An Exploration into Spatial - Temporal Variations Trend Focusing on Forest Classification and Adoption of Classified Error Matrix (Case Study: Central Zagros)

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Abstract: In order to study on the rate of variations in Zagros central region, LANDSAT satellite data from years 1976-2008 were used to prepare a map comprising five classes (of land use) including agriculture, urban, forest, rocks and ranch. Accordingly, the satellite imageries relating to the given period were prepared, interpreted and mapped and variations trend was quantitatively computed, and obtained data were compared to each other while this task was done at three levels i.e. Macro-level (Central Zagros), Meso-level (Dena Protected Area) and Micro-level (Western Dena). On the other hand, measurement of canopy has been introduced as an appropriate factor in forest management and classification at micro level (11). To prepare the given map, distribution of canopy was classified by means of arithmetic interpretation of aerial photographs so that scanned aerial photos 1:20000 (1968) and 1:40000 (2001) were prepared by application of PCI Geometrica orthographically at first step and mosaic pattern was arranged from them. In the next step, the arithmetic orthophotomosaic was classified in three classes (dense canopy, semi-open canopy and open canopy forests) and the resulting map from this classification was prepared using ArcGIS System. To calculate canopy, dotted network with 0.5mm intervals was used as arithmetic layer. Statistical analyses have been adopted for a 30-year period by means of Maximum Likelihood Supervised Technique and in order to determine variation in contrast method after classification as well as Maximum Likelihood Algorithm. The obtained results indicated the rates of total accuracy in images classification for 1976 and 2008 as 90.22% and 94.09% respectively. The computations suggest that areas for farming lands, residential use and open canopy forest have increased, while the dense, semi-open and open canopy forest areas as well as ranches and rocks have been reduced.

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Introduction

With respect to today's importance of ecosystems survey, preparation of applied maps for lands and evaluation and study on variation trend of eco-systemic structure have turned into a crucial approach in the field of resources management (31, 34). In this sense, remote sensing together with aerial photographs and ground control systems are employed as powerful tools to determine and analyze land use planning and land coverage (28, 30). Assessment of land coverage variations is a process that may lead to a proper concept from way of interaction between humans and the environment, and is of greater importance for mountainous-forestial regions (46).

Central Zagros and Dena Protected Zone are one of the biospheric deposits in Iran that are also registered in UNESCO, and solely possess several endemic plant varieties as much as 46 countries throughout of the world. The investigation may show that there are 2000 plant varieties and several medicinal types of plants throughout Kohkilouyeh and Boyer-Ahmad Province in Iran, out of which one thousand plant varieties grow in Dena Protected Zone and these numbers are related the indigenous and unique varieties in the Dena region (8). However, for some period of time, this region has been exposed to many threats; as a result, in order to manage and protect green areas and tree coverage, it requires depiction of these variations and planning and decision making by taking more wide and informative vision for this purpose through acquiring information from past times and the contingent condition in the future and making efforts in the course of their protection. One of the foremost factors exerting land use planning changes is the Urban Development phenomenon.

In 2003, spatial-temporal variations in Millennium National Park that is situated in Sydney, Australia were investigated. To conduct this study, Kate Hughes used satellite images that were taken in 1980, 1998 and 2000 and finally decided to restore the appropriate ecology for this area. In 1996, Humbush (31) and Cropper (24) explored the coverage of Thailand forests by adoption of satellite images that had been taken from 1976 to 1989 where the results signified 28% reduced coverage in the given forests. In 1993, Lieu (34) examined forests coverage in the Philippines. He accomplished this task by using the previously mentioned images taken from 1934 through 1988. In 2003, Roanoke region in Virginia State (USA) was classified by satellite images that were taken in 1985 and 1998 for restoring the ecology in this area (39, 45).

Exploration in the previous study indicates that several researches have been conducted so far in the field of surveying and displaying environmental variations by remote sensing systems. However, due to some reasons including preparation of variations matrix, there was less sensitivity to the changes caused by atmospheric and environmental errors because of wide application and ease of use; hence, variations determination technique that is called "Post-Classification Comparison" is one of the best methods in identifying land coverage variations, which have also been used in this case study.

The present study aims at quantitatively and qualitatively showing rate of variations in forest coverage as well as other applications in spatial-temporal dimensions by canopy parameter via use of accuracy test.

Materials and Methods

Materials

The Studied Region

Zagros region is situated in the West of Iran with approximately 1500km length and 400km width at widest area and it covers a total of 400,000 square kilometers and/or one fourth of the area of Iran. The Zagros range includes 70% of Zagros region and it is spread from Northwestern to Southeastern direction; and Central Zagros is located in an area with 2,500,000 hectares and with an area of over 93,821 hectares, Dena Protected Zone is situated in 51° 9' 36"N to 31° 14' 36"E in the Central Zagros region. According to classifications in the in Iranian Comprehensive Water Plan, this area is located in the water basin of rivers including Karoon, Maroon-Jarahi and Bakhtegan-Maharloo lakes (second degree) and sub-basin 3-4-1-2 (fourth degree). With 4'413m height, Dena peak is the highest point in this region and its lowest point is located at northwestern side of Kolahgaleh city with an altitude of 1,359.2 meters. The Eastern boundary of Dena is limited to Bijan ramp and Northern, Western and Southern sides of this region are restricted to Marbar and Bashar rivers. In terms of frequency of gradient classes, 42.62% of land this region comprise of greater than 60% slope and some parallel watercourses with types of groove and ditch-like erosions and at higher than 30% of gradient in all units, signify the mountainous nature of this area with high sensitivity to erosion (3).

From a vegetation perspective, 29 types of ranch and one ranching subtype have been recognized in the studied area. Forestial types in the studied region comprise of about 43,613 hectares that are situated in hydrologic lots of Ab-e-Malakh, Banestan, Dasht-e-Rose, Dashtak-e-Sisakht, Khafar, Meymand, Pataveh, Sisakht, Sivar, and Rigan Bay. The widest forestial area belongs to hydrologic division of Banestan with an area of 13,619 hectares, and the minimum area of this type belongs to Sivar area with 452 hectares (9).

In terms of forestial coverage, Persian Oak (Quercus Brantii var. Persica) is the dominant variety of trees in this forest (7). Rather than the above variety, some other varieties may be observed in this region such as Montpellier Maple (Acer Monspessulanum), Common Hawthorn (Crataegus Aronia) and Pistachio Tree (Pistacia Atlantica) (16).

Satellite Images and Other Data

In this study, some MSS and IRS satellite images were used related to periods 1976-2008 (33 years) and their specifications are given in Table 1. It should be noted that due to prevention of possible errors, biennial images were taken within closer time intervals in order to reduce impacts caused by seasonal conditions and variation factors during investigations (29).

Similarly, in order to enhance operational accuracy the following auxiliary data were used:

· Aerial photos relating to June 2005;

· Basic topographical maps prepared by the Geographical Organization of Armed Forces in 1998 with the scale of 1:50000;

· Online images from Google Earth

- Stages of work execution:

1- Interpretation of satellites images (36 & 39)

· Geometric correction

➢ Preparation of base map;

➢ Reading of ground control points;

- Selection of adaptation equation;
- Omission of inappropriate control points;
- Correction of image coordinates system;
- Assessment of accuracy in the produced maps;

Fig1: Regional situation of Dena to Central Zagros

Fig2: Regional situation of Dena In 2nd degree water basin

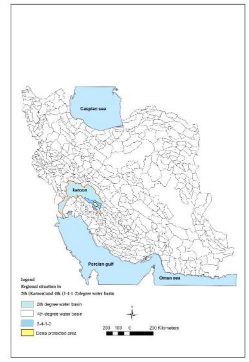


Fig3: Regional situation of Dena In4nd degree water basin

Table 1: Specification of satellite images used in this study

Generator	Magnitude (m)	Number of the used bands	Title of satellite	Used image
USA	**79**	**4**	**Lansat**	**MSS**
India	**24**	**4**	**IRS**	**LISS**

2- *Selection of Interpretation Method*

Classified methods are categorized based on whether these non0imagery data are helpful in analyzing the images, or simply categorize images based on their data using supervised and unsupervised methods, and result evaluation is one of the important stages after classification. Presentation of classification results may reduce their value without any feature that expresses quality and precision of these results (4). To determine the accuracy of classified images in 1976, those satellite images were used that had been taken from control points in the same year, and each of main effects of this region that had been taken via Global Positioning System (GPS) were employed from actual ground points for year 2008.

3- *Preparation of Land Use Map*

In this part, Normalized Difference Vegetation Index (NDVI) was prepared and by adoption of unsupervised classification technique, land use map was prepared for three coverage levels i.e. Central Zagros, Dena Protected Zone, and Western Dena including forest coverage, ranching and urban lands, rocks and farming, and residential lands.

Vegetation Index (NDVI) that is based on spectral values is widely utilized to identify growth conditions for vegetation and it is considered the most practical indices for survey of vegetation variations. Often a certain ratio of close infrared and red bands is used for vegetation coverage maps and study on their conditions, since both these bands are severely adsorbed and reflected by plants. The presence of a high ratio may show sound vegetation while a low ratio signifies unsound vegetation or non-vegetation that is calculated from the following formula (37).

$$NDVI = (NIR - RED)/(NIR + RED) \qquad NDVI\ computation\ Eq.1$$

Where *NIR* is reflector of the radiated ray at wavelength close to infrared band and *RED* is the reflection of radiated beam at visible red wavelength. NDVI range value [+1, -1] may display the fact well that higher value of NDVI denotes greater vegetation (37).

Results

1- *Macro level*: (Central Zagros): According to the results obtained from the amount of lands area with forestial vegetation,, the area of this region was reduced from 360,000 hectares in 1976 to 263,000 hectares in 2007. This area is approximately 96,000 hectares and with respect to Tables 2 and 3, maximum rate of conversion of forestial and ranching lands into urban lands has occurred in an area of 250 hectares.

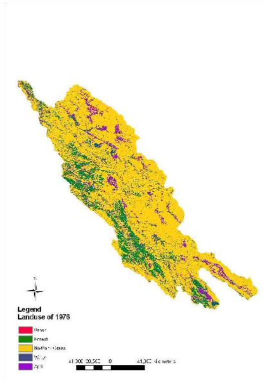


Fig 4: Image of Central zagros classification in 1976

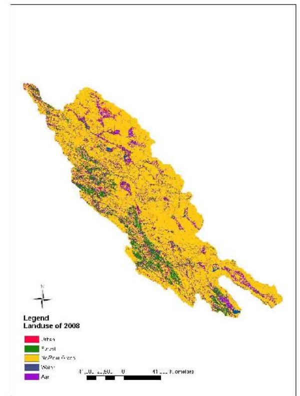


Fig 5: Image of Central zagros classification in 1976

Table 2: Specification of satellite images used in this study

Area of land use classes during several years (in hectares)		
Land Use	**MSS 1975**	**IRS 2008**
Residential and constructed lands	6250.4	17343.5
Lands with forest vegetation	360241.5	263478
Arid lands without vegetation or with low coverage	1746927	1858699
Hydrologic coverage	26844	27062.2
Farming lands	237920.3	311601

Table 3: Exerted changes in land uses during several years

Conversion rate of several uses into each other (in hectares)	
Land Use	
Forest to Residential	424.17
Forest to ranch and arid lands	26074.25
Forest to hydrologic area	494.61
Forest to farming lands	85859.31
Ranching and arid lands to residential	3218.17
Ranching and arid lands to hydrologic area	561.08

2: *The Meso-Level*: (Dena Protected Zone)

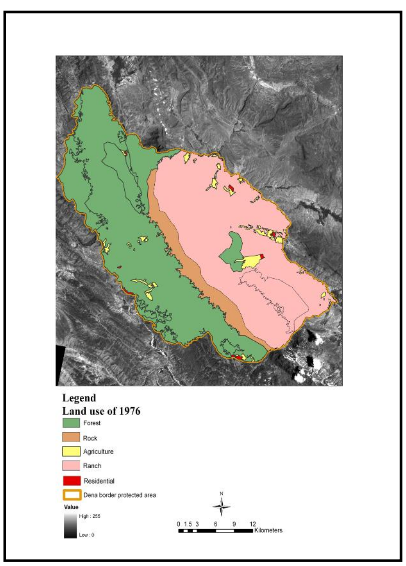


Fig 6:
Classified image of Dena protected Areas in 1976

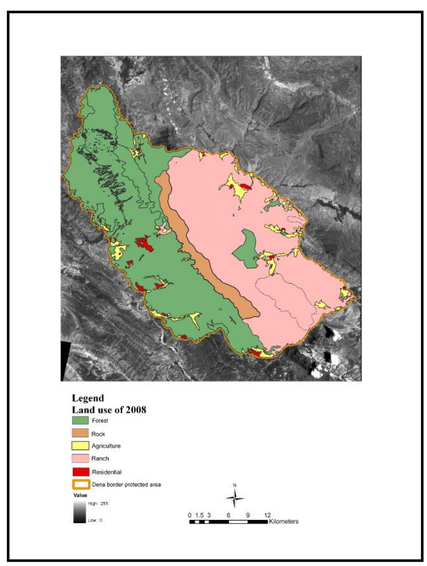


Fig 7:
Classified image of Dena protected Areas in 2008

Accuracy Assessment: Conducting of accuracy assessment for mapping from satellite images is crucially important, particularly if using these maps for management of natural resources. By arranging Error Matrix, accuracy assessment is carried out for the maps prepared from satellite images based on comparison among ground truths and result of maps interpretation (13).

To assess accuracy for the maps prepared from ground truth, the ground truth and random points, which had been derived by GPS system in this region, were utilized and accuracy of producer and user as well as Kappa statistics were extracted from related matrices.

One of the characteristics for accuracy is Kappa coefficient that is extracted from the given matrix. The values of Kappa statistics is used to calculate accuracy of classification to a fully randomized classification. Namely, Kappa value may indicate accuracy of classification to the mode when a fully randomized image (unsupervised) is classified. This action may be denoted by this point that correspondence value will be computed by ground truth after deletion of chance in classification (13).

This value is derived from the following expression:

$$K = \frac{N\sum_{i=1}^{r} X_{ii} - \sum r X_i + X_i}{N_2 - \sum r X_i + X_i} \quad \textit{Calculation of kappa coefficient} \quad Eq.2$$

Where N denotes total number of ground truth pixels, $Xi+$ is the sum of arrays in i^{th} row and X+I is sum of arrays in i^{th} column. As a result, when Kappa coefficient is set to 75% this means results of classification is 75% better than in a mode when pixels are labeled randomly. Value of one means a fully correct classification is based on the derived samples, and negative values of Kappa denote classification weakness and extremely bad results of interpretation.

Error Matrix

Usually, error assessment and estimation of classification accuracy are conducted based on statistical parameters extracted from an error matrix. Error matrix, which is also called "Confusion Matrix", is the product of comparison of pixel with known pixels (in ground truth) and correspondent pixels in classification results. The label of any known pixel is compared with the label of correspondent pixels, and identical results are added together, and labels that are not complied with each other will be calculated. In this table, ground data are displayed as columns and relevant data to results of classification in rows.

Figures that are placed on the main diameter of the matrix characterize the number of pixels, which their labels are complied, with two series of data. In other words, pixels, which have been properly classified, are placed on the main diameter and non-diagonal arrays are error sets. Total accuracy is the average value of classification accuracy that indicates ratio of properly classified pixels to sum of known pixels as defined in Eq. 3. This does not require complex operation, because it is the mean value of classification accuracy and only calculated based on diagonal arrays in the error matrix. Consequently, no useful information may be employed from non-diagonal arrays in this matrix, therefore this is considered as one of its defects in comparison with the Kappa coefficient (13).

Matrix Results: In the present study, error matrix has been utilized for accuracy assessment of images classification in years 1976 and 2008 (Tables 3, 4). Accuracy of user and producer are two parameters, which are separately defined in order to assess the accuracy of classification for different classes. In this table, the number of points taken as sample for any coverage type, rate of mixing samples with others, and eventually accuracy of producer and user are derived from this classification. Producer's accuracy denotes the accuracy of pixels related to a certain class in ground truth map. User's accuracy also expresses possibility of classification in a certain class according to the same class in ground truth map (43).

$$O.A = \frac{\sum_{i=1}^{c} E_{ii}}{N} \quad \begin{matrix} \textit{Computation of overall accuracy} \\ \textit{Computation of total overall } (Eq.3) \end{matrix}$$

where c denotes number of classes, N is total number of known pixels, and Eii expresses diagonal members of error matrix.

Values of Overall Accuracy are computed as 90.22% and 94.09% for years 1976 and 2008 respectively.

Table 4: Classification accuracy in 1976

Coverage Classes	Dense canopy forest	Semi-open canopy forest	Open canopy forest	Palatable Ranch	Ranch	Farming	Residential	Rock	Total	User's accuracy
Dense canopy forest	59	7	0	5	0	0	8		79	74.68
Semi-open canopy forest	2	68	0	00	4	0	0	8	82	82.92
Open canopy forest	0	0	64	0	0	0	0	0	64	100
Palatable Ranch	0	0	0	51	0	0	0	0	51	100
Ranch	0	2	0	0	47	0	5	0	54	87.03
Farming	0	0	4	0	0	71	0	0	75	94.66
Residential	7	0	0	3	0	0	47	0	57	82.45
Rock	0	0	0	0	1	0	0	55	56	98.21
Total	68	77	68	59	52	71	60	63	491	-
User's accuracy	86.76	88.31	94.11	86.44	90.38	100	78.33	87.30	-	-

Table 5: Classification accuracy in 2008

Coverage Classes	Dense canopy forest	Semi-open canopy forest	Open canopy forest	Palatable Ranch	Ranch	Farming	Residential	Rock	Total	User's accuracy
Dense canopy forest	49	2	0	0	0	0	4	0	55	89.09
Semi-open canopy forest	0	37	0	2	1	0	0	0	40	92.5
Open canopy forest	0	1	28	0	0	3	0	1	33	84.84
Palatable Ranch	0	1	0	33	0	0	0	0	34	97.05
Ranch	0	0	2	0	54	0	4	0	60	90
Farming	0	1	0	2	0	18	0	0	21	85.71
Residential	0	0	0	0	3	0	45	0	48	93.75
Rock	0	2	0	0	0	1	0	13	16	81.25
Total	49	44	30	37	58	22	53	14	307	-
User's accuracy	100	84.09	93.33	89.18	93.1	81.81	84.9	92.85	-	-

Discussion and Findings

The results for both images in years 1967 and 2008 indicated that Supervised Parallel piped Classification has the maximum level of accuracy. The criterion for their preference was control points and their adjustment with the produced maps by various techniques. Similarly, for higher accuracy, Normalized Difference Vegetation Index (NDVI) was utilized for ranches and forest (35).

Change of Land Use in Dena Protected Zone

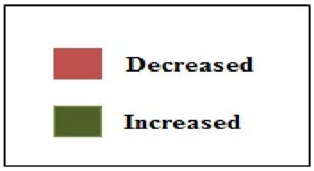
After carrying out classification operation, raster maps derived from classification of satellite images, transferred into IDRISI medium and vector maps were prepared from the given maps. Area of any land uses may be calculated several times, and one can easily determine the value of variations in each of uses within time intervals from 1976 to 2008. The rate of these changes in the period of 1976 to 2008 is given in Tables 6-8.

Table 8: Area of land uses and the exerted changes on them in 1976

Land Use Planning related to year 1976			
Land Use Planning	**Area (hectare)**	**Area (m²)**	**Area (Percentage)**
Forest	45313.94	453139441.98	48.3
Agriculture	2207.35	22073531.41	2.35
Residential	233.04	2330412.016	0.25
Ranch	39910.06	399100680.12	42.63
Rock	6306.79	6307903.29	6.72
Total	93821.53	938215313	100.00

Table 9: Area of land uses and the exerted changes on them in 2008

Land Use Planning related to year 1976			
Land Use Planning	**Area (hectare)**	**Area (m²)**	**Area (Percentage)**
Forest	436136636.29	43613.66	46.49
Agriculture	45306068.32	4530.61	4.83
Residential	8105880.7	810.59	0.86
Ranch	396916386.89	39691.6386	42.3
Rock	49453783.4	4945.38	5.27
Total	938215411	93821.54	100.00



3- *Micro level*: (Dena Western Protected Areas):

Dena Protected Areas is almost bisected from the middle into Eastern and Western parts due to passing through Dena Range where both parts are completely different from each other in terms of climate and vegetation. Since it is intended to examine variation in forest vegetation, and the fact that the Eastern part of Dena Areas lacks forestial vegetation, therefore this part was left, and Western Dena was selected instead.

Structure of Forestial Mass and its Specifications

To identify, study and plan forestial mass accurately, its specifications and properties were analyzed in terms of horizontal structure where this means the surficial distribution of forestial mass on the ground in the forest where the forestial masses were separated by recognizing this factor and canopy index (the surface that is occupied by forestial mass via trees' canopy) was used to carry out this task.

1- Utilized Software and Data

✓ Aerial Photographs

➢1968 with scale 1:20000 (16 plots)

➢2002 with scale 1:40000 (20 plots)

✓ Map's arithmetic files in scale 1:25000

✓ Basic topographical paper map with scale 1:50000 taken from the given area under Nos. 6252I, 6252II, 6252III, 6252IV, 6352III, 6251IV, 6351IV

✓ Satellite imagery taken in 1976 and 2008

✓ PCI- Geometrica software version 9.1

2- Estimation of Canopy Area: Employing data that were obtained from remote sensing may enable decision-makers to be aware of green space area and its development and variation trend within certain times

While due to financial and time-limitation problems achieving these data from the ground is not possible, however this point should be accurately taken into consideration that there is a significant relationship between regression coefficients of aerial photographs taken from canopies, and ground control points (25). In a study that was carried out on Parama forests in Kermanshah City, (8) and Andarz Urban Forests (2), this point was proved and higher regression coefficients and significant relationships were indicated among canopies. Therefore, these relations may be applied to other similar regions. Similarly, those results showed that in order to achieve canopy and classification of urban forests, one might use aerial photographs instead of application of ground vector statistics that are totally incurred considerable time and money.

3- Execution Phases of Canopy Density Level Estimation

✓ *Preparation of Aerial Photographs*

As one of the foremost and most available types of remote sensing data, aerial photographs are considered appropriate information sources for application in forest sustainability management (27). Aerial photographs may be utilized to study on forests, and this may result in very favorable outcomes in forests with wide areas and simple structure of canopy {one-story} and limited plant varieties (27). Such conditions are highly similar to characteristics of Zagros forests, since these forests are distributed within a very vast area {about five million hectares, 15} where varietal frequency is relatively low. With respect to the previously mentioned statements, aerial photographs may be deemed as efficient and useful tools in Zagros forests and of course, results that came from several studies conducted until now may confirm this point (1, 14, 5, and 10). With respect to the structure of Zagros forests, and due to (diagonal and height) and very slow growth as well as climatic conditions and lack of important industrial varieties, on the one hand; and through study on factors like: diameter breast height, average height, number of branches, canopy volume and tree crown; on the other hand, characteristics of canopies were selected as appropriate factors to study on these forests (12, 17). One may utilize these factors as one of the important variables in forestry, forest sciences and eco-forestry (13) in order to examine variations and survey these forests (11).

Map Preparation is one of the foremost applications of aerial photographs (27). Canopy is one of the forestial features that can be studied on aerial photographs and this action may be followed by higher accuracy from aerial photographs in comparison with ground operation since trees' canopy are observed from top view in aerial photographs and as a result, measurements will be more accurate (21, 32). To prepare map of canopy mass, several studies have been conducted on using aerial photographs in forests, and in many of them, canopy map has been adopted instead of canopy mass (density) map (Ahmadi Sani 1, 11, 18, 22, 46, 23, 47). In other studies on aerial photographs, canopy mass (density) map has been prepared. The point which has been considered in the previously mentioned studies is that "canopy" and "density of canopy" differ from each other (12). Canopy is the level that is covered by vertical image of tree crown on the ground; and to calculate the rate of canopy of two trees that are overlapped, the joint coverage resulting from overlapping of trees crown should be omitted; while in order to compute density of canopy that is expressed by percent, the amount of canopy in trees gird is estimated within certain limits (like a typical part or area unit) (26, 38).

➢ First series of photographs: Aerial photographs in 1968 with scale 1:20000 - (16 plots) (The sole available series of photographs in Iranian National Cartographic Center NCC)

➢ Second series of photographs: The latest series of aerial photographs with scale 1:40000 920 plots) (The series of photographs that was available from NCC organization in year 2001)

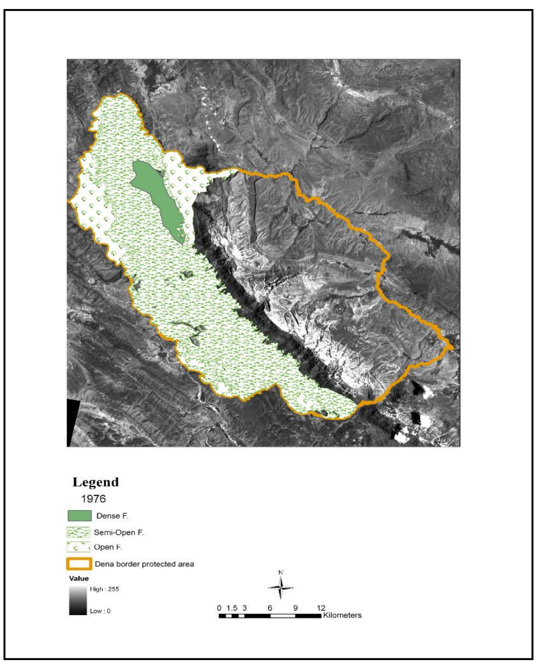
(Photographs were prepared as dispositive and coordinated scans)

✓ *Mosaicking of aerial photographs*

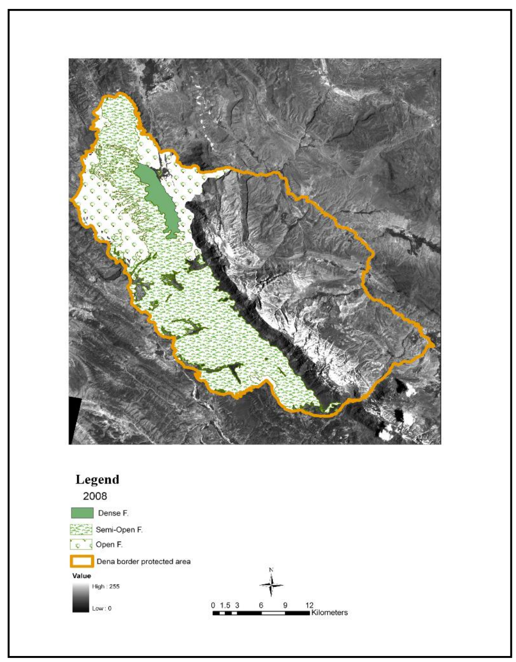
At this stage, the regional photographs prepared from two different scales were integrated into the same scale and juxtaposed, and arithmetic orthophotomosaic was prepared.

✓ *Design of dotted network*: Dotted network was prepared in medium of ArcGIS software so that a dotted network was utilized with 5×5 dimensions and 25 points within 0.5mm identical intervals (16). The same network was adopted for aerial photographs in both periods because of their identical scale, and this network was located on orthophotomosaics and the points on canopy were counted and separated in three classes in such a way that in class I canopy exhibited less than 35% coverage, and class II canopy coverage was 35-70%, and finally in class III canopy had a coverage of more than 70% (16). There is another classification of course:

Class I: Less than 50% coverage; Class II: 50-90%; and Class III: Greater than 90% coverage



Classified image of Dena Forest in 1976



Classified image of Dena Forest in 2008

4- Results:

Table 10: Forest classification in 1976

Forest classification 1976			
Land Uses	**Area (m²)**	**Hectare (m²)**	**Area Percent**
Dense Canopy Forest	24699056.23	2469.91	2.63
Semi- Open Canopy Forest	340079638.5	34007.96	36.25
Open- Canopy Forest	88360747.25	8836.07	9.42

Table 11: Forest classification in 2008

Forest classification 2008			
Land Uses	**Area (m²)**	**Hectare (m²)**	**Area Percent**
Dense Canopy Forest	19998020.29	1999.80	2.13
Semi- Open Canopy Forest	284727297.5	28472.73	30.35
Open- Canopy Forest	131411318.5	13141.13	14.01

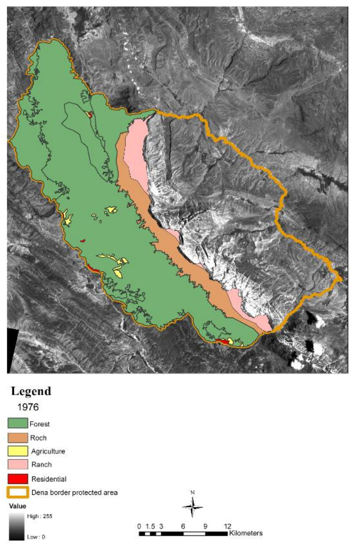


Fig 10: Classified image of Western Dena protected Areas in 1976

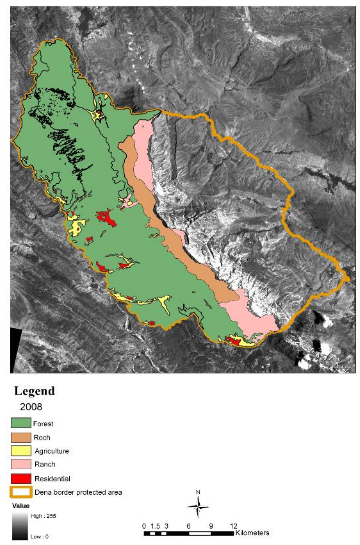


Fig 11: Classified image of Western Dena protected Areas in 2008

Results suggest that such variations have been directed toward reduction of (dense and semi-dense) forest lands and ranches and increase in farming and urban lands and open-canopy forests throughout this region within a 30-year period, that may be considered as population growth and intervention caused by human activities in Dena Protected Zone, so one may refer to this point as follows:

1- *Land Use Plan with positive growth*:

2- *Land Use Plan with negative growth*:

✓ Agriculture: From 2.35 to 4.83%

✓ **Forest:**

✓ Residential: From 0.25 to 0.86%

➢ Dense: From 2.63 to 2.13%

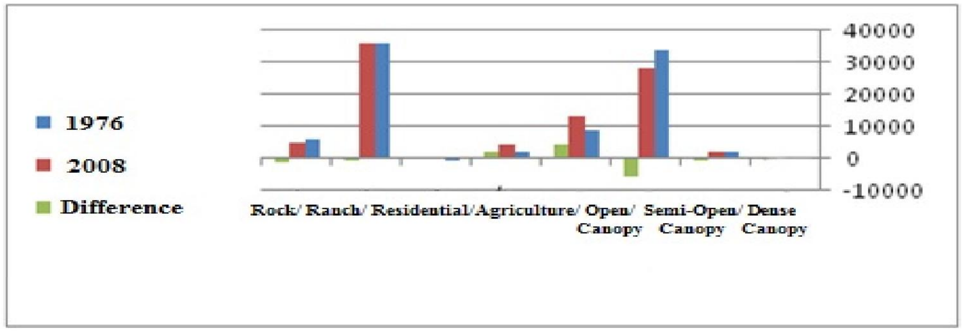
✓ Open- canopy forest: From 9.42 to 14.01%

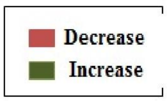
➢ Semi- open canopy: From 36.25 to 30.35%

✓ Rocks: From 5.27 to 6.7%

Table 12: The exerted changes during years 1976 and 2008

Comparison of Land Uses	**1976**	**2008**	**Difference**
Dense Canopy Forest	2469.91	1999.80	-470.10
Semi- Open Canopy Forest	34007.96	28472.73	-5535.23
Open- Canopy Forest	8836.07	13141.13	4305.06
Agriculture	2207.35	4530.61	2323.25
Residential	233.4	810.59	577.55
Ranch	39910.06	39691	-218.43
Rock	6306.79	4945.38	-1361.41





Digram 2: The exerted changes between Years 1976 and 2008

Discussion and Conclusion

In response to economic and social factors etc., land use and coverage models may be changed. In order to acquire information about the rate, spatial distribution, and type of variations that occurred in sources over time, the first step in recognition of reason and place of incidence of such variations in natural resources is the process of revealing these changes, while by means of this information, managers, policy-makers, and users may make more knowledgeable decisions concerning possession, protection and sustainable use of natural resources.

Overall, the total area of 85,800 hectares at macro-level and 1700.28 hectares at Meso and micro-levels from Central Zagros have been converted from natural vegetation into farming and residential areas from 1976 to 2008. While the rate of open canopy forest has increased up to 4.56%, this may refer to conversion of semi-open canopy into open canopy forests. At the same time, farming and residential lands and ranches have increased 2.48%, 0.61% and 0.33% correspondingly and this point totally signifies the variations in land use of semi-open canopy forests into such uses. Farming land use varies by development in former points while there has been no residential use planning in water basin of Dash-e-Rose and Pataveh Plains during past years, therefore settlement activities have been executed within recent years. The other point is reduction of rock use up to 1.43% (Dena Range) that has been converted into farming, residential and often ranching-use planning.
In a general conclusion, it can be said:

15.84% of the existing lands in 1976 and 2008 were affected by changes (irrespective of possible errors in the available tools).

The impetus for forestial vegetation changes has been the increase in farming, urban, and constructed lands (passing gas pipeline V) in the Western Dena region.

This trend denotes the point that during events of the Islamic Revolution and the Iraqi Imposed War, and due to lack of management plan for these regions in the one hand, and inappropriate increase of industrial development throughout this country after the war on the other hand, as well as paying no attention to Iranian natural resources, the central region of Zagros Range and Dena Protected Zone have been degenerated. Thus, in order to decrease stress and losses caused by these variations, and to improve prevalent models for lands management toward realization of comprehensive sustainable development and stable planning in this region, the trend of these variations should be adequately taken into consideration; and it is recommended to execute Land Survey Plans for all points in Central Zagros and Regions Management Plan for the Dena Protected Area.

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