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Estimation of Vegetation and Land Use Changes Using Remote Sensing Techniques and Geographical Information System (Case Study: Roodab Plain, Sabzevar City)

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Abstract. Land use may be regarded as one of the most important factors affecting the environment with respect to human activities. So far, destroying the rangelands and changing them into the waste lands and poor rangelands has been proposed as the most significant variations of land use done by human beings. This paper has been conducted to evaluate the variations of vegetation percentage and land uses in Barabad-Darook village with the area of 1522.99 km^2 in Sabzevar city during 1987-2007. Thus, using satellite-based images of TM and ETM^+, the most appropriate band composition has been selected and a mapping of vegetation cover and land use was provided through maximum likelihood algorithms to correct the errors of geometer and radiometer highlights. At last, the accuracy of extracted maps was to be determined by the means of overall accuracy test and Kappa coefficient in order to achieve the validation of research process. Results indicate that waste lands have been increased from 84.75 to 89.49 and third-rated rangelands have been reduced from 6.85 to 4.14 percent. On the other hand, first-rated rangelands were reduced from 0.03 to 0.01 percent which covers 5170791.45 m^2 of total area in the district. Also, the results show that irrigated agricultural lands are to be decreased from 6.53 to 0.07 percent. In total, due to improper exploitations of regional water resources and vegetation cover, land uses have been changed into fallow and waste lands leading to the decrease in the percentage cover of high quality rangelands. Research findings demonstrate that considering the accepted accuracy, new remote sensing technology can be applied to exactly estimate the area changes of land use and vegetation.

Key words: Land use, Land cover change detection, Remote sensing, GIS

Introduction

Increasing growth of population and land use changes have resulted in the egregious variations of natural areas and non-normative exploitation and demolition of ecosystems (Lu and Weng, 2007). So, these variations appearing into two forms of conversion and change may be made because of such factors as drought, fire, floodwater and volcanic and human activities which involve the grazing, expansion of cities and agricultural lands and management procedures of natural resources. Converting the land uses like deforestation, urban sprawl and agricultural lands' expansion can be directly evaluated through satellite images (Tipanaiat and Nitin, 2003). Through the resultant changes of excessive grazing, brush cutting and other destructions are hardly measured by the help of sensing techniques (Lefsky and Cohen, 2003; Ustine, 2004). Using time series images serves as a prevalent method to assess the economic and social effects on natural habitats and then, evaluate the demolition rate of lands (Ghorbani, 2007; Lu and Weng, 2007). By studying the characteristics of various wavelengths' spectral reflectance, it is possible to distinguish different classes of land uses (Ahani, 2006; Ghorbani *et al*., 2006). In this regard, Apan (1997) has drawn a map of vegetation in Midori region, Philippines using TM data. Dellepiane and Smith (1999) compared the images to specify the changes of forests into agricultural lands as the most significant variations in the vegetation of this area. Dontree (2003) tried to prepare a vegetation cover map of national forests in Thailand by TM and ETM$^+$ images during 1972, 1989 and 2000. Furthermore, Khalaghi (2006) conducted a detection mapping of Caspian coast changes using Landsat TM and ETM$^+$ images, object-oriented classification and basic pixel methods. It seems that limit index has significantly contributed to make distinguishes between various kinds of land uses and on the other hand, vegetation maps are to be favorably applied in the sampling process for defining different classes of land uses. Hosseini *et al.* (2007) have studied the evaluation capability of satellite ETM$^+$ images for mapping the lands' vegetation cover and emphasized the importance of data integration techniques. They found that near and mid-infrared bands are of considerable significance to draw a map of forests. Feizizadeh and Mirrahimi (2007) used the images of Landsat TM and spot HDR satellites and investigated the landscape changes of Tabriz by the means of object-oriented classification. They revealed that more than 46 percent landscape of Tabriz were to be destroyed for 16 years. Ahani *et al.* (2009) have evaluated the land changes in TangeSorkh watershed, Shiraz using satellite images. Results indicated that the variability rates of waste lands and rainfed agricultural lands have increased from 4.2 and 12.8 to 11.5 and 17.1 while the forests and rangelands have been reduced from 29.8 and 36.9 to 28.3 and 26.8 percent, respectively. Thus, in order to investigate and estimate the changes of vegetation and land uses in Barabad-Darook village, this study has utilized satellite TM and ETM$^+$ images and band analyses for a 20-year period.

Materials and Methods

Barabad-Darook village is placed in the district of Roodab, Sabzevar city in Khorasan province with the area of 1522.99 km^2 and far from Sabzevar for 45 kilometers located within 57' 15" eastern latitude and 36' 5" northern longitude. This region's mean height and mean slope are 850m above sea level and about %1, respectively (Fig. 1). The district is centralized in New Ghaleh village involving 35 villages and farms such as Asghar Abad, Barabad, Rarvand, Poshte Abbas, Tessband, Manouchehr well, Ney well, Hassan Abad, Darin, Damrood, etc. In addition, the village is surrounded by the districts of Bashtin, Kahand Mazinan in the north, Beyhad village in the eastern north and Khashed and Kooh Homaee villages from the east and south and finally, adjacent to Shahrood city in the west.

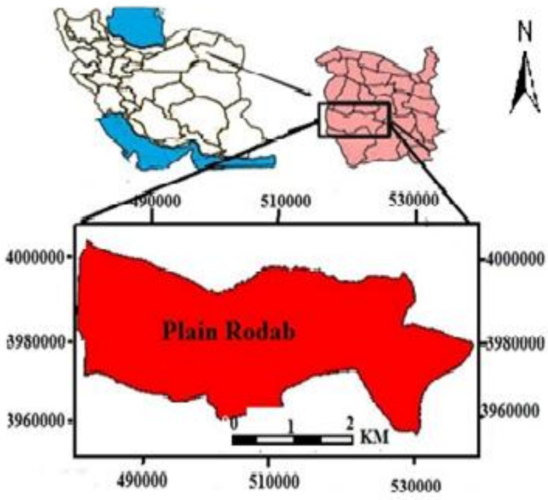

Fig. 1. Map of the study area

In this paper, first step is taken to identify specific areas having strong and poor vegetation and then, separate these desired areas from each other. Therefore, we have used the Normalized Difference Vegetation Index (NDVI) as the basis of percent vegetation map (see Equation 1) (Ahani, 2006).

VP= (NDVI+1)×50 (Equation 1)

In the above equation, VP is the vegetation map of the area.

On the other hand, TM and ETM$^+$ sensing images of Landsat satellite were applied to study the land use variations. These images have been attributed to the years of 1987, April 29th and 2007, May 4th. Moreover, geometric correction was done by the use of topographic maps with the scale of 1:50000 (e. g. hydrographic and road networks) provided by national topography Institute and control points taken by GPS. Geo-reference images are of high efficiency due to the estimation of four fundamental components including position and scale points, stretching and rotation capabilities of them (O'Connor and Roux, 1995). To perform the mentioned process (Lu and Weng, 2007), sufficient control points (20 ones) which had suitable transmittance have been collected from the studied region and implemented on each image through PCI-Geomatica 10.3 software and geo-coding function. For taking the required samples, values of pixels and land images with the error of 0.42 and 0.39 RMS were regarded as the research references using the nearest vicinity method. Numerical value of pixels has been computed to measure the atmospheric error ratio at the level of satellite images in the regions relevant to water bodies. With respect to the existence of atmospheric error and necessity of error correction, the use of Log residuals' procedure led to the numerical reduction of dark pixels. Definite classes were to be classified and results have been compared. To do so, land use classes should be extracted on the basis of scale and locational separation of satellite images. In this paper, determining the land use classes integrated of second and third levels presented in Michigan's classification system has been tried (Table 1), (Anderson and Holte, 1981). In order to recognize the training regions and perform the mentioned classification, GPS field data and questions are likely to be given.

Table 1. Land use classes

Land Types	Land Vegetation Cover/Land Use
Agricultural areas	Fallow
	Garden
	Irrigated agriculture
	Rain fed agriculture
Rangelands	First-rated rangeland
	Second-rated rangeland
	Third-rated rangeland
Waste lands	Waste lands

Correlations between image bands propose the existence of common information meaning as the correlation of bands increases, more data will be available in common (Foody, 1992; Ahani, 2006; Ghorbani, 2007; Lu and Weng, 2007). Using statistical features of training samples may serve as the most prevalent method to choose the best bands concerning the sum of taken bands. Thus, (Equation 2) referring to Optimum Index Factor (OIF) was used (Chavez *et al.*, 1982). In this regard, 432-band composition which is of the highest OIF value has been selected as the most appropriate band.

$$OIF=\frac{\sum_{j=1}^{3} SDi}{\sum_{j=1}^{3}|CCj|} \quad \text{(Equation 2)}$$

In above equation, $\sum_{j=1}^{3} SDi$ and $\sum_{j=1}^{3}|CCj|$ are the sums of three bands' SD of criterion and absolute of correlation coefficients between two bands out of three ones. After selecting the best band composition, training area samples were taken. To draw the samples, it has been tried to take samples from homogeneous regions, compare the value ranges of pixels and training samples and then, put the pixels into separating classes. With regard to available regional information, training area samples taken by the help of global position system and monitored classification, a mapping of land uses has been conducted for the desired area using maximum likelihood method during 1987-2007. Regarding variance and covariance matrices, the accuracy of layers prepared through processing the satellite images was evaluated (Singh, 1998). Overall accuracy was calculated by the means of (Equation 3), proposed by Dellepiane and Smith (1999).

$$OA=1/N\ (\Sigma Pii) \quad \text{(Equation 3)}$$

In above expression, OA is the overall accuracy. N is the total number of training pixels and ΣPii is the sum of correctly classified pixels. Kappa coefficient is measured using (Equation 4), suggested by Foody (1992).

$$K= (OA-1/q)\ (1-1/q) \quad \text{(Equation 4)}$$

Where K and q represent Kappa coefficient and incorrectly classified pixels, respectively. Finally, confidence limits of classes which are classified on the basis of (Jensen, 2005) a specific method have been estimated at 1 and 5 percent statistical levels according to (Equation 5).

$$S=P-[Z\ (PQ/N)\ 0.\ 5+(50/N)] \quad \text{(Equation 5)}$$

As it has been shown in above expression, Q is the percent of incorrectly classified samples measured by the use of (Equation 6), and N is the number of samples. Z can express the converted values of r which are computed by the (Equation 7), according to Z. S shows the minimum confidence value (Afshinnia, 1993).

$$Q= (100-P)\ 7 \quad \text{(Equation 6)}$$

$$Z= (100-r)/100 \quad \text{(Equation 7)}$$

Where r and P may act as percentages of statistical levels and correctly classified samples, Q is the percent of incorrectly classified samples and Z can express the converted values of r. After being assured of classification accuracy, next step is to assess the land use changes so that statistical calculations of these changes have been performed through software of ENVI (4.7) and the percent values and area of districts have been measured where the land uses were changed. This technique assumes that land use changes are given according to class-to-class matrix. Using linear algebra algorithms and basic statistics including differentiation and percentage rates, the differences between the two classes are revealed on the basis of pixel, area and discrepancy percent rates (ENVI User's Guide, 2008). (Fig. 2), shows the graph of map drawing stages of land uses using satellite images.

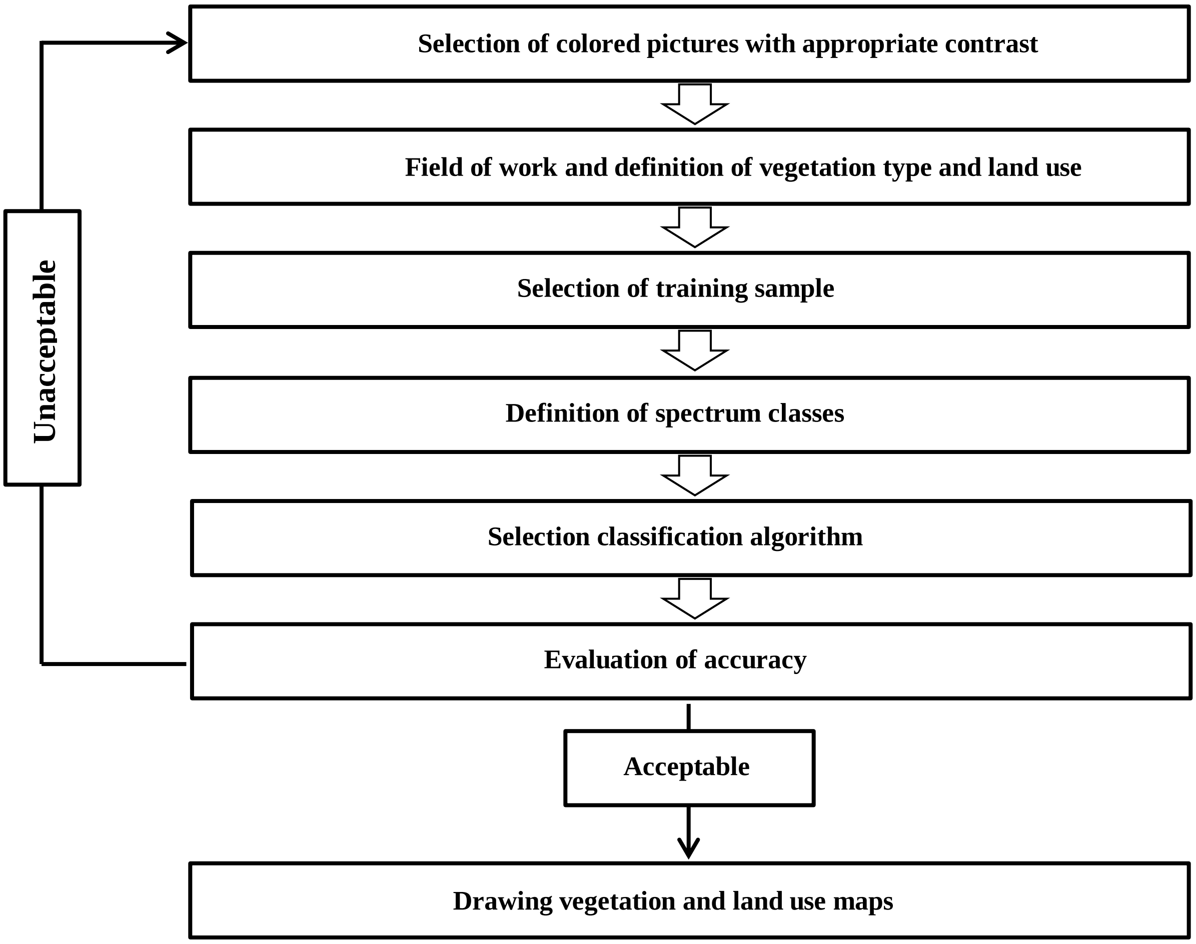

Fig. 2. Flow chart of map drawing stages of land uses using satellite images

Results

Percent vegetation map was provided through Normalized Vegetation Index (NDVI) and TM and ETM$^+$ sensing images of Landsat satellite in 2007 (Figs. 3 & 4). Comparing (Figs. 3 and 4), indicates that vegetation percent of the desired region is likely to be reduced regarding this period. Training areas were specified in order to achieve the monitored classification of GPS field work and questions.

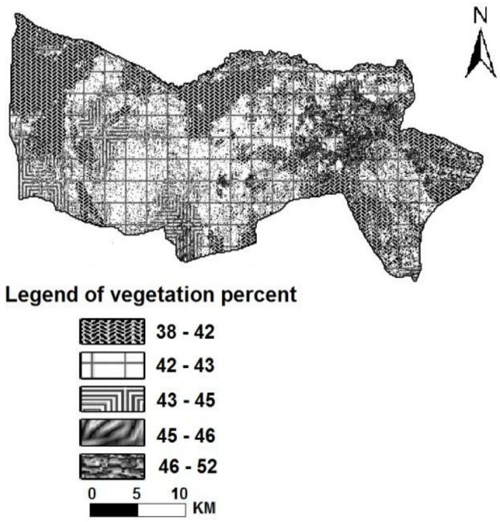

Fig. 3. Percent vegetation map of case study in 1987

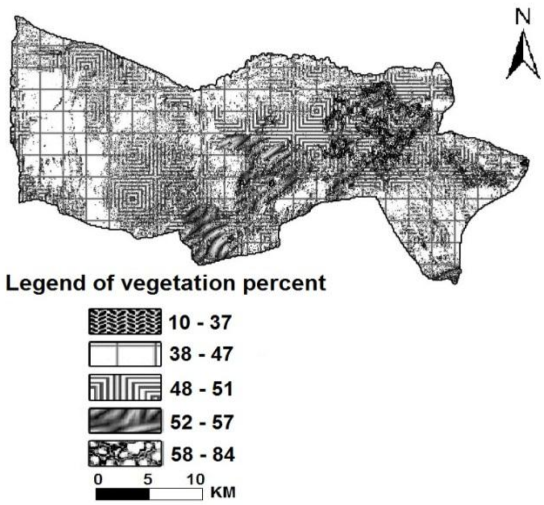

Fig. 4. Percent vegetation map of case study in 2007

Map of land uses (1987)

Statistical table of land use classes specified for 1987 and area percent of every village have been demonstrated. According to data presented in (Table 2 and Fig. 5), the highest extent of land cover is related to waste lands having the area of 1286747165.14 m^2 (84.48% of total area). Poor pasture is accounted for the area of 104037421.47 m^2 (6.85%) and ranged as the next item. (Fig. 6), shows the land cover of the studied region in 1987 and (Table 3), shows the number of pixels related to 1987.

Table 2. Classes of land cover in 1987

Land Use Classes	Area/m^2	Percent Area
Irrigated agriculture	99197161. 78	6. 53
Rain fed agriculture	10611903. 04	0. 69
Garden	2763868. 55	0. 18
Residential areas	10214657. 60	0. 67
Waste lands	1286747165. 14	84. 48
Good rangeland	5345391. 45	0. 35
Medium rangeland	4096630.97	0. 26
Poor rangeland	104037421.47	6. 85
Sum	1523014200	100

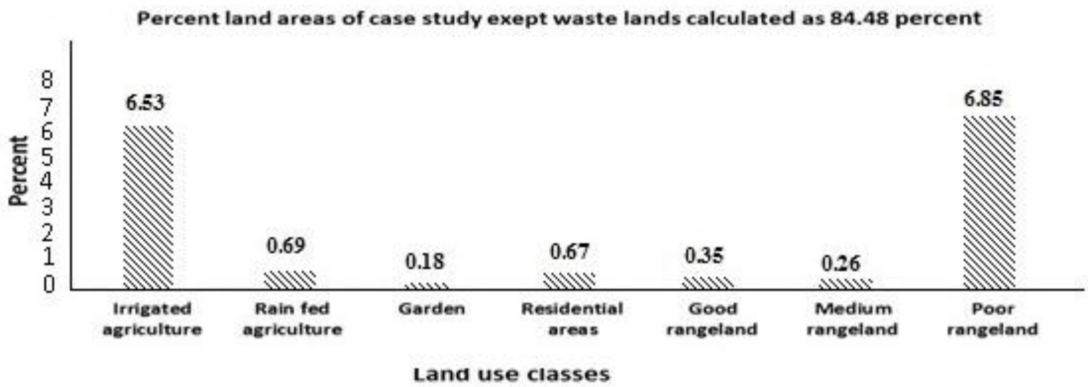

Fig. 5. Comparison of various vegetation classes' area of case study in 1987

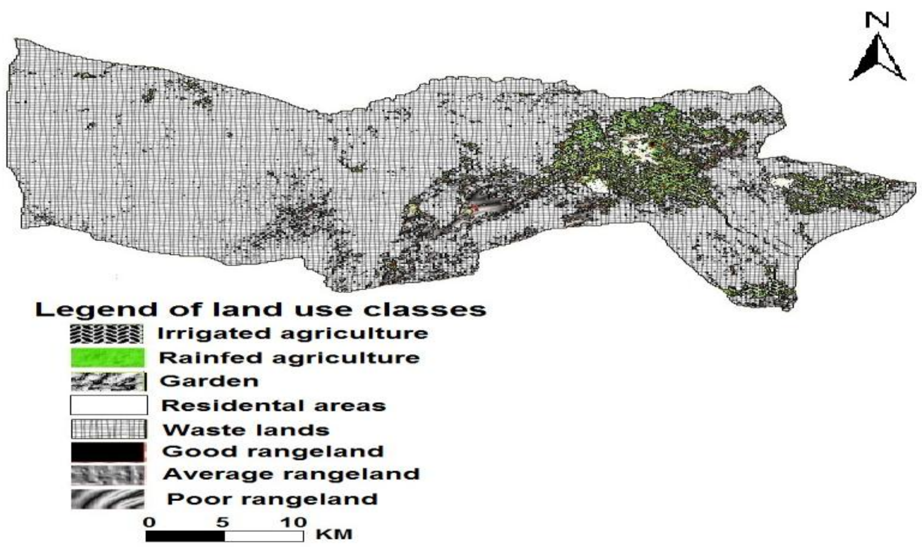

Fig. 6. Land use map of case study in 1987

Table 3. Number of pixels related to 1987

Class	Number of Pixels
1. Agricultural lands: irrigated, rain fed and garden	138636
2. Residential areas	12579
3. Waste lands	1584663
4. Ranges including good, medium and poor	139753

Map of land uses (2007)

To extract new classes of land cover in the studied region, ETM$^+$ images of Landsat satellite related to 2007 have been applied. Statistical table of land use classes attributed to the year of 2007 and area percent has been presented. According to data suggested by (Table 4 and Fig. 7), the highest cover extent was found for waste lands as 1363047749.8 m^2 (89.49%). Poor pasture is ranged as next case due to its area of 108818100 m^2 (7.14). Also, (Fig. 8), displays the vegetation of the considered region in 2007 and (Table 5), shows the number of pixels related to 2007.

Table 4. Land coverage classes of case study in 2007

Land Use Classes	Area/m^2	Percent Area
Irrigated agriculture	1139400	0. 07
Rain fed agriculture	7910099. 99	0. 51
Fallow	29844000	1. 95
Residential areas	6412050. 20	0. 42
Waste lands	1363047749. 8	89. 49
Good rangeland	174600	0. 01
Medium rangeland	5668200	0. 37
Poor rangeland	108818100	7. 14
Sum 1523014200	100	

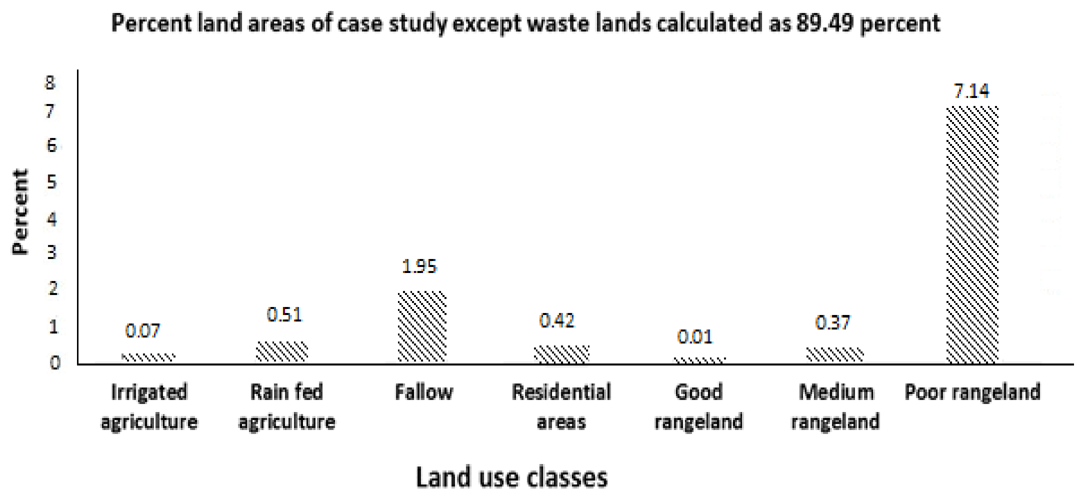

Fig. 7. Comparison of various vegetation classes' area of case study in 2007

Table 5. Number of pixels related to 2007

Class	Number of Pixels
1. Agricultural lands: irrigated, rain fed and garden	47898
2. Residential areas	7896
3. Waste lands	1678630
4. Ranges including good, medium and poor	141207

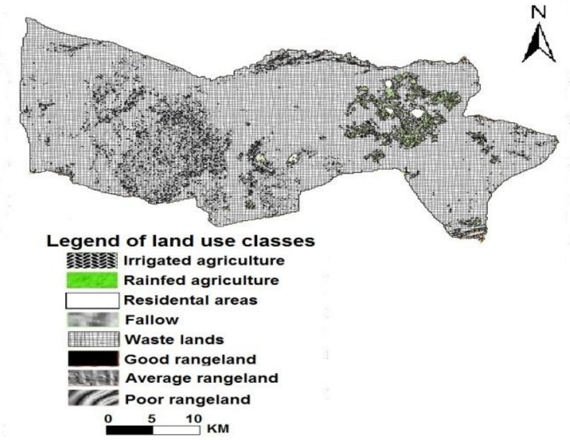

Fig. 8. Land coverage classes of case study in 2007

Comparison of land use changes' trend during 1987-2007

In order to investigate the vegetation changes trend of the studied area during 1987-2007, the areas explored by the maps which were related to the land vegetation for the mentioned period have been compared and then, a comparison of numerical decrease and increase of them (in m^2 and %) was done. In (Table 6 and Fig. 9), these comparison results are to be shown. (Fig. 9) is the descriptive of comparing the percent vegetation changes for the given period. Based on (Fig. 9) and (Table 6), the highest percent changes were attributed to fallow regarding 100% increase and afterwards, medium rangelands associated with 36.38% increase refer to the fact that the extent of intensely destructed lands due to human activities has been raised in the addressed region and as compared to the study period of 30 years, a very alarming trend can be observed. Among the reductive changes, the highest decrease calculated as 100% reduction of the area has been found with respect to the gardens; in other words, it can be regarded as a worrying trend.

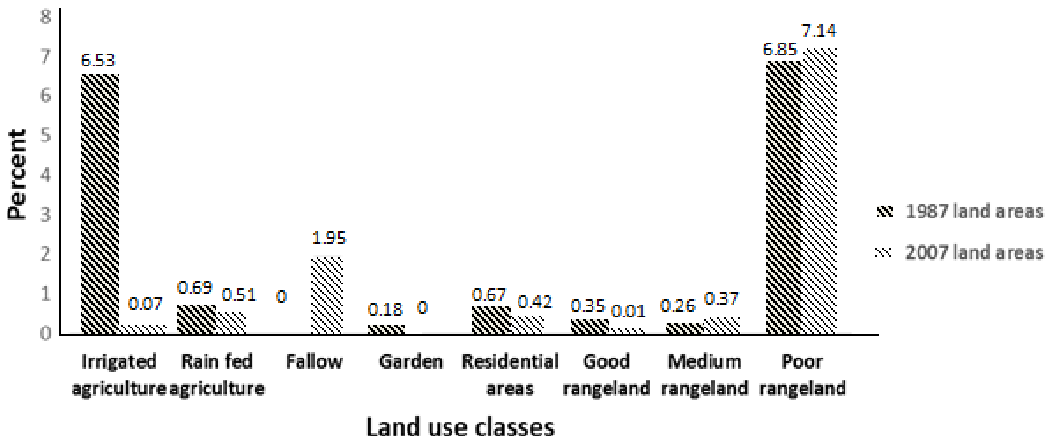

Fig. 9. Comparison of land cover changes of case study during 1987-2007

Table 6. Review of land cover changes' trend during 1987-2007

Land Use Classes	Area/m^2 in 1987	Area/m^2 in 2007	Change Rate/m^2	Change Percent	Change Type
Irrigated agriculture	99197161.78	1139400	-98057761.78	-98.85	reduction
Rain fed agriculture	10611903.04	7910099.99	-2701803.05	-25.46	reduction
Fallow	-	29844000	29844000	100	increase
Garden	2763868.55	-	-2763868.55	-100	reduction
Residential areas	10214657.60	6412050.20	-3802607.4	-37.22	reduction
Waste lands	1286747165.14	1363047749.8	76300584.66	5.92	increase
Good rangeland	5345391.45	174600	-5170791.45	-96.73	reduction
Medium rangeland	4096630.97	5668200	1571569.03	38.36	increase
Poor rangeland	104037421.47	108818100	4780678.53	4.59	increase

Assessment of classification accuracy

No classification is to be considered comprehensive if the accuracy of it may not be evaluated. In this research, the evaluation of each classification's accuracy was randomly performed by the help of GPS through gathering true ground points and implementing the taken control points. Kappa coefficient which contributes to measure the accuracy of classification as compared to a randomized one is ranged between 0 and 1 displaying the completely randomized classification and completely standardized one. In current study, Kappa coefficient has been calculated as 0.81 and 0.83 using maximum likelihood method and ETM^+ and TM satellite images, respectively. Overall accuracy of classification which reveals the validity rate of done classification and should be given more than %85 based on the land use maps drawn by TM and ETM^+ satellite images (Anderson and Holte, 1981) was computed as 89.16 and 88.76 percent, respectively. (Tables 7 and 8), represent the results of accuracy assessment of classification for 1987 and 2007, respectively.

Table 7. Accuracy assessment of classification for 1987

Class	Agricultural Areas	Residential Areas	Waste Lands	Range Lands	Total	Errors of Com mission
Agricultural areas	117840	984	17469	3854	140147	0. 15
Residential areas	15796	11070	2531	5803	35200	0. 68
Waste lands	1518	126	1426196	12704	1440544	0. 009
Range lands	3482	399	138467	117392	259740	0. 54
Total	138636	12579	1584663	139753	1875631	
Errors of omission	0. 15	0. 11	0. 10	0. 16		

Table 8. Accuracy assessment of classification for 2007

Class	Agricultural Areas	Residential Areas	Waste Lands	Range Lands	Total	Errors of Com mission
Agricultural areas	41671	857	25415	9873	77816	0. 46
Residential areas	5137	6870	19997	2128	34132	0. 79
Waste lands	142	47	1510767	23531	1534487	0. 01
Range lands	948	122	122451	105675	229196	0. 53
Total	47898	7896	1678630	141207	1875631	
Errors of omission	0. 13	0. 12	0. 1	0. 25		

Discussion

Change detection may be defined as a process to determine the status discrepancies of an event or object at a variety of times (Singh, 1998). Nowadays, the unplanned land use and vegetation changes are likely to be studied as an acute problem and most of them may be done with the lack of systematic planning and little attention to their environmental impacts. In past four decades, the vegetation changes resulting from the variations of land uses have increasingly occurred with several unfavorable aspects and intensified the destructive trend of lands. Since these changes happen at broad levels, necessary and valuable tool is the remote sensing technology to evaluate them because of frequent vegetation of the earth (Hennessy *et al.*, 1983). Results suggest that during two studied periods (1987-2007), waste lands constitute the dominant element of our country landscape. Rangelands marginally surround it while placing between fallows and lands with no vegetation. Existence of rain fed agriculture and sporadic residential areas specifies the earth rupture and human factor in the region. On the other hand, breeding the sheep and calves which is seen as the most fundamental procedure of animal husbandry in the form of pastoralist and open grazing considerably affects the regional landscape and alters natural lands into agricultural ones and pastures. Most the heating fuel has to be supplied by the firewood made of forest trees and range bushes. Consequently, rangelands are likely to be demolished due to economic dependence on land and water-related activities along with region susceptibility to economic and livelihood measures as well as challenges of agricultural land uses for production associated with land use changes. In total, these factors explain the causes of destruction trend of Foroughan landscape in Sabzevar. But the major reason of this uptrend during 1987-2007 should be attributed to the rainfall decrease and excessive grazing which play crucial roles in the progress of it. In this respect, any activities' effectiveness aiming to preserve and restore this region's rangelands will be guaranteed if before targeting and planning, identification and investigation steps must be taken to review the communication procedures and strategies to create the required coordination between the interested and influenced groups in the studied area. Because multiplicity of above-mentioned groups like those existing in the region ought to cause the inevitable chaos and inefficiency. Research findings state that vegetation and production changes have been affected by rainfall variations and managerial elements concerning a 20-year assessment. Accordingly, Buffington and Herbel (1965) in the southern United States, Anderson and Holte (1981), Hennessy *et al*. (1983), Arzani (1994) in Australia, O'Connor and Roux (1995) in southern Africa and Ghorbani (2007) have reported that the most important element influencing the regional vegetation changes are drought and precipitation variations in long term. Results of steppe areas' studies mention that the changes in arid regions are gradually taken place and their environmental conditions are recorded in a specific manner that the probability of huge and rapid variations does not exist. Inappropriate range management must be spoken as another main factor which can significantly have impacts on plant composition and vegetation changes. Decrease in the production rate of regional bases is influenced by management or unsuitable grazing and ignorance of entry and exit times despite the increase in rainfall rate. Lack of vegetation-production cooperation may be resulted from the aforementioned causes in the studied years. Meanwhile, annual precipitation variations are of no definite trend to predict these changes or non-existence of them. These results are in conformity with those reported by West *et al*. (1984), Ustine (2004), Apan (1997), Ahani *et al.* (2009), Mather (2005) and Sneva *et al*. (1980) studying the American sagebrush grasslands. West *et al.* (1984) reviewed these variations of five 13-year exclosures in western sagebrush grasslands of Utah, America and declared the fact that despite rainfall rate of the studied years which was of desirable trend, a meaningful enhancement has not been found in permanent regional grasses; in other words, the forage production before and after the exclosure had no meaningful increase so that they concluded that to correct and enhance the range production through increasing the perennial grasses' mass, more time is required and time scale of 13 years is not sufficient. Arokhi and Niazi (2000) applied Landsat images of 1988 and 2001 and conducted the change detection of land use within the district of Dareh Shahr. In order to assess the accuracy of drawn maps, overall accuracy and Kappa coefficient have to be used. It is to be concluded that NDVI's accuracy and Kappa coefficient as 98.5 and 97 percent were the highest values among change detection techniques whereas the calculated 72.5 and 50 percent were accounted as the lowest accuracy values for the change detection of land uses and vegetation in the desired area. Final comments on the effective factors in the changes of regional vegetation require the uniformity and stability of applied monitoring system regarding the unit instructions for measuring the status and trend of range changes for the given periods with enough intervals so that expert views' differences will be minimized. Therefore, having access to an evaluation system in which measurement and statistics must be provided in a fixed and continuous manner at same times during different years through utilizing common and appropriate methods and strategies based on climatic conditions and vegetation is apparently needed with respect to the importance of being aware of range changes' trend and recognizing the management contribution and climatic fluctuations to measure each factor. Also, this system should make the application of digital information of satellites possible to assess the regarded rangelands, specify the evaluation indices of range status and calculate long-term capacity of them.

Literature Cited

Afshinnia, M., 1993. Statistical Methods and Their Application in Science. *Atta Press*, vol. 1, No. 19: 622 pages. (In Persian).

Ahani, H., 2006. Evaluation of Water Dangers using Geographical Information System and Harvesting Techniques, Global Model in Rahim Abad. FasaAgriculture College, Shiraz University. (In Persian).

Ahani, H., Ghorbani, A., Rastegar Moghadam, M., Falah Shamsi, R. and Baghernejad, M., 2009. Evaluation of Land Use Changes using Satellite Images. *Agriculture Science and Natural Resources Jour.*, Vol. 16. (In Persian).

Anderson, J. E. and Holte, R. E., 1981. Vegetation Development over 25 years without Grazing on Sagebrush Dominated Rangeland in Southeastern ldaho. *Range Management Jour*., 34:25-29.

Apan, A., 1997. Land Cover Mapping for Tropical Forest Rehabilitation Planning using Remotely Sensed Data. International *Jour. Remote Sensing*, 18(5): 1029-149.

Arokhi, S. V., Niazi, I., 2000. Comparison of Different Change Detection Techniques of Land Use and Vegetation using RS, GIS (case study: DarehShahr, Ilam province). *Remotely Sensing Jour*., vol. 1, No. 1: 61-77. (In Persian).

Arzani, H., 1994. Aspects of Estimating Short-term and Long-term Rangeland Carrying Capacity. Ph.D. thesis, University ofNew south Wales.

Buffington, L. C. and Herbel, C. H., 1965. Vegetation Changes on a Semi-desert Grassland and Rangeland from 1963 to 1985, 35:139-164.

Chavez, P. S., Berlin, G. L. and Sowers, L. B., 1982. Statistical Methods for Selecting Landsat Mss Raito. *Jour. Applied Photogrammetric Engineering*, 8(1): 23-30.

Dellepiane, S. G. and P. C., Smith, 1999. Quality Assessment of Image Classification Algorithms for Land Cover Mapping: A review and a proposal for a cost-based approach. *International Jour. Remote Sensing*, 20(8): 1461-1486.

Dontree, S., 2003. Land Use Dynamics from Multi -temporal Remotely Sensed Date, Case Study: Northern Thailand. Proceedings of Map in Malaysia.

ENVI User's Guide, 2008. Copyright ITT Visual Information Solutions, Registered in the United States Patent and Trademark Office, 459 pages.

Feizizade, B. V. M. and Mirrahimi, H., 2007. Change Detection of Tabriz Landscape using Object-oriented Methods and Urban GIS. (In Persian).

Foody, G. M., 1992. Compensation for Chance Agreement in Image Classification for Assessment. *Photogrammetric Engineering and Remote Sensing*, 58: 1459-1460.

Ghorbani, A. D., Tiver, B. F. and Brien, C., 2006. Biological Soil Crusts Classification using Ground –levelSpectra. Proceeding of the 27th Asian Remote Sensing Conference, Ulaanbaatar, Mongol.

Ghorbani, A., 2007. Terrestrial Survey and Remotely-sensed Methods for Detecting the Biological Soil Crust Components of Rangeland Conditions. The School of Natural and Built Environment, Ph.D. Thesis, University of South Australia, Australia.

Hennessy, J. T. R., Gibbens, P., Tromble, J. M. and M. Cardenas, 1983. Vegetation Changes from 1935 to 1980 in Massachusetts Dunelands and Former Grasslands of Southern New Mexico. *Range Management Jour.*, 36(8): 370-374.

Hosseini, S. Z. S., Khaje-Al-Din, J., Azarnivand, H., Farahpour, M. and Khalilpour, S. E., 2007. Estimation and Mapping of Vegetation Rate of Rangelands by Processing Sensing ETM+ Images. *Rangeland Science Jour.*, vol. 1, No. 1: pp 79-90. (In Persian).

Jensen, T. J. R., 2005. Introductory Digital Image Processing: a Remote Sensing Perspective. Englewood Cliffs, NJ: Prentice-Hall.

Khalaghi, S., 2006. Change Detection of Caspian Coast, Human Science and Literature College. Tabriz University. (In Persian).

Lefsky, M. A. and Cohen, W. B., 2003. Selection of Remotely Sensed Data, InM. A., Wulder and S. E., Franklin(Eds.). Remote Sensing of Forest Environments: Concepts and Casestudies, pp13-46, Kluwer Academic Publishers, Boston, USA.

Lu, D., and Weng, Q., 2007. A Survey of Image Classification Methods and Techniques for Improving Classification Performance. *International Jour. Remote Sensing*, 28(5): 823-870.

Mather, P. M., 2005. Computer processing of remotely-sensed images. 3rd Ed, John Wiley &Sons, Ltd., p: 319.

O'Connor, T. G. and Roux, P. W., 1995. Vegetation changes in a Semi-arid Grassy Dwarf Shrub-landsin Karoo, SouthAfrica: Influences of Rainfall Variability and Grazing by Sheep. *Jour. Applied Ecology*, 32(2): 612-626.

Singh, A., 1998. Digital Change Detection Techniques Using Remotely Sensed Data. *International Jour. Remote sensing*, 10(1): 1989-2003.

Sneva, F. A., Rittenhouse, L. R. and Tueller, P. T., 1980. Forty-year Inside and Outside, pp: 10-12.

Tipanaiat, U. and Nitin, K. T., 2003. A Satellite-based Monitoring of Changes in Mangroves in Krabi, Thailand. Proceedings of map Asia conference, Malaysia.

Ustine, S. L., 2004. Remote Sensing for Natural Resource Management and Environmental Monitoring.3rd Ed., pp: 522, John Wiley & Sons, Inc., Hoboken, New Jersey.

West, N. E., Provenza, D., Johnson, P. S. and Owens, K., 1984. Vegetation Changes after 13-year Livestock Grazing Exclusion on Sagebrush Semi-desertin West Central Utah. *Range Management Jour.*, 31(3): 262-267.

برآورد تغییرات پوشش گیاهی و کاربری اراضی با استفاده از تکنیک‌های سنجش از دور و سیستم اطلاعات جغرافیایی (مطالعه موردی: دشت روداب شهرستان سبزوار)

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چکیده. کاربری زمین به عنوان یکی از مهمترین عوامل تحت تاثیر قرار دهنده بر محیط زیست از سوی انسان قلمداد می‌شود. تاکنون، از بین بردن مراتع و تبدیل آنها به اراضی بایر و مراتع فقیر از مهمترین تغییرات کاربری اراضی از سوی بشر بوده است. این مطالعه با هدف ارزیابی تغییرات درصد پوشش گیاهی و کاربری اراضی در فاصله زمانی ۱۹۸۷ الی ۲۰۰۷ در روستای براباد-دروک شهرستان سبزوار با مساحت ۱۵۲۲/۹۹ کیلومتر مربع انجام شده است. برای این منظور، با استفاده از تصاویر ماهوارهای لندست TM و ETM^+، اصلاح خطاهای ژئومتری و رادیومتری، بهترین ترکیب باندی انتخاب و نقشه درصد پوشش گیاهی و کاربری اراضی با استفاده از الگوریتم حداکثر احتمال تهیه گردیده است. در نهایت به منظور اعتبارسنجی فرآیند تحقیق، صحت نقشه‌های استخراجی با آزمون صحت کلی و ضریب کاپا تعیین شد. نتایج تحقیق نشان می‌دهد که اراضی بایر از ۸۴/۴۸ به ۸۹/۴۹ درصد و مراتع درجه سه از ۶/۸۵ به ۷/۱۴ درصد افزایش یافته‌اند. در مقابل مراتع درجه یک از ۰/۳۵ به ۰/۰۱ درصد کاهش داشته که سطحی معادل ۵۱۷۰۷۹۱/۴۵ متر مربع از کل مساحت دهستان را شامل می‌شود. همچنین نتایج نشان می‌دهد که اراضی زراعت آبی از مساحت ۶/۵۳ درصد به ۰/۰۷ درصد کاهش یافته است. در مجموع به دلیل بهره‌برداری نادرست از منابع آبی و پوشش گیاهی منطقه، تغییرات کاربری اراضی به سوی اراضی بایر و آیش رفته و نیز باعث کم شدن درصد پوشش مراتع با وضعیت خوب شده است. نتایج این تحقیق نشان می‌دهد که با دقت قابل قبول می‌توان از تکنولوژی جدید سنجش از دور جهت برآورد دقیق مساحت تغییرات کاربری اراضی و پوشش گیاهی استفاده نمود.

کلمات کلیدی: کاربری اراضی، تغییرات پوشش گیاهی، سنجش از دور، سیستم اطلاعات جغرافیایی