key aspects such as forest fires, agricultural and water resources dynamics. Considering that drought affect the health of vegetation, information and maps produced using remote sensing can be an indicator for assessing the level of disease or the effects of drought [1]. The Hyperspectral sensor was installed on the EO-1 satellite and placed in November 2000 in a quasi-polar orbit. This sensor depicts a spectral range of 356 to 2575 nm electromagnetic spectrum with a spectral resolution of 10 nm and a spatial resolution of about 30 meters; it and has 242 bands, of which 196 are non-repetitive bands. Hyperspectral images have been used in various research projects. Patel et al, using these images, detected the changes in the growth parameters of crops such as leaf area index, chlorophyll and biomass [2]. Petrovic et al, using hyperspectral data from Hymap combined with geochemical data, studied the properties of minerals and chemical changes in hydrocarbon-affected areas, altering ground rock, and with high precision zoning the altered and non-altered areas in the region [3]. In the present study, hyper-spectral images of Hyperion were used to detect the water stress of agricultural products.

II. CASE STUDY

The study area in the west of Urmia Lake and Urmia city, Iran, has an area of about 143 km^2 and was located in the geographical location of 37 °, 35 ', 30 " to 37 °, 46' , 30 " northern latitude and 45 °, 0 ', 33 " to 45 °, 04 ', 36 " eastern longitude. The study area was determined according to cropping time, availability of images, and arable land. Figure 1 shows the location of the study area.

III. MATERIAL AND METHOD

Hyperspectral Hyperion imagery (EO-1) [4] from 2010/5/30 (growing season for harvest) is used to derive indicators. Embedded lines were corrected in bands used to reflect the neighboring pixels using a 3 × 3 kernel [5]. Atmospheric Correction was done using Logarithmic residuals (LR) and internal average relative (IAR) method [6-7]. To extract areas affected by water stress three indicators (e.g. Greenness Index (GI), Canopy Water Index (CWI) [8], and Light Use Efficiency Index (LUEI)) [9] were been used. Considering there are many indices for calculating vegetation density, three types of indicators, namely the Normalize Difference Vegetation Index (NDVI) [3], Enhanced Vegetation Index (EVI) [10], and Red Edge Normalize Difference Vegetation Index (RENDVI) [11] were used to derive GI. These indices can be derived due to the sensitivity of the bands signals to concentration of chlorophyll, leaf width, foliage aggregation, and the type of canopy structure. Indicators and the relationship of calculation of each indicators are presented in Table 1.

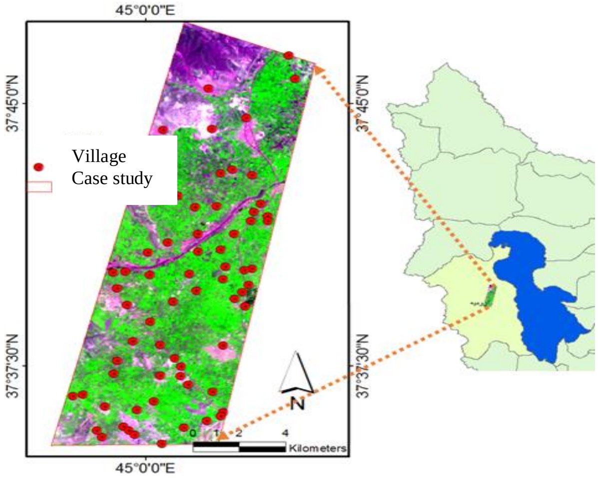

Figure1: Location and villages in the study area

Table 1. Indexes and calculation function (B is number of band)

Sort of Index	Index
GI	NDVI=$(B_{45}-B_{33}/B_{45}+B_{33})$, EVI=$2.5*(B_{45}-B_{33}/B_{45}+6*B_{33}-7.5*B_{11}+1)$ and RENDVI=$(B_{40}-B_{35}/B_{40}+B_{35})$
CWI	WBI=(B_{76}/B_{83})
LUEI	ARI=$(1/B_{20})-(1/B_{35})$

IV. RESULT AND ANALYSIS

In this study, two general correction methods of LAR and LR were used. LAR correction done by removing non-vegetation locations on the image seemed to be the best correction for the subject of agricultural stress studies. Figure 2 shows the comparison of these two types of corrections to calculate vegetation index.

After correction, the three individual vegetation indices was combined with the water band index and the anthocyanin reflection index. Figure 3 shows the combination of NDVI, RENDVI and EVI vegetation indices with WBI and ARI indices.

To compare the results of each of the five classes of indices combinations, the area of the classes was calculated. Table 2 shows the area of each of the classes in each of the compounds.

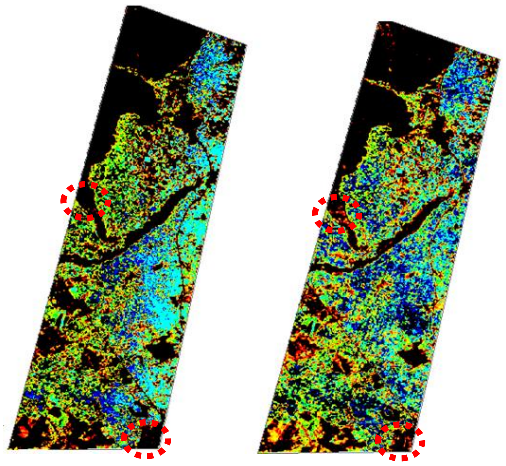

Figure 2: Comparison of the effects of atmospheric correction types for stress detection in agricultural products, left-side correction by LAR and right correction by LR (dotted lines represent areas with clear difference in the correction of the two methods).

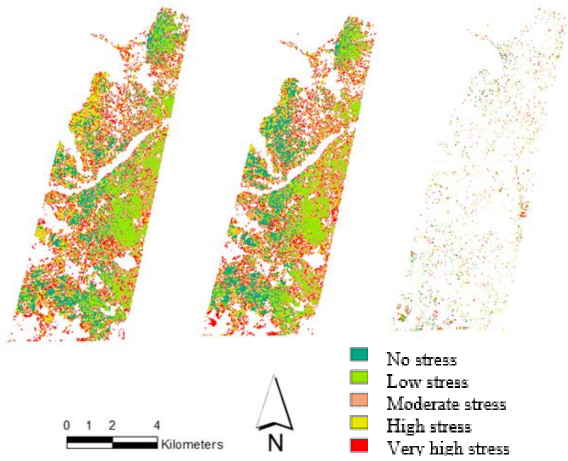

Figure 3: The result of overlapping indicators for the study of agricultural stress, from left to right, is the combination of EVI, RENDVI and NDVI with WBI and ARI indices

Table 2: Area of classified image classes for extracting agricultural stress in various vegetation indices (hectare)

Class No.	NDVI with and WBI ARI	EVI with and WBI ARI	RENDVI with ARI and WBI
No stress	1398	80	1350
Low stress	1516	142	1515
Moderate stress	1848	146	1844
High stress	1761	152	1783
Very high stress	1737	137	1782

According to Table 2, the area of stress in GI is different from each other. However, RENDVI and NDVI vegetation indices show close proximity. The EVI somewhat different, which is due to the number of coefficients and bands that lies within the range of the blue spectrum, which cannot readily reflect vegetation. When combined with the WBI and ARI indicators, this eliminates many areas of vegetation land use.

V. CONCLUSION

Vegetation indices are the most popular satellite banding calculations. These are used to calculate the vegetation cover, to study vegetation types, and the vegetation of a region at different times. In this study, we combining these indices with water indices, crown cover and brightness of plant pigments using Hyperion data, to estimate areas of influenced by water stress. The results show that by combining various vegetation cover indices with different WBI and ARI indices different results are obtained. The two vegetation indices RENDVI and NDVI offer nearly close result, but the combination of the NDVI, WBI, and ARI indices seems closets to reality. The survey of observation data from the area of crops in 2010 and 2011 indicates that the area of agricultural farms is reduced by about 5000 hectares during this period [12]. To record and follow this ongoing trend, the combination of the NDVI index with the WBI and ARI indices is recommended instead of other GI indices.

REFRENCES

[1] Marcos B., Viliam H. & Rasel V.,2010. Hyperspectral sensing: principles and applications, Translation: Alavi panah, K., Minai, M.and Nasiri, H., Norbakhsh press.

[2] Patel N.K, Patnaik C, Dutta S, Shekh A.M, Dave A.J. Study of growth parameters using airborne imagine spectrometer data. International Journal of Remote Sensing, 22(12), 2401-2411, 2001.

[3] Petrovic A, Khan S.D, Thurmond A.K. Integrated Hyperspectral Remote Sensing, Geochemical and Isotopic Studies for Understanding Hydrocarbon-induced Rock Alterations. Journal of Marine and Petroleum Geology, 35: 292-308, 2012.

[4] United States Geological Survey (USGS). Online Spectral Library (presented in http://speclab.cr.usgs.gov, 2012.

[5] Goodenough D.G, Dyk A, Niemann O, Pearlman J.S, Chen H, Han T, Murdoch M, West C. Processing HYPERION and ALI for Forest Classification.IEEE Trans. Geosci. Journal of Remote Sensing, 41(2): 1321-1331, 2003.

[6] Kruse F.A. Use of Airborne Imaging Spectrometer Data to Map Minerals Associated with Hydrothermally Altered Rocks in the Northern Grapevine Mountains, Nevada and California, Journal of Remote Sensing of Environment. 24(1): 31-51, 1988.

[7] Ben-Dor E. Kruse F.A. the Relationship between the Size of Spatial Subsets of GER 63 Channel Scanner Data and the Quality of the Internal Average Relative Reflectance (IARR) Correction Technique, International Journal of Remote Sensing, 15(3): 683-690, 1994.

[8] Penuelas J, Filella I, Biel C, Serrano L, Save R. The Reflectance at the 950-970 Region as an Indicator of Plant Water Status. International Journal of Remote Sensing, 14:1887-1905, 1995.

[9] Gitelson A.A, Merzlyak M.N, Chivkunova O.B. Optical Properties and Nondestructive Estimation of Anthocyanin Content in Plant Leaves. Journal of Photochemistry and Photobiology, 71:38-45, 2001.

[10] Heuete A. R. A Soil-Adjusted Vegetation Index (SAVI). Journal of Remote Sensing of Environment, 25:
295-309, 1988.

[11] Gitelson A.A, Merzlyak M.N. Spectral Reflectance Changes Associated with Autumn Senescence of Aesculus Hippocastanum L. and Acer Platanoides L. Leaves. Spectral Features and Relation to Chlorophyll Estimation. Journal of Plant Physiology, 143: 286-292, 1994.

[12] Iranian Ministry of Jahade-Agriculture (MOJA). Agricultural Statistics and the Information Center, Tabriz, Iran, 2011