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# Utility of the Normalised Difference Vegetation Index (NDVI) for land/canopy cover mapping in Khalkhal County (Iran)

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**ABSTRACT**

*Normalized Difference Vegetation Index (NDVI) is commonly used for assessing and monitoring ecological variables such as vegetation cover, above-ground biomass and Leaf Area Index. This paper examines the utility of NDVI for mapping the land/canopy cover characteristics in Khalkhal County in north-west of Iran. Images were selected by considering seasonality and phenological patterns, and three images from three sensors including: Landsat TM (30/09/1987), ETM$^+$ (29/07/2002), and IRS P6LISSIII (26/05/2008) were selected. Preporccessing stages including geometric and radiometric corrections and topographic normalization were conducted, and NDVI of those images were derived. Land / canopy cover of 270 sites using point intercept method were estimated and sample sites using GPS were recorded. Collected points transferred on image and using zonal-based attributes average of 16 pixels around the GPS points transferred to excel file and correlated with field collected data. Derived maps were evaluated for accuracy assessment and correlation analyses. Results showed that: although there is some considerable evidence that the results of the derived NDVI are acceptable, however by comparison of the derived maps with the field data, there are considerable differences. Accuracy assessment showed that the results are not acceptable. Finally, the correlation analyses between individual land/canopy covers showed that there are no significant ($p>0.05$) relationships between data extracted from images versus field collected data. Therefore, the use of NDVI in the routine procedure in the same regions of Khalkhal County is not suitable for canopy/land cover mapping. Results of this study suggest that further analysis are required to determine the usefulness of the NDVI calculated from course resolution satellite data for estimation of land/canopy cover when there is high heterogeneity exists on the study area.*

**Key words**: Remote sensing, Indices, Landsat, IRS, Azerbaijan, Ardabil province, Iran

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## INTRODUCTION

Remote sensing has developed as a powerful tool in environmental studies because it can provide calibrated, objective, repeatable and cost effective information for large areas and it can be empirically related to collected field data [25, 22]. One of the most common applications of remote sensing is land/canopy cover monitoring and assessment via remote sensing indices which combine reflectance measurements from the bands of remote sensing instruments [41, 22]. Remote sensing indices derived from satellite data are one of the primary sources of information for operational monitoring of the land's vegetative and other land covers. These indices are radiometric measures of the spatial and temporal patterns of land covers such as vegetation photosynthetic activity that are related to canopy biophysical variables such as Leaf Area Index (LAI), fractional vegetation cover, biomass, etc. [7, 46, 22]. Spectral indices are simple mathematical combinations of two or more spectral values to produce a single value that describes a photosynthetic organism's quality or condition and quantity [47, 51, 27, 13, 45, 5, 6, 20, 22].The basic idea of a spectral index is to collapse the multispectral or hyperspectral remote sensing values to a particular measure, which is related to some characteristics (i.e. vegetation cover and greenness) of an object [48].

Moreover, these mathematical combinations are designed to minimize the effect of external influences such as solar irradiance changes due to the atmospheric effect or variations in soil background optical properties in the vegetation canopy spectral response. Healthy green vegetation has distinctive reflectance in the visible and near-infrared regions of the spectrum. At visible and in particular red wavelengths, plant pigments strongly absorb the energy for photosynthesis, whereas in the near-infrared region, the energy is strongly reflected by the internal leaf structures. This strong contrast between red and near-infrared reflectance has formed the basis of many different vegetation indices. When applied to multispectral or hyperspectral remote sensing images, these indices involve numeric combinations of the sensor bands that record land surface reflectance at various wavelengths. Pearson and Miller [40] first presented the near infrared/red ratio for separating green vegetation from soil background. Since then, numerous vegetation indices have been proposed, modified, analyzed, compared and classified [47, 51, 27, 13, 45, 5, 20].The NDVI is the example of the most common vegetation indices to analyze the green cover of photosynthetic vegetation in image processing.

**Normalized Difference Vegetation Index (NDVI)**

The NDVI, which is a combination of red and NIR reflectance measurements (equation 1), is one of the most widely used vegetation indices in the world [43] and has been used extensively as an indicator of the state of vegetation over many spatial and temporal resolutions [28, 36]. It is based on the difference between the maximum absorption of radiation in the red spectral band and the maximum reflection of radiation in the near-infrared spectral bands. Values of the NDVI range between –1.0 and +1.0, but are usually positive for soil and vegetation. For bare soils alone, depending on composition and wetness, NDVI varies between 0.1 and 0.2 [9]. Glenn et al., [22] reported that in remote sensing studies bare soil value scaled at 0, and 100% vegetation scaled at +1 to get fractional cover for a given pixel or area of interest in the scene. Denser and/or healthier vegetation will have higher values. NDVI values for vegetation usually offer a means of efficient and objective evaluation of phenological characteristics [44]. NDVI increases near-linearly with increasing LAI and then enter an asymptotic phase in which NDVI increases very slowly with increasing LAI [54, 32]. This index shows positive correlation with photosynthetic activity, vegetation cover, biomass, and LAI [50]. Lacking the plants' absorption / reflectance mechanisms, soil spectra typically do not show such dramatic spectral differences on this index [33]. According to experimental measurements with different soil backgrounds [30], NDVI approach their maximum values at fractional vegetation covers between 80 to 90%. Similar experiments conducted by Díaz and Blackburn [15] showed NDVI reaching asymptotic values at fractional vegetation covers of only 60%. Gutman and Ignatov [26] resolved this problem by prescribing local LAI equal to infinity and derived green vegetation cover from a scaled NDVI taken between bare soil NDVI and dense vegetation NDVI. Wittich and Hansing [53] studied the relationship between NDVI and vegetation fraction at five test areas in Germany, and showed that, to a first approximation, the vegetation cover fraction was adequately described by the linear expression of NDVI over a wide distributed range of heterogeneous vegetation densities. Several other studies also showed a strong linear relation between fractional vegetation cover and NDVI [34, 32].

$$\text{NDVI} = \frac{\rho NIR - \rho R}{\rho NIR + \rho R} \qquad \text{equation 1}$$

where ρ is the reflectance value in the indicated spectral bands. "R" is the reflectance in the red channel and "NIR" is the reflectance in the near-infrared channel of different sensors such as TM, $ETM^+$, IRS, etc. On the other hand, some other studies outlined that NDVI cannot be accurately transformed between field and satellite scales in a linear fashion [42, 23, 24]. Indeed, there is little knowledge of interactions between spatial heterogeneity in a photosynthetic canopy and spatial scale of measurement, although researchers are beginning to address such issues [23, 24, 48]. Another problem with NDVI is that often it is not a product of the process with which it is correlated [27, 9]. That is, NDVI can be an indicator of different things such as at different locations and times (both seasonally and inter-annually). These include dissimilarities in canopy background (i.e. substrate) reflectance characteristics: the presence of leaf litter, senescent (i.e. standing dead) vegetation, and woody materials; differences in green vegetation coverage, density, geometry and phenology; short and long-term climate variation; canopy bi-directional reflectance properties; and contrasting management practices [27, 9]. Li et al. [37] have shown that the scene brightness can account for up to 30% of the variation of NDVI for some land covers. Another problem is the expected difference between NDVI measured at the surface and from space, which is related to dissimilar atmospheric attenuation of red and near infrared radiation [9]. Moreover, Huete [27] and Huete et al. [29] reported that the NDVI is the inherent nonlinearity of ratio-based indices and the influence of additive noise effects, such as atmospheric path radiances. They also reported, the NDVI exhibits scaling problems, asymptotic (saturated) signals over high biomass conditions, and is very sensitive to canopy background variations with NDVI degradation particularly strong with higher canopy background brightness. The canopy background correction is relevant for vegetation monitoring since 70% of the Earth's terrestrial surface consists of open canopies with significant canopy background signals exerting some effect on the canopy reflectance properties.

**Application of the NDVI in Iran**

One of the applied indices, which are frequently used in Iran, particularly using coarse to moderate spatial resolution imagery such as MODIS, Landsat MSS, TM, $ETM^+$, SPOT, ASTER, IRS and other sensors data is the NDVI [3, 18, 1, 31, 4, 2, 21, 17]. For example, the NDVI has been used for monitoring agricultural drought in Mashhad region and a new drought index by considering this index was introduced [49]. Moreover, it has been used for vegetation mapping in Nishabour plain Ghaemi et al., [21] who is reported the high potential of this index for the used purposes. Naghibi et al. [39] reported that, the application of the NDVI did not show significant results, for vegetation monitoring. Esfandiari et al. [16] reported that there is low potential using the NDVI in detection of *Avicennia* or Mangrove forested area in south of Iran. Moreover, the NDVI has been used for individual species detection. For example, Behbahani et al. [8] used the NDVI for individual *Pistatica atlantica* detecting in south Khorasan province and concluded that there was significant correlation for detecting this species. Overall, NDVI has been used for predictive modeling for natural resource management at national to local scale in Iran. Moreover, this index has been applied in interdisciplinary fields such as watershed management sectors. For example, in driving empirical models of hydrology, erosion and sediment estimation [2, 17] this index has been used as a land cover estimator, and produced land cover map, were incorporated in model calculation without reliable calibration procedures. This study was conducted to evaluate the suitability of the NDVI for land/ canopy cover estimation in Khalkhal County in south of Ardabil province in northwest of Iran.

## MATERIALS AND METHODS

***Study area***

Khalkhal County is located in northwest of Iran (south of Ardabil province / Figure 1). The County lies within latitudes 37° 07′ to 37° 53′N and within longitudes 48° 12′ to 49°00′E, covering an area of 292867 ha. Initially, digital 1:25,000 topographic maps of the study area were used to derive a 20×20 m Digital Elevation Model (DEM) Map using ArcGIS9.3 based on Thin Plate Splines (TPSs) algorithm of the study area (Figure 2). Altitude varies from 521 to 3230 m, about 2709m elevation differences (Figure 2). Mean annual precipitation is about 360 mm (15.7% of that in March and 1.7% in August as the highest and lowest during a year), mean annual temperature is 9.7ºC (Max 35 and Min -35.5ºC), and generally with cold semi-arid climate. More than 95% of this county is mountainous area. Soil depth, texture, and physical, chemical and biological components are different. The major land uses are rangeland (more than 80%) and rest of the land uses are dry farming, irrigated farming, gardens, residential and industrial areas and forest lands respectively. Major vegetation types on natural lands are: *Juniperous* semi-steppe woodlands, Hyrcanian forest, steppic shrublands and meadow lands. Agricultural lands almost distributed up to 20 to 30% slopes. Riversides and valleys with moist condition are covered with garden and wild trees. Highland areas with smooth slops and low temperature are covered with meadow lands, with two types: including high and short meadows. Hyrcanian forest has dense canopy cover (100%) and *Juniperous* semi-steppe woodlands with canopy cover varied from 0 to 50% with three layers including herbaceous, shrubby and tree plants.

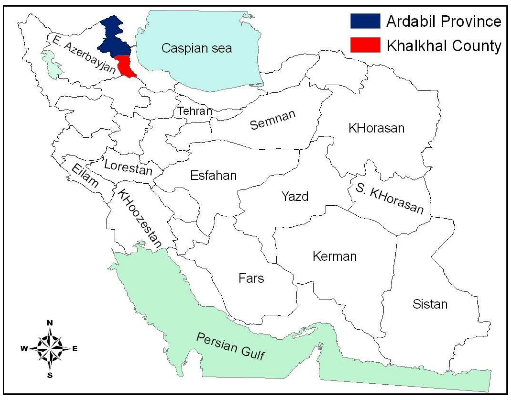


**Figure 1. Study location in Iran and Ardabil province**

**Seasonality and phenological consideration**

By considering seasonality and phenological patterns of the Khalkhal County, according to 2709m altitude variation, there is no considerable seasonality variation, but phenological stages are different (there are 4 discernable seasons, however with different temperature and type of precipitation in different elevation, phenological stages are different). Growing season in near Ghezelozan River and low altitude areas, each year start almost from late February and lasted to end of September, if moisture is available. According to this situation, in coastal areas of this river, farmers are usually planted two crops in each growing season, however on rangeland area by the limitation of moisture; growing season usually lasted maximum up to late May. On the other hand, in the highland areas of the

County growing season is very short and lasted in less than 3 months (Start almost late March to early April and ended at the late September). Therefore by considering these differences, the peak growing stage on the County is not the same, which can create problem in the getting greenness values from satellite data. Overall, by considering these issues, the best time of the image selection to cover both low and high altitude areas was to select an image in late April or early May of each year. Moreover, another issue in which can be considered in image selection is the moisture content affected by recent rainfall or close to image acquisition time, thus to avoid the moisture affects on the image data, 15 days before image selection were considered, however there was no considerable rainfall in this period for the selected images. Therefore, possible images by considering seasonality and phenological patterns and moisture content were selected.

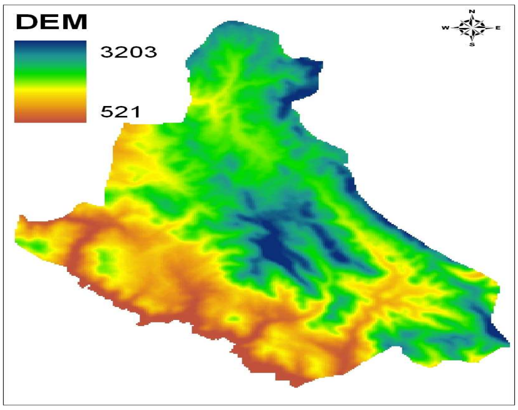


**Figure 2. DEM of the Khalkhal County**

### Field data

Sample locations defined systematically by considering road accessibility and different land uses and land covers in the first place, then samples located randomly in each land uses and land covers. Samples located in an appropriate distances from the roads and boundary of each land uses. Some parts of the study area because of the lack of road accessibility did not covered by sampling. Land / canopy cover (Table 1) estimated using line point intercept method (500 points on a 100 ×100 m plot size, over five 100 m transect) by including necessary precautions for ground sampling such as homogeneity of sampling area for remote sensing studies. Major land covers such as bare soil, litter, stone (>3cm), non woody plants, shrubs, trees on different land uses were recorded. The center of each sample location using a $\text{Garmin}_{\text{etrexVista}}$ GPS (±10m) was recorded and using Oziexplorer 3.95.4q transferred to computer as the shapfile format. In ArcGIS all attributes, which were collected from the field, classified and added to the GPS points. In 2009 about 114 samples and 2010, 156 samples (totally 270 samples) were collected. Precipitation of the first year (2009) of sampling was 359mm and year 2010 was 380mm.

**Table 1. Main land covers, which were considered for sample collection in this study.**

| Main Land covers | Sub land covers / Descriptions | | No. of Samples |
|---|---|---|---|
| Out crops | Area's which is covered by more than 30% stone (stone larger than 3 cm & out crops are included) | | 15 |
| Agricultural lands | Dry farming | | 42 |
| | Irrigated farming | | 12 |
| | Garden & wild trees such as *Salix* spp. & *Platanus orientalis, Phragmites australis* , … | | 28 |
| Residential & industrial areas | Including urban, rural, road, … | | 24 |
| Rangelands | Steppic shrublands | | 106 |
| | Meadow lands | Short meadows | 3 |
| | | High meadows | 11 |
| Forests | Hyrcanian forest | | 2 |
| | *Juniperous* semi-steppic woodlands | | 27 |
| Total | | | 270 |

### Satellite Data and Data Analysis

A full scene of three images from three sensors including: 1) Landsat Thematic Mapper (TM) (30/09/1987/ path 167, row 34), 2) Landsat Enhancement Thematic Mapper plus (ETM+) (29/07/2002/ path 167, row 34)), and 3) Indian Remote Sensing (IRS) P6LISSIII (03/04/2008/ path 065, row 042) were acquired. Obtained image has been registered to the Universal Transverse Mercator (UTM) map projection with a datum of the WGS84 by vendors. The study area is located in zone 39(N) of UTM. However, according to the collected Ground Control Points (GCP) and other GIS layers such as registered topographic maps, acquired images were still required to be rectified. Using affine transformation model acquired images geometrically corrected to the WGS84 to align accurately with the GIS layers and collected GPS points. In image geometric correction Root Mean Squire (RMS) errors of 18 points selected from 50 GCP were (RMS) 1.22 pixels. Period of field data collection synchronized almost with IRS images in 2008. The IRS image synchronized almost on average of the full growth of annual and perennial plants on the study area. Image preprocessing stages, including atmospheric, radiometric corrections, topographic normalization and image enhancements, were conducted before image utilization (Chavez, 1996; Chander and Markham, 2003). NDVI of the selected images were calculated. Collected sample points transferred to ArcGIS9.3 and a polygon using selected images by average of 16 (4×4) pixels around the GPS points was derived. Using the derived polygon and each selected images and zonal-based attributes function of ERDAS Imagine8.7, mean value of each channel in each image transferred to an excel file, and then estimated attributes from sample location added to this file.

**Accuracy assessment**

By considering literature such as Carlson and Ripley [9] and Glenn et al. [22], and also as in this study there was no close range spectra collection, thus by considering Gutman and Ignatov [26] proposed method and controlling bare ground in defined areas from field visits, which were about -0.25 to + 0.18 on the study area. On the other hand, dense vegetation cover varies from +0.27 to +0.74. Thus, by considering literature and controlled areas from this study, bare soil scaled as 0, and 100% canopy cover scaled as maximum value of NDVI of each image in this study area. Overall accuracy calculated based on Dellepiane and Smith [14] formula and Kappa statistic calculated based on Foody [19] formula.

**Correlation analysis between field vs. image data**

**A. Correlation Analysis based on row / heterogeneous data**

The relationships between field collected data (land cover attributes) and the NDVI, which was derived from 16 (4×4) pixels around the GPS points, tested using SPSS16 and interpreted.

**B. Correlation analysis based on classified (modified)/ homogeneous data**

The relationships between field collected and classified (modified) data (land cover attributes) and the NDVI, which was derived from 16 (4×4) pixels around the GPS points, tested using SPSS16 and interpreted. The classification (modification) of the field collected data based on the Table 2, by considering literature [23, 24, 48] which was claimed that NDVI can show significant relationships with the homogeneous land covers. In the modification process the sites with lower than the mentioned covers at each sites, were eliminated and correlation analysis built on the remained data.

**Table 2. The classified field collected data based on the homogeneous patterns.**

| Land cover units | Sub land covers / Descriptions |
|---|---|
| Grasses & Grass Likes | Areas which were covered by more than 20% grass or grass-like plants |
| Forbs | Areas which were covered by more than 2% forb plants (most of the sites have lower than 2% forb canopy caver) |
| Shrubs | Areas which were covered by more than 5% shrubby plants |
| Trees | Areas which were covered by more than 20% tree plants |
| Total canopy cover | Areas which were covered by more than 20% canopy covers |
| Litter | Areas which were covered by more than 2% litters (most of the sites have lower than 2% litter caver) |
| Stone & out crops | Areas which were covered by more than 20% stone & out crops |
| Bare soil | Areas which were covered by more than 10% bare soils |

## RESULTS AND DISCUSSION

**NDVI maps derived from images**

The collected sample points and Landsat $ETM^+$ 2002, as an example, is shown in Figure 3. According to this Figure, there is no considerable water body and snow on the study area in the times of acquired images; however some small cloud can be seen on the image, which were considered in NDVI interpretation. Moreover, Hyrcanian forest, Meadows (short & high) and Garden and Wild trees with about 100% canopy cover are considerable on this image, which were considered in the interpretation of NDVI results. As shown in Figure, according to the road accessibility limitation, the sample locations were selected regarding to the existing roads, thus some parts of image is not properly covered by field samples. Derived NDVIs for three selected images are presented in Figures 4 to 6. As Figure 4 for image 1987 (TM) shows, the NDVI value fluctuated from – 0.67 to +0.69, in Figure 5 for image 2002 ($ETM^+$) the derived values varies from -0.44 to +0.74 and in Figure 6 for image 2008 (IRS) values varies from -0.75 to +0.27. By considering the theory of NDVI that varies from -1 to +1, although the lowest values in three produced maps by existing cloud are acceptable, by interpretation of these produced maps using the NDVI, there are no 100% canopy cover at the study area. For bare soil as mentioned the amount of NDVI varies from -0.25 to 0.18 in three selected images. However, from the field collected data and existing forest area with 100% canopy cover (Hyrcanian forest, Garden & Wild trees, etc/ Figure 3) the validity of the NDVI maps for TM, $ETM^+$ and IRS P6LISSIII imagery in applying to such area is questionable and needs more investigation.

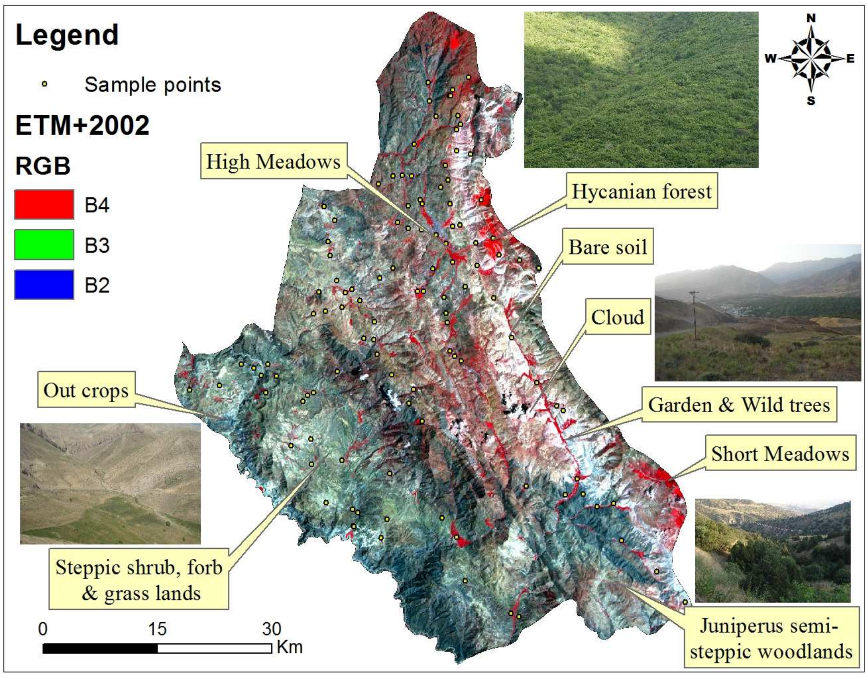


**Figure 3. Landsat ETM+ 2000, location of sample points, dry farming and irrigated farming visually cannot discriminate by considering small extent and mixed pattern.**

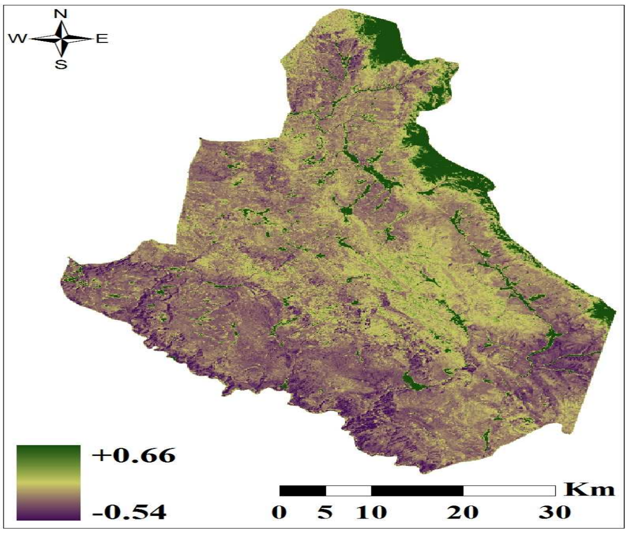


**Figure 4. Derived NDVI for the study area from Landsat TM 1987 (a small part of the Khalkhal County in south west of the image are not included)**

The accuracy of derived NDVI, depended on many issues, including the familiarity of the analyst with the pattern and distribution of different land cover components (e.g. woodland, shrubland, etc), as well as familiarity with their spectral and spatial patterns on the remote sensing imagery. Overall, by considering the summary of confusion matrices (Table 3) results were unacceptable, which means using IRS images for different indices on the areas such Khalkhal county more consideration are required.

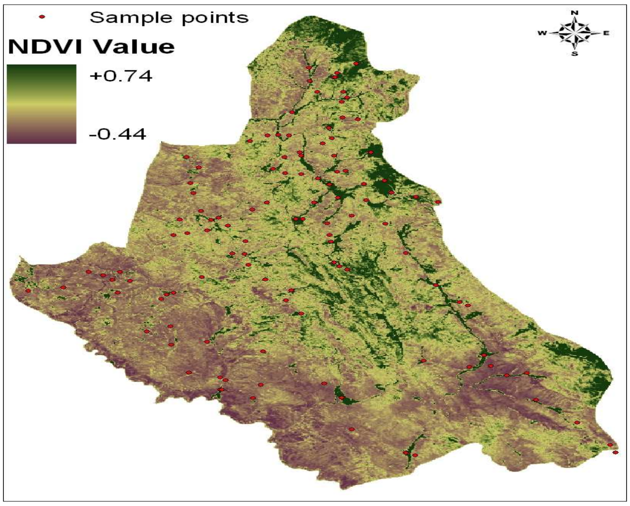


**Figure 5. Derived NDVI for the study area from Landsat ETM+2002**

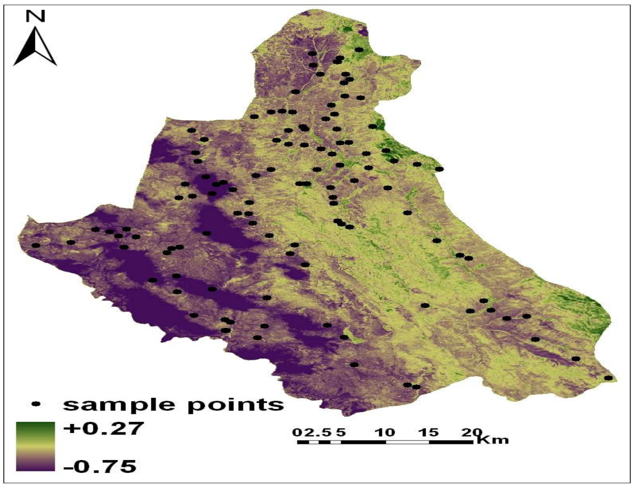


**Figure 6. Derived NDVI for the study area using IRS 2008 image (there is some cloud, which were considered in the analysis)**

**Table 3. Summary of confusion matrices for the results of overall accuracy and Kappa statistics of real NDVI (non-scaled) from derived image and scaled NDVI values for the produced maps/ Abbreviations in Table used are: P= Producer accuracy; U= User accuracy; OA= Overall Accuracy; K= Kappa statistics.**

| Pre-defined class name | Images | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30/09/1987 | | | | 29/07/2002 | | | | 26/05/2008 | | | |
| | Real NDVI (non-scaled) | | Modified NDVI (Scaled) | | Real NDVI (non-scaled) | | Modified NDVI (Scaled) | | Real NDVI (non-scaled) | | Modified NDVI (Scaled) | |
| | P (%) | U (%) | P (%) | U (%) | P (%) | U (%) | P (%) | U (%) | P (%) | U (%) | P (%) | U (%) |
| Bare ground | 33 | 33 | 43 | 41 | 34 | 31 | 44 | 44 | 35 | 33 | 44 | 45 |
| Stone | 35 | 31 | 45 | 44 | 35 | 36 | 46 | 46 | 37 | 35 | 48 | 47 |
| Liter | 9 | 11 | 39 | 36 | 14 | 13 | 38 | 35 | 13 | 17 | 39 | 42 |
| Total canopy cover | 22 | 23 | 25 | 30 | 28 | 27 | 28 | 23 | 30 | 29 | 30 | 30 |
| Tree canopy | 27 | 26 | 7 | 8 | 27 | 31 | 25 | 33 | 28 | 26 | 26 | 25 |
| Shrubs canopy | 5 | 8 | 55 | 50 | 13 | 10 | 49 | 52 | 14 | 16 | 34 | 35 |
| Forbs canopy | 8 | 9 | 56 | 54 | 11 | 15 | 56 | 52 | 13 | 12 | 58 | 58 |
| Grasses & Grass likes canopy | 25 | 23 | 28 | 32 | 25 | 28 | 32 | 34 | 25 | 28 | 39 | 39 |
| | OA =21% | | OA =31% | | OA =28% | | OA =30% | | OA =29% | | OA =34% | |
| | K =0.20 | | K =0.32 | | K =0.28 | | K =0.34 | | K =0.29 | | K =0.34 | |

**Results of calculated NDVI from extracted Pixels vs. field collected data**

**A. Results based on field collected data (raw data / heterogeneous data) and correlation analysis**

Results of correlation for NDVIs calculated from extracted 4×4 pixels of each image and land covers are presented in Table 4 and as an example, Figure 7 shows the relationship between total canopy cover and NDVI value in Landsat TM imagery of 1987.

**Table 4. Correlation results between fields collected data and the NDVI, which all are not significant.**

| Images<br>Land/Canopy cover | 30/09/1987 | 29/07/2002 | 26/05/2008 |
|---|---|---|---|
| Grasses & Grass likes | 0.00 | 0.00 | 0.002 |
| Forbs | 0.026 | 0.006 | 0.013 |
| Shrubs | 0.012 | 0.004 | 0.018 |
| Tree | 0.00005 | 0.003 | 0.00005 |
| Total canopy cover | 0.003 | 0.007 | 0.011 |
| Liter | 0.00005 | 0.007 | 0.004 |
| Stone | 0.002 | 0.001 | 0.001 |
| Bare soil | 0.002 | 0.00 | 0.002 |

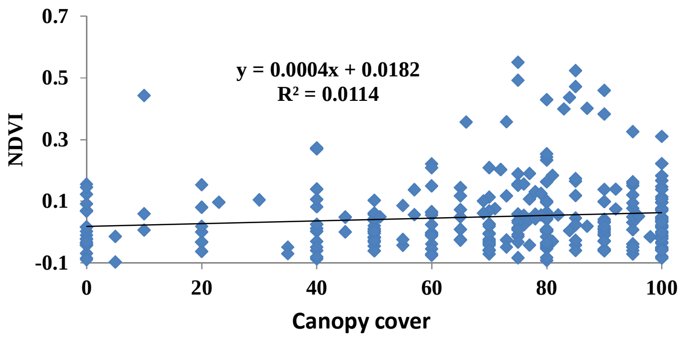


**Figure 7. Relationship between total canopy cover and NDVI value in Landsat TM imagery 1987, as an example.**

## B. Results based on classified field collected data and correlation analysis

Results of relationships between classified field collected data and NDVI extracted from 4×4 pixels of each images are presented in Table 5. As can be seen from Table, correlation between field and image data are improved about 75% in comparison with raw field collected data. These results are contrast with the results of derived NDVI from the image. It means these results support the claim of previous studies, which if the image scene is heterogeneous, digital image interpretation cannot produce a good result. However, by reducing the heterogeneity, the significance of relationship has increasingly are improved.

**Table 5. Results of correlation analysis between NDVI and categorized land cover attributes (**p>1%, * P>5% and ns= non-significant.**

| Land covers | Sensors | $R^2$ |
|---|---|---|
| Grasses & Grass likes | TM1987 | $0.12^{ns}$ |
| | $ETM^{+}2002$ | $0.10^{ns}$ |
| | IRS2008 | $0.18^{*}$ |
| Forbs | TM1987 | $0.11^{ns}$ |
| | $ETM^{+}2002$ | $0.11^{ns}$ |
| | IRS2008 | $0.19^{*}$ |
| Shrubs | TM1987 | $0.29^{*}$ |
| | $ETM^{+}2002$ | $0.43^{**}$ |
| | IRS2008 | $0.31^{*}$ |
| Trees | TM1987 | $0.57^{**}$ |
| | $ETM^{+}2002$ | $0.64^{**}$ |
| | IRS2008 | $0.71^{**}$ |
| Total canopy cover | TM1987 | $0.26^{**}$ |
| | $ETM^{+}2002$ | $0.22^{**}$ |
| | IRS2008 | $0.21^{**}$ |
| Litters | TM1987 | $0.21^{ns}$ |
| | $ETM^{+}2002$ | $0.48^{*}$ |
| | IRS2008 | $0.26^{ns}$ |
| Stone | TM1987 | $-0.53^{*}$ |
| | $ETM^{+}2002$ | $0.51^{*}$ |
| | IRS2008 | $0.50^{*}$ |
| Bare soil | TM1987 | $0.76^{**}$ |
| | $ETM^{+}2002$ | $0.75^{**}$ |
| | IRS2008 | $-0.75^{**}$ |

There is different value of NDVI for each image, which were taken in different time of the year. This results support the finding of Rundquist [48] which NDVI vales affected by different season of the year. By considering the source of errors such as error of interpreter, field data collection, geometric and atmospheric correction, and etc, which are expected in any remotely- sensed method, in the NDVI can also affect, however the results of this study show that in using the NDVI in the areas such as Khalkhal County, particularly for canopy /land cover mapping by different purposes, particularly for a secondary analysis such as using the NDVI map for erosion, sediment, flood, etc estimation more caution should be considered. Or at least if the NDVI is used for canopy caver map extraction, the accuracy assessment process should be considered. For example, Amirian [2] and Esmali and Ghorbani [17] have been used the NDVI, however there are no evidence of accuracy assessment process in their works.

Overall as Jiang et al. [32] reported, there exist many perspectives and discrepancies on the two related issues of the relationship between NDVI and fractional vegetation cover and the scale effect of NDVI. The principle behind derivation of fractional vegetation cover from NDVI is to relate the NDVI of mixed pixels to reference NDVI values, such as the NDVIs of dense vegetation and bare soil, assuming the individual component NDVIs in mixed pixels can be represented by these reference NDVIs. However, even if component NDVIs can be estimated as the reference NDVI without error, there are still sources of uncertainty caused by the scale effect of NDVI in retrieving vegetation fraction from NDVI. NDVI of mixed pixels and that of the components in mixed pixels are not at the same spatial scale, as the former is at pixel scale, while the latter is at sub pixel scale. It remains unclear the extent to which the pixel scale NDVI corresponds to the sub pixel scale NDVI and what possible relationships exist between them. The relationship between NDVI and fractional vegetation cover appears to be directly influenced by the scale effect of NDVI and an understanding of this effect is essential to understanding the relationship between NDVI and fractional vegetation cover, and for accurate retrievals of vegetation fraction.

As Rundquist [48] reported NDVI has been criticized because of its sensitivity to atmospheric conditions and substrate reflectivity, as well as its insensitivity to increases in vegetation biomass past particular thresholds. Yet, the use of NDVI remains widespread and is attractive because of the ease with which it is calculated. In literature, there is also evidence that NDVI cannot be accurately transformed between field and satellite scales in a linear fashion [42, 24]. Indeed, there is little knowledge of interactions between spatial heterogeneity in a photosynthetic canopy and spatial scale of measurement, although researchers are beginning to address such issues [42, 23]. These include dissimilarities in canopy background (i.e. substrate) reflectance characteristics: the presence of leaf litter, senescent (i.e. standing dead) vegetation, and woody materials; differences in green vegetation coverage, density, geometry and phenology; short and long-term climate variation; canopy bi-directional reflectance properties; and contrasting management practices [27]. There also some other issues which reported by previous studies that results of NDVI complicated. These complication related to nonlinear spatial and temporal variations in the spectral mixing of green vegetation and soil background [27], litter and standing dead vegetation [52], canopy shadows [10], complexities associated with atmospheric attenuation[35], and Sun–sensor–target geometry [38].

To sum up by considering the results, the NDVI has no significant capability to detect different canopy/ land covers in Khalkhal County by the common procedure. Thus, by considering land/canopy cover variation and phenological variation the NDVI is not a suitable index for this region. By considering some preliminary study of using the NDVI based on each land covers, the relationships of field collected data and image information are significantly increased. Thus by considering these results, 1) phenological consideration using the NDVI is necessary, the way of considering to phenology is that to select images based on elevation categories. Thus further studies by considering 1) Increasing the sample sites; 2) Testing different images and sensors; 3) Testing other indices; 4) Deriving possible new indices; 5) Testing segmentation or phsiogonomic type based indices; and 6) Testing altitude based / phenological based indices are required.

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## REFERENCES

[1] Abdollahi J, Bghestani N, Savaghebi MH, Rahimian MH. *J. Sc. Tech. of Agri. Nat. Res.*, **2008**. 44: 301-313.
[2] Amirian S. MSc. thesis, The Faculty of Agriculture, The University Mohaghegh Ardabili. 118p. **2010**.
[3] Arzani H. In proceeding of the 1st Remote Sensing Conference in Kuwait, **2005**. 26-28 pp.
[4] Arzani H, Noori S, Kaboli SH, Moradi HR, Ghelichnia H. *J. of the Iranian Nat. Res.* **2009**. 61(4): 997-1016.
[5] Bannari A, Morin D, Bonn F. *Review*, **1995**. 13, 95-120.
[6] Baret F. In F. M. Danson, & S. E. Plumer (Eds.), Advances in environmental remote sensing. Chichester: Wiley, **1995**.
[7] Baret F, Guyot G. *Environ.* **1991**. 35, 161– 173.
[8] Behbahani N, Fallah Shamsi SR, Farzadmehr J, Erfanifard SU, Ramazani Gasak, M. *Range J.*, **2010**. 4(1): 93-103.

[9] Carlson TN, Ripley DA. *Environ.* **1997**. 62: 241-252.
[10] Curran PJ. *Phi T Roy A.* **1983**. 309: 257-270.
[11] Chander G, Markham BL. IEEE. T. *Geosci. Remote.* **2003**. 41: 2674-2677.
[12] Chavez PS Jr. Photogramm. *Eng. Rem. S.* **1996**. 62: 1025-1036.
[13] Crippen RE. *Environ.* **1990**. 34: 71-73.
[14] Dellepiane SG, Smith PC. *Int. J. Remote Sens.* **1999**. 20: 1461- 1486.
[15] Díaz B. M., & Blackburn, G. A. *Int. J. Remote Sens.* **2003**. 24: 53-73.
[16] Esfandiari E. MSc. Thesis, Khorramshahr University of Marine Science & Technology, **2008**.
[17] Esmali Ouri A, Ghorbani A. *Afr. J. Agric. Res.* **2011**. 6(22): 5112-5122.
[18] Farzadmehr G, Arzani H, Nazari Samani, A. A. *J. Iranian Nat. Res.* **2005**. 58(3): 719-729.
[19] Foody GM. *Eng. Rem. S.* **1992**. 58: 1459-1460.
[20] Fuentes DA, Gamon JA, Qiu HL, Sims DA, Roberts DA. *J. Geophys. Res-Atmos.* **2001**. 106: 33565-33577.
[21] Ghaemi M, SanaiiNejad SH, Astraii AR, MirHusseini P. *Iranian J. Field Crops Res.* **2010**. 8(1): 127-137.
[22] Glenn EP, Huete AR, Nagler PL, Nelson SG. *Sensors.* **2008**. 8: 2136–2160.
[23] Goodin DG, Henebry GM. *Int. J. Remote Sens.* **1998**. 19 (3): 3213-3220.
[24] Goodin DG, Henebry GM. *Int. J. Remote Sens.* **2002**. 23(2): 3865-3871.
[25] Graetz RD. *Environ.* **1987**. 23: 313-331.
[26] Gutman G., & Ignatov, A. *Int. J. Remote Sens.* **1998**. 19: 1533–1543.
[27] Huete AR. *Environ.* **1988**. 25: 295-309.
[28] Huete AR, Liu HQ. IEEE. T. *Geosci. Remote.* **1994**. 32: 897–905.
[29] Huete AR, K. Didan., T. Miura., E.P. Rodriguez., X. Gao, Ferreira G. *Environ.* **2002**. 83: 195-213.
[30] Huete AR, Jackson, RD, Post DF. *Environ.* **1985**. 17, 37-53.
[31] Javadnia E, Mobasheri MR. In Proceeding of the 1st Geo-matic conference, **2008**.
[32] Jiang Z, Huete AR, Chen J, Chen Y, Li J, Yan G, Zhang X. *Environ.* **2006**. 101: 366–378.
[33] Karnieli A. *Int. J. Biometeorol.* **2003**. 47(4): 179-187.
[34] Kustas W. P., Schmugge, T. J., Humes, K. S., Jackson, T. H., Parry, R., Weltz, M. A. *J. Appl. Meteorol*, **1993**. 32, 1781−1790.
[35] Kaufman Y.J. In Theory and Applications of Optical Remote Sensing (G. Asrar, Ed.), John Wiley and Sons, Inc., pp. **1989**. 336 - 428.
[36] Leprieur C., Kerr, Y. H., Mastorchio, S., & Meunier, J. C. *Int. J. Remote Sens.* **2000**. 21: 281−300.
[37] Li Z, Cihlar J, Zheng X, Moreau L, Ly H. IEEE. T. *Geosci. Remote.* **1996**. 34, 1308-1322.
[38] Middleton E. *Environ.* **1991**. 38: 45-62.
[39] Naghibi SJ, Habibian SH, Habibian SMR. *J. Plant Ecophysiol.* **2009**. 1(3): 62-74.
[40] Pearson RL, Miller LD. The 8th International Symposium on Remote Sensing of the Environment'. Ann Arbor, MI. **1972**. pp. 1355–1379.
[41] Pickup G, Chewings VH, Nelson DJ. *Remote Sens. Environ.* **1993**. 43: 243-263.
[42] Quattrochi DA, Lam NSN, Qui HL, Zhao W. (eds D.A. Quattrochi & M. F. Goodchild), **1997**. pp. 295-308.
[43] Ramsey RD, Wright Jr DL, McGinty C. *Geocarto Int.* **2004**. 19: 39-47.
[44] Reed BC, White M., Brown J.F. An Integrative Environmental Science (ed M.D. Schwartz), **2003**. Vol. 39, pp. 365-381.
[45] Richardson AJ, Everitt JH. *Geocarto Int.* **1992**. 1: 63-69.
[46] Richardson AJ, Wiegand CL. *Eng. Rem. S.* **1977**. 43: 1541-1552.
[47] Rouse JW, Haas RH, Schell JA, Deering DW, Harlan JC. NASA/GSFC Final Report, NASA, Greenbelt., **1974**.
[48] Rundquist BC. *Remote Sens. Environ.* **2002**. 81: 129-135.
[49] SanaeiNejad SH, Davari K, Abedi A. *Iranian J. Agri. Sci. Technol.* **2007**. 21(1): 89-96.
[50] Schmidt H, Karnieli A. *J. of Arid Environ.* **2000**. 45: 43-59
[51] Tucker CJ. *Remote Sens. Environ.* **1979**. 8: 127-150.
[52] van Leeuwen WJD, Huete AR. *Remote Sens. Environ.* **1996**. 55: 123-138.
[53]Wittich KP, Hansing O. *Int. J. Biometeorol.* **1995**. 38: 209-215.
[54] Wood FF, Lakshmi V. *J. Climate.* **1993**. 6: 839-857.