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# Mapping Soil Organic Carbon Using IRS-AWIFS Satellite Imagery (Case Study: Dehaghan Rangeland, Isfahan, IRAN)

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**Abstract.** Soil organic matter has positive consequence**s** for the quality and productivity of soil and also environment, agricultural and biological sustainability and conservation of biodiversity and soil. Organic matter plays an important role in the physical and chemical processes of soil and thus, it is of a great effect on the spectral characteristics of soil. This study was done in order to develop the mapping surface of soil Organic Carbon (OC) of various land uses, particularly rangelands using remote sensing technology in Dehaghan in the south of Isfahan. The data of IRS-P6 and AWIFS satellites with 49 ground control points and accuracy less than 0.3 pixels were recorded. Stratified random sampling method was used. Soil samples were collected from the depth of 0-15 cm at each point. Bulk density of soil samples was determined according to Hunk method and OC% was computed by Walky-Black method. For the preparation of land use map and False Color Composite (FCC), the supervised classification was conducted using maximum likelihood algorithm and Optimized Index Factor (OIF). In order to map the surface soil OC, the multivariate regression model was fitted using band 2 (red band) as the dependent variable. Red band had a relationship with surface soil OC in the study area. Relationship of the red band and surface soil OC content was negative. IRS-P6 and AWIFS satellite images according to the cover of spectral and spatial resolution were considered as a useful method for the preparation of land use map and the map of surface soil OC levels in the study area.

**Key words:** AWIFS, Soil organic carbon, Modeling

## 1. Introduction

Soil has the largest carbon source storage and contains two-third of carbon of the earth. Approximately, 1500Gt of it is located in the highest layer and in the depth of one meter upper the soil (Schimel *et al*., 1994). Source of soil Organic Carbon (OC) contains more than two times carbon of the atmosphere and has stored about three times of the amount of the biological resources of the earth (Lal *et al*., 1995).

Under different environmental conditions, soil has high potentials to maintain OC and it is the most important source of carbon storage. Therefore, any changes in carbon storage have considerable effects on carbon dioxide of the atmosphere (Schuman *et al*., 2002). Soil organic matter has positive consequences in the quality and productivity of soil and also environment, sustainability and conservation of biodiversity and agricultural and biological soil (Amir Aslani, 2004).

Soil organic matter plays an important role in chemical and physical processes resulting in large effects on the spectral characteristics of soil. Organic matter has a significant effect on the spectral VNIR and SWIR. The reflex of organic soil is less than sand and the reflex of sand is less than silica. Then, Organic soil seems darker in the optical images (Maumgsrdner *et al*., 1985). Increasing the amount of soil organic matter leads to a reflex less than normal one. When the amount of organic matter reaches about 9 percent, the effects of other soil parameters on reflex will be disappeared (Naghipoor Borj, 2008).

First experience of the relationship between organic matter and reflex in the visible and near Infrared range was obtained by Bumgardner *et al*. (1970) and Al-Abbas *et al*. (1972). Henderson *et al*. (1992) studied the spectral reflexes of three types of soil organic matters. Their study showed a negative relation between carbon level

and soil spectral reflex in the visible and near infrared region. Similarly, Montgomery (1976) reported a strong negative relationship (r=0.58) between carbon and spectral reflex in the near infrared region (0.76- 0.9 Micrometers) in soil of Alabama region (Luo *et al*., 2008). Chen *et al*. (2000) found a relationship between the intensity of colored image in visible bands of electromagnetic spectrum and the amount of soil OC in 15 cm and then, generalized it to the entire image. High estimation accuracy ($R^2$=0.97-0.98) in their research was the reason of achieving a map of organic material with high precision. Bajwa *et al*. (2001) evaluated the relationship between soil fertility factors and spectral data and have shown that the amount of organic matter had a strong relationship with reflex.

This relationship was in the highest red band and lowest near inferred band. Dematte *et al*. (2003) studied the effects of organic matter on the spectral reflex of tropical soil and concluded that there was an inverse relationship between soil organic matter and spectral reflex. Chen *et al*. (2005) used satellite images in three uncover aged regions of USA and obtained different regressions with a high coefficient of determination ($R^2$=0.89). Sullivan *et al*. (2005) observed that thermal infrared band showed only 38% and with visible and infrared bands, it showed 93% changes in organic matter in the depth of 1 cm.

Rangeland includes almost half of the arid lands and more than one-third of source of biosphere carbon. Rangeland is one of the most important field ecosystems in terms of OC although the amount of carbon per area unit is negligible; however, due to their large area, these lands have great potentials for carbon storage. In global scale, the rangeland stores about 500 billion tons of carbon. In rangeland ecosystems, the biggest carbon source exists in the soil organic matter which contains 90% of the

total OC in the ecosystem and it reduces as the depth increases (Paul and Clark, 1996; Schuman *et al.*, 2002).

Increases of clay content of soil and annual rainfall cause the increase in OC and in contrast, the increase of the annual temperature causes its decrease (Bauer *et al.*, 1987; Burke *et al.*, 1989). Due to the advance of remote sensing technology in various ways of collecting data and information management and few studies done by this technology for mapping the soil OC abroad and in the country, no study has been done in the rangelands and this technology can be used in order to utilize its facilities to reduce costs and time. Hence, this study has been conducted by the hypothesis of satellite Imagery to map soil OC in different land uses particularly, rangelands. The purpose of this study is to map the surface soil OC of various land uses particularly, Dehaghan rangelands using remote sensing technology.

## 2. Materials and Methods
## 2.1. Introduction to the study area

Study area is located between 51°29′30″ to 51°38′8″ eastern longitude and 31°52′23″ to 32° northern latitude with the area of 19521 ha in Dehaghan in Isfahan, Iran (Fig. 1).

Regional climate is semi-arid and the mean annual rainfall in the region is 277.6 mm. Annual mean temperature is 11.8 °C. Regional winds are seasonal and Western and Southwestern downwind of the region. Averagely, strong wind in the study area was 35 km per hour. Geological formations of the study area consist of red marn, not separation of stones and gadvan formation is darian. In the study area, two groups and soil units (Calcisol, Regosols) are separable (Consulting Engineers Wide Espadana Poplar, 2009).
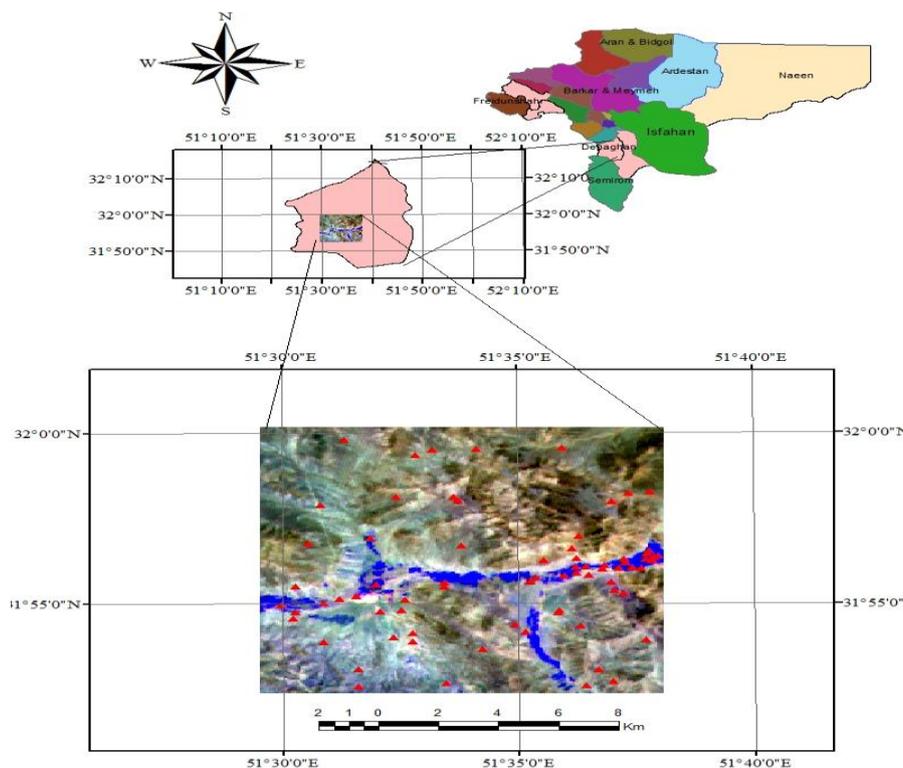


Fig. 1. Map of study area and sampling points on the satellite image and map of Isfahan province and Dehaghan

## 2.2. Sampling method and experimental analysis

Before referring to the study area to collect soil data, maps of 1.50000 and 1.25000 topography of the study area were prepared. Prepared maps were compared to satellite images and an overview of the phenomenon was achieved. Also, these observations were completed by land observation to investigate and identify the various phenomena in the roads and other general characteristics of the area. The stratified random sampling method was used (Khajeddin, 1995). So, homogeneous areas were initially determined according to the vegetation, soil characteristics and land use types in the desert. Then, one point within each homogeneous region was randomly selected using GPS into different homogeneous classes. After determining coordinate sampling points, this point was considered as the center of an imaginary circle with a radius of about 30 m and the circle quadrates of $10*10=100$ m$^2$. To reduce the error of the experiment in each homogeneous class, the mentioned quadrate was repeated 10 times in order to collect data closer to the average ground truth. Soil samples were collected using cylinder grinding method from the soil depth of 0-15cm and mixed (each mixed sample consisting of a mixture of 4 samples) from each depth at each point.

According to research, the amount of soil OC in the depth higher than 30cm is very poor and not significantly increased (Gao, 2007). Soil samples were moved to Faculty of Natural Resources of Isfahan University of Technology laboratory. Samples were air-dried and after destroying structure and crushing hunk, it was passed through 2mm sieve to separate the stones and gravels (Abdi, 2005). Then, the soil samples were put into the closed plastics and they were prepared to test. The bulk density of soil samples was determined according to the Hunk method (g/cm) and then, the soil OC percentage was determined using Walkley-Black method (Zarin Kafsh, 1993; Nosetto *et al*., 2006). By the help of equation (1), the amount of soil OC was determined based on kg ha$^{-1}$ (Naghipoor Borj, 2008).

$$OC=10000 * \%OC \times Bd * E \quad \text{(Equation 1)}$$

Where

OC = Organic Carbon (kg ha$^{-1}$)
Bd = Bulk density of soil (gr/cm3)
E = Depth of sample (m)

## 2.3. Used Satellite Imagery

Satellite images were related to Satellites IRS-P6[1] and AWIFS[2] (Table 1). These satellites belong to India.

Table 1. Characteristics of Images of IRS-P6 (2003) and AWIFS Satellites on 22/5/2009

| Band Number | Spectral Range (micrometers) | Spectral Range | Ground Resolution (m) |
|---|---|---|---|
| 2 | 0.52- 0.59 | Green | 70-60 |
| 3 | 0.62- 0.68 | Red | 70-60 |
| 4 | 0.77- 0.86 | Near Infrared | 70-60 |
| 5 | 1.55- 1.7 | Mid-infrared | 70-60 |

[1] Indian Remote Sensing Satellite
[2] Advanced Wide Field Sensor

False Color Composite (FCC) was formed. This method shows more remarkable phenomena such farms, orchard, intersection of the major and minor roads and waterways clearly. After determining common points and introducing the points in ERDAS software, the image of the study area was recorded in the UTM[3] projection system and geometric correction was performed.

## 2.4. Processing of satellite data band combination and making False Color Composite (FCC)

In order to increase contrast and clearance of elementary satellite data as well as better identification of different field phenomena, enhancement method was used (Chitsaz, 1999). In this study, to make suitable FCC for studying the phenomena as well as determining educational samples, FCC was made by Optimum Index Factor (OIF)[4] (Jaafari Garzin, 2002). Using this index, the best band combination with the lowest correlation coefficient and the maximum variance among the band combination was obtained; in the other words, standard deviation of bands was identified and using band correlation, optimum index factor for the combination of three bands was determined. The band which has the highest rate of OIF was used to create FCC.

## 2.6. Images classification and land use map preparation

In the process of mapping by the means of satellite images, it requires to determine specific and finite phenomena such as rock, orchard, urban area and roads in the final map (Fayzizadeh and Hajee Mir Rhimi, 2008). By making FCC on the images, we can represent the identifiable field phenomena. In this part of the study using the supervised classification, the effects and phenomena

were studied. In order to supervise classification, preparing suitable educational samples is required to achieve a perfect representative of different land covers. Therefore, to select suitable educational samples of field information and FCC, topographic maps of 1.50000 and 1.25000 and the trial and error representing the typical user and reflecting coverage target were used. Finally, maximum likelihood method was utilized as the most useful tool in the supervised classification (Arzani, 1998).

## 2.5. Statistical analysis and selection of appropriate band and index

After preparing the field data and satellite images, their analysis was conducted. To determine band or suitable index to prepare the required maps, SPSS 18 software was used. Correlations between field measurement parameters and laboratory with the digital data of satellite image and index were reviewed. Field and laboratory data as the introduced dependent variables and satellite images' digital data and index as independent variables were applied in the analysis. In SPSS 18 software using a simple regression, multivariate linear and regression methods, relationships between field information and satellite images were studied; in other words, field and digital data that had equal coordinate systems were put compared. Then, by introducing dependent variables and soil OC level in SPSS 18, their relationships with various bands and indices were evaluated by multiple regression method. Various models were fitted to the data and finally, the best model was selected according to the correlation coefficient, other statistical parameters of variance analysis table and regression model. Then, by examining the significance of regression coefficients, the final models with higher $R^2$ values were selected.

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[3] Universal Transfer Mercator
[4] Optimum Index Factor

## 3. Results

In order to prepare the maps of surface soil OC and land use, regression methods and supervised classification were used. These regression methods were determined by consideration to the relationships between the measured parameter in laboratory, band spectral features and indices and correlation coefficient of each model was statistically assessed. Using the obtained models, the best bands or band combinations of assessing AWIFs that can predict the changes' process of surface soil OC in the regional level in the study area can be determined. (Table 2), shows the correlation of experimental results with the bands and indices which express the accuracy of laboratory results.

## 3.1. Geometric correction

To register satellite images to prepare the maps, 49 ground control points with UTM coordinates from National Cartographic map with the scale of 1.25000 were selected and after omitting the points with high RMS error, images with less than 0.3 pixel caution were recorded (Table 3).

## 3.2. Preparing false color composite

In this study to make suitable FCC for studying phenomena and determining the educational samples, FCC was made by Optimum Index Factor (OIF). Using this index, the best band combination with the lowest correlation coefficient and the maximum variance among the band combination were obtained. (Table 3), shows the correlation between different bands. So, the band combinations 2, 3 and 4 for FCC were used.

Table 2. Pearson correlation of experimental results with the bands and indices

| Soil Depth | Green Band | Red Band | Near Infrared | Middle Infrared | NDVI Index | SAVI Index | RVI Index |
|---|---|---|---|---|---|---|---|
| (0-15 cm) | $-0.88^{**}$ | $-0.91^{**}$ | $0.65^{**}$ | $-0.84^{**}$ | $0.88^{**}$ | $0.89^{**}$ | $0.86^{**}$ |

**= Significant at 1%

Table 3. Correlation between different bands using AWIFs data

| Correlation | Band 1 | Band 2 | Band 3 | Band 4 |
|---|---|---|---|---|
| Band 1 | 1.00 | | | |
| Band 2 | 0.89 | 1.00 | | |
| Band 3 | 0.20 | 0.25 | 1.00 | |
| Band 4 | 0.80 | 0.78 | 0.30 | 1.00 |

## 3.3. Images' classification and land use map preparation

Land use map in five categories including agricultural land, orchard, rangelands, rocks and urban area was separated by the acceptable accuracy (Fig. 2). Accuracy of this classification with the ground truth based on confusion matrix was assessed and the overall accuracy computed as 81.78% and overall kappa as 75% were obtained. Confusion matrix is a standard method to determine the accuracy of the classified map (Jaafari garzin, 2002). Areas of each land use layer were calculated and rangelands cover the most regions of the study area (Table 4).
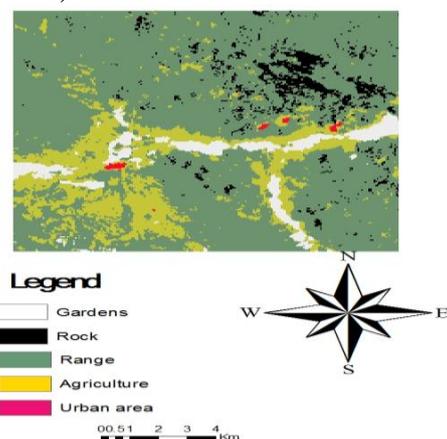


Fig. 2. Land use map of the study area

Table 4. Areas of Land Use layers of the study area

| Land Use Layers | Area of Layers (ha) |
|---|---|
| Urban area | 49 |
| Orchard | 1007 |
| Rocks | 905 |
| Farming area | 3320 |
| Rangelands | 14239 |
| Sum | 19521 |

### 3.4. Mapping of surface soil organic carbon (0-15cm)

To select the appropriate band that is highly correlated with soil OC content and show its surface changes, a multiple regression analysis in SPSS 18 software was done. In multivariate regression analysis, the amount of surface soil OC (0-15cm) that was determined during field function and experimental measures and basic bands of satellite image were considered as dependent and independent variables, respectively. Using regression, correlation coefficient and adjusted coefficient of determination $R^2$, the best model was selected. The fitted model for the amount of surface soil OC as a dependent variable shows that the bands 2 (red band) with the satellite images had the highest correlation with the content of surface soil OC (0-15cm). $R^2$ of this model was calculated as 83% (Table 5). Regression model of surface soil OC content (0-15cm) is given in equation (2).

SOC= -83.05 B2 + 26967.80  (Equation 2)

Where

SOC: amount of soil organic carbon from the depth up to 15cm

B2: sensor band in red wavelength

Results of regression analysis using T-test show that $H_0$ hypothesis was rejected ($P<0.01$) and the model can obtain a correlation between the OC content of surface soil (0-15cm) with soil spectral characteristics of second band (red band) with the satellite images so that the model is significant (Table 5). High values of $R^2$ (83%) indicate the appropriateness of the selected model with the explained coefficient of 83% and its relationship with the OC content of surface soil (0-15 cm). Thus, the obtained model was applied for the images of AWIFs and band 2 (red band) of the study area and the images of content of surface soil OC (0-15cm) were prepared. Then, by regrouping techniques, the image was divided into 7 categories of OC. Map of surface soil OC (0-15cm) is shown in (Fig. 3). Area of each class of OC in the produced map was calculated according to the types of land use and its results are given in (Table 6). Also, the accuracy assessment of produced map showed that its total accuracy was 71.32% and its total kappa was 0.63 (Table 7).

Table 5. Variance analysis model for content of surface soil organic carbon (0-15cm)

| Coefficients | Non Standardized | Std. Error | Standardized | T Value |
|---|---|---|---|---|
| Constant | 8026967 | 1015.2 | | 26.56** |
| Band ٢ | -83.05 | 4.43 | -0.91 | -18.74** |
| $R^2$ adjusted | %82 | | | |

**Significant at 1%

Table 6. Area classes of organic carbon in soil surface (0-15cm) (Ton ha$^{-1}$)

| OC  Categorize Ton/ha | Orchard | Ruck | Rangelands | Agriculture | Urban | Total |
|---|---|---|---|---|---|---|
| Nun classified | - | 905.4 | - | - | 49.32 | 954.7 |
| >15 | 0.0 | - | 4062.6 | 242.6 | - | 4305.2 |
| 16.5-15 | 0.72 | - | 6243.8 | 930.6 | - | 7175.1 |
| 19.5 -16.5 | 31.32 | - | 3797.2 | 1848.2 | - | 5676.8 |
| 22 -19.5 | 120.6 | - | 124.2 | 292.6 | - | 537.4 |
| 33-22 | 443.16 | - | 11.16 | 5.76 | - | 460.8 |
| 40-33 | 214.56 | - | 0.0 | | - | 214.5 |
| <40 | 196.92 | - | 0.0 | 3319.92 | - | 196.9 |
| Sum of area | 1007.28 | 905.4 | 14239.08 | | 49.32 | 19521 |

Table 7. Accuracy assessment of content map of surface soil organic carbon (0-15cm)

| OC Categorize Ton/ha | >15 | 16.5-15 | 19.5 - 16.5 | 22 - 19.5 | 33-22 | 40-33 | <40 | Total | User Accuracy (%) | Kappa |
|---|---|---|---|---|---|---|---|---|---|---|
| >15 | 68 | 4 | 2 | 3 | 0 | 0 | 0 | 77 | 88.31 | 0.87 |
| 16.5-15 | 7 | 173 | 54 | 13 | 9 | 4 | 1 | 261 | 66.28 | 0.55 |
| 19.5 -16.5 | 4 | 14 | 196 | 8 | 18 | 6 | 1 | 247 | 97.35 | 0.68 |
| 22 -19.5 | 1 | 2 | 2 | 9 | 0 | 0 | 0 | 14 | 64.29 | 0.62 |
| 33-22 | 2 | 2 | 15 | 1 | 65 | 12 | 4 | 101 | 64.36 | 0.59 |
| 40-33 | 3 | 2 | 5 | 2 | 7 | 37 | 6 | 62 | 59.68 | 0.56 |
| <40 | 2 | 3 | 2 | 3 | 3 | 3 | 24 | 40 | 60.00 | 0.58 |
| Total | 87 | 200 | 276 | 39 | 102 | 62 | 36 | 802 | | |
| Product accuracy (%) | 78.16 | 86.50 | 71.01 | 23.08 | 63.73 | 59.68 | 66.67 | | | |
| Means | | | | | | | | | 71.32 | 0.63 |
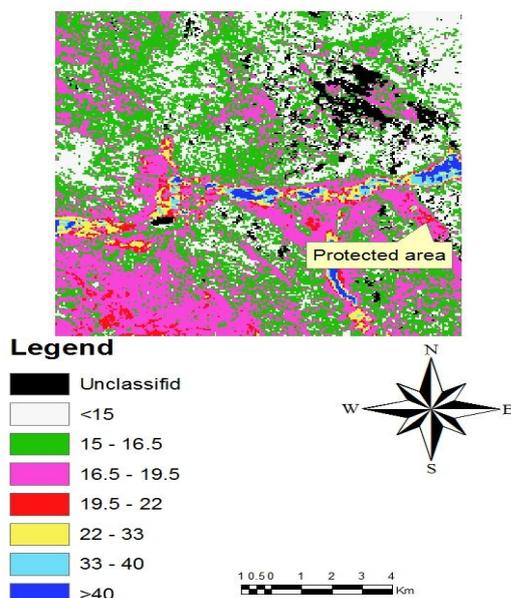


Fig. 3. Map of content of surface soil OC (0-15cm) ton/ha

## 4. Conclusions

Rangelands are the most important terrestrial ecosystems to store soil OC. Although the amount of rangelands' OC per area is low, given the high breadth of them, they have a high potential to store OC (Schuman, 2002). Organic matter in the soil has a direct impact on the quality and soil fertility. Also, its impacts on the environment are very important to stabilize carbon and prevent global warming. Sustainability and conservation of agricultural and biological diversity, rangeland production, forests and soil biological function are also intensified by soil carbon sequestration and have positive effects (Amir Aslani, 2004). In addition, by contemplating the development of remote sensing technology in gathering information and various ways of data management, few studies have been done on the technology for the evaluation of OC in the rangelands abroad (Hunt *et al*., 2004) and there is no study about inland rangelands. This technology can utilize their opportunities to reduce costs and save time and changes of this element can be assessed. For the preparation of land use map of the study area, the supervised classification along with maximum likelihood algorithm and the FCC method were used. Ahmed *et al*. (2009) used FCC to improve the satellite images in

order to draw land use map from color composite 432 in TM landsat and color composition 431 in MSS image for better enhancement in their study. Barth (1999) used 457 colored composite in Landsat TM images to achieve more improvement for determining land use (Fayzizadeh and Hajee Mir Rhimi, 2008). Also, they have been highly applied in the investigations about studying the land use and land cover maps using the supervised classification method by the maximum likelihood algorithm (Li *et al.*, 2008; Bayasikhan *et al.*, 2009). The results of this classification showed the ability of these methods as compared to the unsupervised classification method due to the positive impacts of appropriate selection of training examples of classified images. Studied done in terms of image classification regarding this method of classification have been recognized more suitable than the unsupervised classification for land cover mapping (Shalaby and Tateishi, 2007). Since the purpose of this study was to map the surface soil OC using remote sensing technology while referring to the hypothesis that this technology for proper mapping of OC can be used, the multiple regression models were offered that confirm the changes in soil OC level statistically. According to regression analysis (Table 5) using few indices and different bands, only band 2 (red band) provided an appropriate model. Value of this band can be expressed in the map preparation of OC. Therefore, it can be concluded that using the band 2 (red band), the estimation of OC is possible and this band enjoys a reasonable credit in assessing the levels of OC. As one can see in the orchard land use, soil OC rates in this land use (0-15cm) were placed at the highest levels. Therefore, the areas with the high vegetation coverage are located at the highest level in soil carbon content (>40 ton ha$^{-1}$) (Fig. 3). This situation can be seen as a good one in rangeland land use. It means the more

vegetation of the northeast to the southern and southwestern areas, the more levels of carbon of rangelands. Then, we can conclude that with the increase of vegetation, surface soil OC levels are higher and Baumgardner *et al.* (1970) confirm these findings. It should be noted that for preparing the map of soil OC in the study area using regression models, bands of wavelengths (band 2) have been used. Then, red band has the most relationship with the amount of soil OC in the study area and the studies of Bajwa *et al*. (2001) confirm these results. Its main reason is severe absorption of this wavelength by photosynthetic pigments in the leaves and plant biomass intensifies its absorption. Since the increase in plant biomass is the result of higher photosynthetic activity, carbon is removed from the atmosphere and stabilized as OC in the plant tissues. Then, there is a positive correlation between these two cases. But according to the presented models in this study, the relationship of the red band with the level of soil OC is an inverse one due to the absorption of this wavelength by soil humus and soil color gets darker (Alavipanah, 2003). This point is consistent with the results reported by Dematte *et al*. (2003), Henderson *et al*. (1991) and Montgomery (1976). In the soil OC mapping using regression models, high $R^2$ coefficients defined in this study (85%) are consistent with the results of Chen *et al*. (2005). According to (Table 6), if we classify the study area according to the amount of OC into the classes of poor to excellent (the classes smaller than 16.5, 16.5 to 22, 22 to 40 ton ha$^{-1}$ and more than 40 ton ha$^{-1}$ are poor, middle, good and excellent ones) considered as the amount of OC, many areas of the rangelands in the study area are located in poor class (aApproximately 10306 ha of the 14239 ha), 3921 ha in the middle and only 11.16 ha of rangelands may be put in good class of OC. This situation is also true in the case of

agricultural land but about orchard, there are better conditions because less than one ha can be placed in poor class, almost 657 ha of orchard in good class and 196 ha in excellent class OC. According to the mentioned cases along with the rangelands' modification and reclamation as well as the orchard, the amount of this land use carbon can be increased. Rangelands include most of the study area calculated as 14000 ha of 20000 ha. Then, it makes the rangelands to allocate greater proportion of carbon while the orchard includes only 1000 ha of the area. Therefore, as compared with other land uses, rangelands have more OC in the study area and the obtained results from this study are consistent with those expressed by Derner and Schuman (2007). Carbon of rangeland soils decreases during the farming operations and may take years to return to its previous level of soil OC (Derner and Schuman, 2007). The most important factor in accelerating the reduction of OC in soil organic matter and soil OC is an agriculture work that enhances the decomposition of soil organic matter resulting from the plowing. Another factor to reduce soil OC that can be mentioned is to increase the erosion of arable land. Increasing soil erosion due to the change detection, surface soil organic matter transfers with a high percentage of carbon. In addition, the tillage leads to mix down the layers of soil with lower OC percentage with the surface soil containing more OC; then, surface soil OC levels can be reduced in comparison with the initial state. Concerning the highest amount of OC between the existing land uses related to the rangelands in terms of environment, rangelands have had the highest value and importance in the storage of soil OC in the study area and require the support and cooperation of organizations and agencies to maintain these environmental values obtained during the long years. Therefore, it must be considered that due to the unnecessary manipulations of human interventions, storing carbon is not released again and does not add to the amount of carbon dioxide in the atmosphere which has a lot of environmental hazards. This article has a few things to note. Plants cannot completely cover the soil and soil background reflectance is always on agricultural and forest lands.

Soil samples were taken from a farm or garden that has carbon sequestration and were affected by soil background reflectance and calculated by the means of the mentioned equations. If the vegetation cover is nice and large, OC of soil is greater and again, the reflection will be affected. The collection reflects the influences of soil and vegetation and different equations are applied.

Regarding remote sensing, multiple reflective bands must be considered and satellite data have been recorded and are available for the users. Then, each user can use these data to determine the information directly and indirectly. It can be referred to such direct chemical and physical properties of soil as vegetation and indirect ones as underground water conditions or the amount of mineral deposit located within the depth of the earth. AWIFs sensing images of IRS-P6 satellite according to the coverage of spectral and spatial resolution have useful functions for preparing the land use map and the map of surface soil OC levels in the study area.

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# تهیه نقشه کربن آلی خاک سطحی با استفاده از تصاویر ماهواره‌ای IRS-AWIFS
## (مطالعه موردی: مراتع دهاقان)

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**چکیده**

ماده آلی خاک، اثر مثبت مستقیمی بر کیفیت و حاصلخیزی خاک و همچنین بر محیط زیست، پایداری و بقاء کشاورزی، تنوع زیستی و کارکرد زیستی خاک دارد. ماده آلی، نقش مهمی در فرآیندهای شیمیایی و فیزیکی خاک و در نتیجه اثر زیادی بر ویژگی‌های طیفی خاک دارد. مطالعه حاضر به منظور تهیه نقشه کربن آلی خاک سطحی کاربری اراضی مختلف بخصوص مراتع با استفاده از فناوری سنجش از دور در شهرستان دهاقان در جنوب استان اصفهان انجام شده است. بنابراین داده‌های ماهواره IRS-P6، سنجنده AWIFS انتخاب شد که با تعداد ۴۹ نقطه کنترل زمینی با دقت کمتر از ۰/۳ پیکسل ثبت داده شد. روش نمونه برداری طبقه‌بندی شده تصادفی انتخاب شد. نمونه‌های خاک از عمق ۱۵-۰ سانتی متر در هر نقطه جمع آوری شد. وزن مخصوص ظاهری نمونه‌های خاک به روش کلوخه و درصد کربن آلی خاک از روش والکی بلک (Walky-Black) تعیین شد. برای تهیه نقشه کاربری اراضی و تهیه تصاویر رنگی کاذب، طبقه بندی نظارت شده با استفاده از الگوریتم حداکثر احتمال و شاخص فاکتور بهینه (OIF) استفاده شد. به منظور تهیه نقشه کربن آلی خاک سطحی از مدل سازی رگرسیونی چند متغیره و پیش رونده در نرم افزار SPSS ۱۸ استفاده شد. در نقشه کربن آلی خاک سطحی در منطقه مورد مطالعه، با استفاده از مدل‌های رگرسیونی، باند۲ (باند قرمز) مورد استفاده قرار گرفته است. باند قرمز بیشترین رابطه را با میزان کربن آلی خاک سطحی منطقه مورد مطالعه داشته است. رابطه باند قرمز با میزان کربن آلی خاک سطحی یک رابطه معکوس می‌باشد. تصاویر باندهای سنجنده Awifs ماهواره IRS-P6 با توجه به پوشش طیفی و قدرت تفکیک مکانی، کارایی مناسبی جهت تهیه نقشه کاربری اراضی و نقشه میزان کربن آلی خاک در منطقه مورد مطالعه دارد.

**کلمات کلیدی:** Awifs، کربن آلی خاک، مدل سازی