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Analysis of Landscape Ecology Metrics of Mehriz City during 2002-2010 by Approach of Land Cover Changes Study

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Abstract: Landscape is an arrangement with combination of locational ecosystems or land usages in a region with repeated similar form. Ecosystems naturally have face with various changed in their successive proceeding which usually has consistent and calm nature according to system structure and type of changes. The surveying land cover changes has serious role in environment management and planning. Therefore, the present study aims on analysis the landscape ecology metrics in this research such as number of patch, area, cover percentage, total edge, edge density, the mean patch size, and Shannon diversity index. The analysis of the obtained metrics from satellite images in 2002-201, it was indicated that gardens usage class area has significantly decreased, and human-made lands usage, green spaces, and planting trees have significantly increased.
Keywords: landscape ecology, land cover, metric, GIS

Introduction

Review on Concept of Landscape Ecology

Troll introduced the expression of “landscape ecology” in 1939. This German biologist-geographer aimed on combination two fields of ecology and geography. The “geographical” elements dominated on landscape ecology since 1939 to 1970 significantly, which were mainly developed in Eastern Europe, Canada, and Australia, and were used in vast landscape ecology potentials. (Burel & Baudry, 2003:6) Landscape is an arrangement with combination of locational ecosystems or land usages in a region with repeated similar form. (Apan et al., 2002:43) The basic views about landscape were in European cultures during centuries, but this view became universal since 1980s, when this school developed in North America. In 1990s, the scientific discussions about landscape ecology accelerated quickly. The related discussions about landscape ecology are proposed in spatial scales and their focuses are bringing solidarity between human and environment. Its usage in each landscape is executable from city to forest, grassland, and tundra. Using these principles, beside simplicity, can lead to integrated designs and planning, reducing disruption and falling of landscape. (Dramstad et al., 2007: 7)

Ecosystems naturally face with various changes in the path of their sequences that have consistent and calm nature according to system structure and type of changes. Meanwhile, some environmental factors, in interruption with the existed mechanisms in nature, intensify or change evolutions procedures and can lead to irretrievable changes or damage of ecosystem. Studying the process of these changes identify effective parameters and determination of modifying strategies besides being able to indicate system sequential process including both ascending and descending process in this period chronically.

Monitoring land usage changes and land cover has serious role in environment planning and management. If we want to protect environment and satisfy environmental needs of human, an environmental planning should be based on all related decisions to land development to provide related necessities to land usage. (Beer and Higgins, 2006: 45)

Land usage changes is an issue that may happen by factors such as drought, fire, flood, volcanic activity, and human activities such as grazing, urban sprawl, agricultural lands, and natural resources management. (Ustine, 2004:153) The time and place changes analysis is a great challenge in landscape ecology and environmental management. (Chiesa *et al.*, 2009:1695)

Today, high speed and extensive changes (structural and process) in landscape are resulted by human destructive activities and made planners face with problems, while landscape ecology as a knowledge-based issue can have an important role in monitoring these changes. It means that a proper perception about landscape dynamisms and communications can be achieved in order to use in planning, management, and monitoring these changes using this approach by identification the structural factors, streams, main processes, and factors of making changes (destructive) in landscape.

Landscape and usage of various regions are changing for urbanization and population growth. This phenomenon has various economic-social, and environmental consequences. The urbanization development and human-made usages in nature make infrastructural changes in structure, landscape ecological function, and gradual changes in locational structure and landscape model. The analysis of the spatial and structural characteristics of the constituting patches of landscape is very important daily issues on interpretation and modelling the time-place changes. These studies have developed more by development of fields such as remote sensing, GIS, and landscape ecology. Non-attention to environmental attitudes in managerial planning of landscape and implementation nature models finally enters serious damages to their natural systems.

The study of landscape based on ecological principles and scales of landscape as its constitutional elements are proper tool to map and quantification the locational properties of each usage. The principles of landscape ecology can be used as holistic approach in landscape design. This approach not only proposes ecological and biological issues in landscape design, but also encompasses sociological and economic issues and can help in more stable environmental landscape design which is more proper according to culture and aesthetics. The

landscape ecology principles evaluate all type pf landscape ecologies and provide more proper managerial strategy (Maakhdum, 1999: 87).

The landscape metrics have been known as important tools to describe shape, size, and locational physiognomy characteristics (Wu *et al.*, 1997:31) of landscape. The landscape metrics are used to quantify locational characteristics of patches, classes, or total mosaics of landscape. Metrics are the best way of comparing various landscape situation. Today, landscape metrics have been changed to developed indexes to find classified maps patterns. (McGarigal & Marks, 1994:21)

Researches Review

Many studies have been conducted in Iran and the world about landscape ecology so far.

Parivar et al. (2008) in a research under the title of "analysis locational changes and locational distributions of Tehran green urban spaces in landscape scale" evaluated the condition of combination and distribution spatial elements of landscape structure and their changing process by landscape metrics quantitatively through Landsat satellite images in 1988 and 2002 and found that the green space patches have had intensive destructive process according to the extent, continuity, and nature of the composition and spatial distribution.

Eskandari et al. (2011) in an article under the title of "lands usage and analysis of landscape of Golsefid village using GIS and RS environmentally" found many metrics using QuickBird satellite images and found by their analysis that the existence of human-made patchs such as village endangers mine, sand and rubble in both sides of road and petrochemical popes of edge areas in critical condition and damaged bio-diversities.

Karami and Feghi (2012) in their study under the title of "monitoring and comparing land usage of North and South Zagros by landscape ecology approach (case study: Kordestan and Kohkiluyeh and Boyerahmad provinces)" found by quantification the related metrics to land usage patchs that stable usage cover percentage for Kordestan province are agriculture (45%), green land (41%), and forest (12%), respectively; for Kohkiluyeh Boyerahmad province are forest (45%), green land (35%), and agricultural land (12%), respectively.

Fathizad et al. (2013) conducted a research under the title of "studying land usage based on landscape metrics analysis using remote sensing (RS) and GIS in dry and semi-dry region of Dehloran. They found various metrics using satellite images in 1985 and 2007 and concluded from criterions analysis that the mean pasture lands were extensively altered by agricultural, poor pasture, residential area, and moor.

Zhua et al. (2010) in an article under the title of "evaluating the environmental effects on gulf region that was influenced intensively by urban and political development according to landscape view (case study: Gulf of Liao Cheng, China) by the obtained metrics from satellite in 2000-2006 and they concluded by the analyses

that the salt marshes in the gulf was destructed for rapid increasing of urbanization in gulf area and corridor relationship with urban and rural points.

1. Methods and Materials

Study Area

Mehriz city in south of Yazd province is in 30 km of Yazd city beside the strategic road between Tehran-Bandar Abbas (Yazd-Kerman). The continuity of Shirkooh heights are in the western part of the city led to the formation of rich groundwater aquifers and air adjustment it is compared to other parts of the province Yazd. The climate of this city is moderate and dessert. Mehriz town center is "Mehriz city". This city has 14684 km² area. According to statistics of 2006, it had a population of approximately 44,397 people. Mehriz city is in circuit 31 degree, 33 minutes, 35 minutes of northern latitude and 54 degree and 24 minutes to 54 degree and 25 minutes of eastern longitude. The distance of Mehriz city from province center is 30 km. the following image is satellite image of this town and Mehriz city.

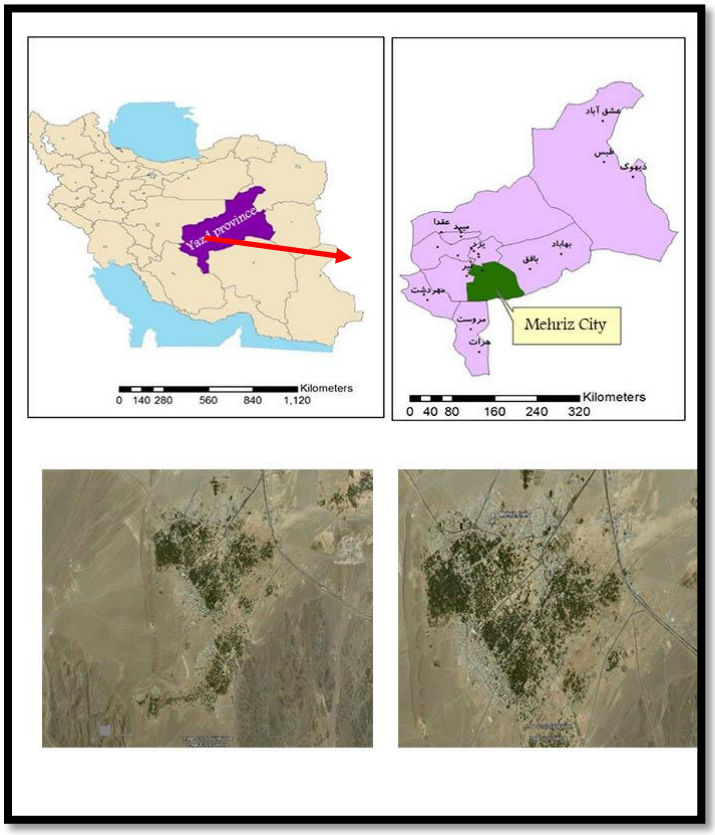

Fig. 1 situation of Mehriz city in state and studied range (Mehriz city) from satellite image

Methodology

In order to start this project, first data bank was made; as though, region boundary, that was Mehriz city, was indicated, then field observations in area limitations was done by GPS. Later, QuickBird satellite images of

2002 and 2010 were extracted. Then related images was transferred to ArcMap (v.9.3) and cut according to the aimed boundaries.

The Georeferencing was the first action in ArcMap software; as though, Georeferencing or real locational coordinate system belonging to images was conducted using discrete controlling points (according to the obtained points from field observations) for both two-series images in 2002 and 2010. 14 discrete controlling points was taken for both image and the image coordinate system and WGS 1984 UTM Zone 40N zone was belonged for each point to have real locational coordinate on image. After the geo-referring, making land cover layer land (Land Cover) was done. The land cover layer according to the objective of this research has six substrate agricultural land (crop), gardens, bare land, man-made land, urban green spaces, and tree planting. This condition was detected based on visual and field visits. To complete the construction of a geodatabase, the database was created with the substrates mentioned above and then drawing and polygon was performed for each of the above groups. The reason of making the geo-database instead of making independent complicated layers is automatic and timely calculation of area and environment of complications in descriptive tables of each sub-layer of geodatabase.

Calculating *Landscape Metrics*

The fragmentation process is the one used to measure landscape metrics that is one of the most important processes influencing landscape performance and structure and divides landscape to smaller pieces. (Ahern and Leitão, 2003:72)

After indicating the fragmentation in landscape, the landscape metrics can be calculated. The landscape ecological metrics are useful tools to enter to ecosystem view in environmental planning by which landscape processes can be quantitatively measured (Darmstadt et al., 2007: 27).

Landscape metrics are patterns of algorithms to quantify locational characteristics of patch, classes, or entire landscape mosaic. Metrics are the best way of comparing various landscape situations. Ability of quantitative description of a landscape structure is a pre-condition of studying landscape change and performance and various metrics have been extracted to reach this objective of landscape ecology.

Landscape metrics describes spatial structure of a landscape as a united collection with determined identity in each time and are useful to obtain an initial classification of landscapes (Ahern and Leitão, 2003:71). In addition, they are very useful in approaching the urban planning language and ecosystems. Moreover, landscape metrics are important in supporting decisions related to different planning strategies. For example, metrics can help to discern what the most important patches are in land usage.

The used metrics in this research are in table (1) including NP ،CA ،PLAND ،TE ،ED، MPS, and SDI that are analyzed in part of various land classes usages for 2002 and 2010. The reasons of selecting these metrics are previous studies and importance of them in interpretation locational distribution of landscape structure. In

addition, the used metrics, to quantify landscape quality structure of Mehriz city, are calculated by the added patch analyze to ArcGIS software.

The following table indicates the used metrics in this research with the following definition, description, and their units.

Table (1) – the used landscape ecology metric and their descriptions

Landscape metrics	***Abbreviation sign***	***Unit***	***Definition***
No. patches	NP	--	Total no, of patches in each class or landscape
Class area / Total area	CA	Hectare	Total area of each class or landscape
Cover percentage	PLAND	%	Ratio of cover percentage in each landscape
Total edge	TE	Meter	Total perimeter of all patches in landscape
Edge density	ED	Meter/ Hectare	Ratio of perimeter to area of each class or landscape
Mean patch size	MPS	Hectare	The mean patch size in landscape
Shannon diversity index	SDI	--	The relative amount of patches: if a patch is in landscape, this amount is zero and increase by increasing patches

Findings and Results

In this part, the obtained results from landscape metrics are analyzed. Each land cover was measured in 8 years period since 2002-2010 and the changes in mentioned classes are referred according to the obtained analyses from metrics.

Agricultural Lands

Agriculture and farming was occupation for people in Mehriz since ancient times and agricultural land in the area is sparsely or continuous in this region, total area of agricultural land according to calculations in

ArcGIS was about 518 hectare in 2002 which reached to 542 hectare in 2010 and nearly had no change. This amount of change shows increasing in changing gardens to agricultural lands. Therefore, cover percentage (PLAND) shows this fact, too. They have nearly similar amounts. Number of patches (NP) in 2002 was relatively more in 2002 showing more fragmentation and dispersion of patches in past years which becomes integrated and coherent today and this matter relatively shows Shannon diversity index (SDI), because it shows that number of patches was more in 2002. The total edge of patch metrics (TE) shows this amount has reduced during 8 years. The next metric is patch edge density (ED) that is sum of perimeter on area of used land. This amount was 100 m/hec in 2002 more than amount in 2010. The last metric is MPS that is mean patch size in each usage class and shows this matter that patches size in 2010 are relatively bigger.

Table (2) – landscape metrics in 2002-2010 in agricultural lands usage class

Metrics	NP	CA(ha)	PLAND(%)	TE(m)	ED(m/ha)	MPS(ha)	SDI
2002	٥٦١	٥١٧/٧١	٢٩/٧٠	٢٣٥٤٦٠/٣٣	٤٥٤/٨٠	٠/٩٢	٥/٣٠
2010	٣٣٩	٥٤١/٨٣	٢٨/٥٠	١٨٦٣٧٢/٨٧	٣٤٣/٩٦	١/٥٩	٤/٧٠

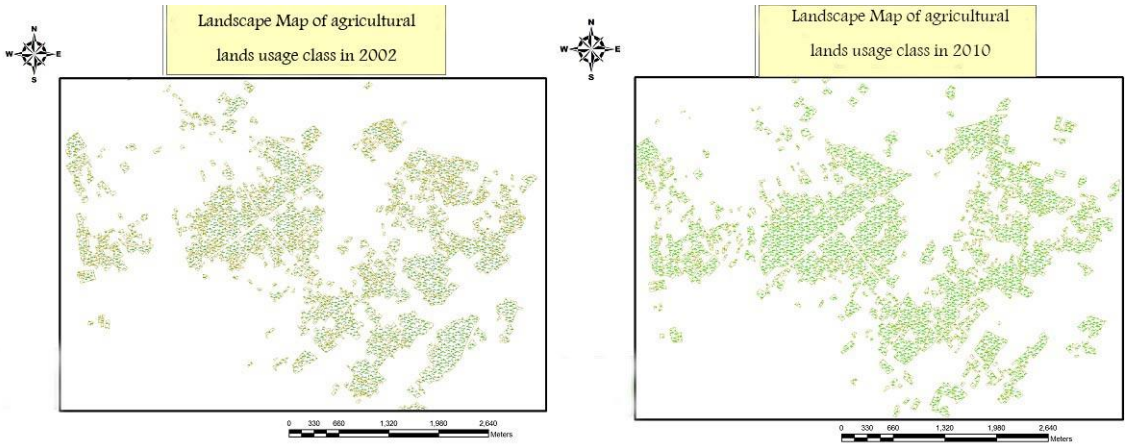

Fig. (2) – map of landscape of agricultural lands usage class in 2002-2010

Garden

Mehriz city was known to garden city of Yazd province since ancient times and shows existence of affluent gardens in Mehriz city. In calculation, it was indicated that the gardens area in Mehriz city was 570 hectare

in 2002 that reached to 379 hectare in 2010 that unfortunately it had miserable reduction during 8 years whose main reason for this catastrophic phenomenon is extreme land usage changes from garden to human-made land usages or agricultural and semi-agricultural lands. The total edge metrics reduced following by this reduction. Of course, MPS didn't change a lot. The Shannon diversity metrics didn't also so much change, because they are many patches in spite of garden classes' reductions which are effective in this metric. Edge density matric (ED) was relatively more in 2010 than 2002, because this amount increased by area reduction and its reverse relationship with metric.

Table (3) – landscape metrics since 2002-2010 in gardens usage class

Metrics	NP	CA(ha)	PLAND(%)	TE(m)	ED(m/ha)	MPS(ha)	SDI
2002	٤١٠	٥٦٩/٥٠	٣٢/٧٠	٢٠٩٠٢٤/٧٧	٣٦٧/٠٣	١/٣٨	٤/٩٠
2010	٣١٢	٣٧٨/٩٣	٢٠	١٧٣٧٣٦/٠١	٤٥٨/٤٩	١/٢١	٤/٦٩

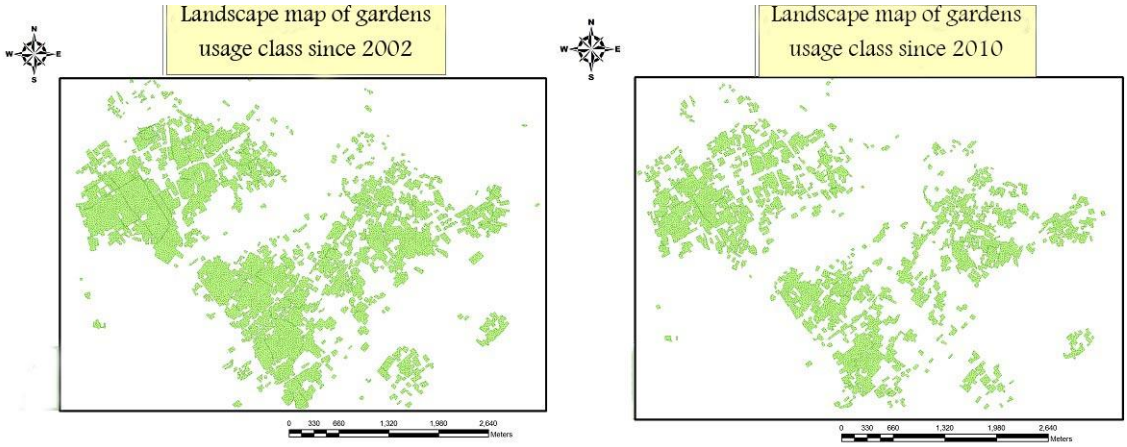

Fig. (3) – landscape map of gardens usage class since 2002-2010

Human-Made Lands

Urban development and growth was so high during 8 years and some human construction growth increase more along with this development. The human-made land areas was doubled and 21% cover percentage in 2002 changed to 34% coverage percentage in 2010 which shows very fast extension of residential lands and other human-made lands such as factories, etc. The total edges (TE) metric was also doubled. This amount wasn't significantly changed for different effectiveness of two perimeter and area metrics in ED metric during

8 years. The human-made MPS in 2002 was a little bigger and finally number of patches and Shannon diversity was more in 2010 for many distributed constructions.

Table (4) – landscape metrics since 2002-2010 in human-made usage class

Metrics	NP	CA(ha)	PLAND(%)	TE(m)	ED(m/ha)	MPS(ha)	SDI
2002	٣٢٦	٣٧٧/٤٧	٢١/٦٠	١٥٣٨٤٣/٦٥	٤٠٧/٥٥	١/١٥	٤/٨٧
2010	٧١٣	٦٤٢/٥٠	٣٤	٢٩٩٤٧٥/٠٨	٤٦٦/١٠	٠/٩٠	٥/٨٩

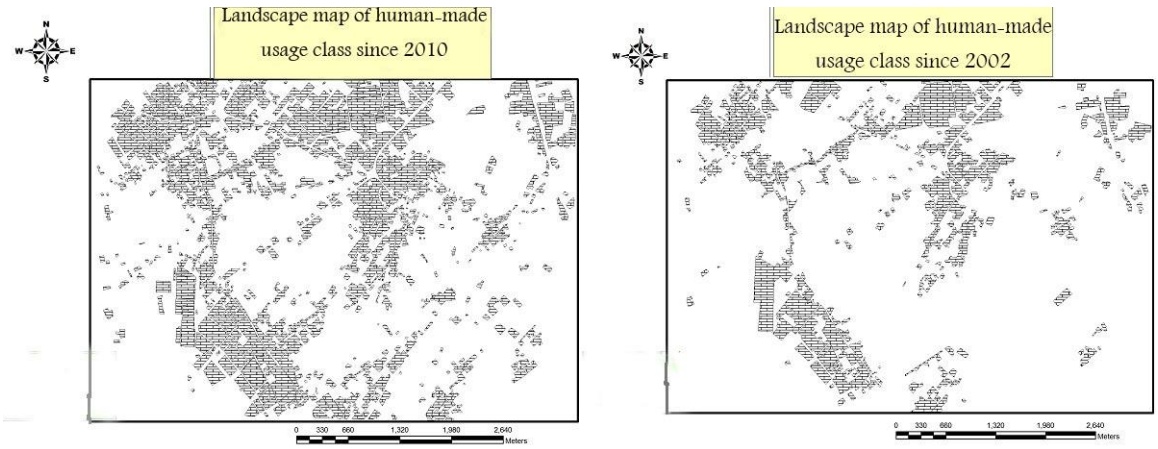

Fig. (4) –landscape map of human-made usage class since 2002-2010

Green Spaces

The NP and SD significantly increased in studied years. Therefore, the PLAND was increase 5 times. TE and ED metrics reduced for highly influential factor of area. The MPS relatively increased. Since green spaces is one of the main elements for beatification of city face, and its air smoothing performance is also noticeable, green spaces have seriously mentioned during 8 years.

Table (5) – landscape metrics since 2002-2010 in green space usage class

Metrics	NP	CA(ha)	PLAND(%)	TE(m)	ED(m/ha)	MPS(ha)	SDI
2002	٢٥	١/٧٦	٠/١٠	٢٦٨٤/٨٤	١٥٢٣/٥٤	٠/٠٧	٢/٨١
2010	٩٩	١٠/٠٦	٠/٦٠	١٠٦٦٤/٣٠	١٠٠٦/٠٦	٠/١٠	٣/٥١

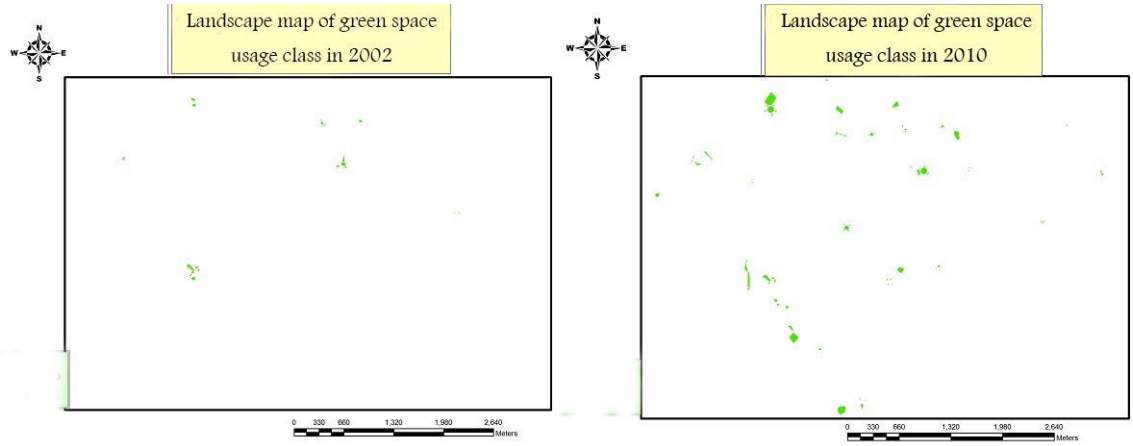

Fig. (5) –landscape map of green space usage class since 2002-2010

Planting Trees

Planting trees are put in different class for its importance and having different performances than green spaces. Number of patches increased from 6 cases to 11 cases and Shannon diversity increased to 1.5 unit. Their area was increased to 2.5 hectars in 2010. ED was more in 2010 for more effect of edge factor in this case. The MPS are highly different for few number of patches and extension of patches is relatively bigger in 2002.

Table (6) – landscape metrics since 2002-2010 in planting trees usage class

Metrics	NP	CA(ha)	PLAND(%)	TE(m)	ED(m/ha)	MPS(ha)	SDI
2002	٦	٤/٤٥	٠/٣٠	٢٧٧٢/٩٢	٦٢٢/٩٣	٠/٥٠	١/٧٧
2010	١١	٧/١٩	٠/٤٠	٤٨٣٩/٩٧	٦٧٣/١٥	٠/٦٥	٢/٢٢

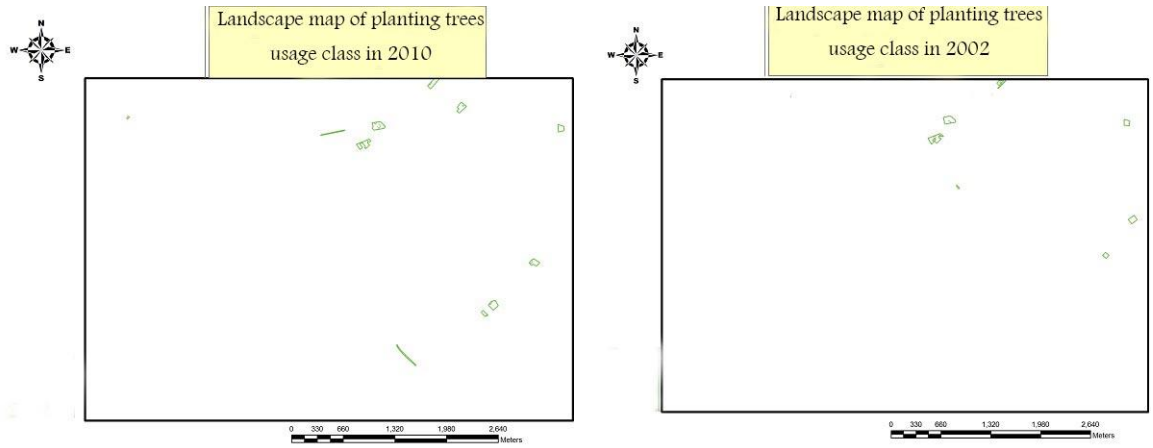

Fig. (6) – landscape map of planting trees usage class since 2002-2010

Barren Lands

In definition of barren lands is written: "land reclamation was once detained but later left and it is not plowed and activities are not exploited. For example, it was agricultural land in 10 years ago and the owner didn't complaint but there is no activity there now." In addition, the article 4 of civil law stated in this regard: "urban barren lands are the ones with survival and civil background that gradually change to uncultivated state both with and without owner". The polygons of these lands were drawn according to civil maps and definitions, the subordinated organizations lands and field observation.

According to calculation, NP increased in recent years and SD increased relatively. The barren lands area increased to 40 hectar. However, PLAND didn't so much changed. According to priority of edge factor to area factor in this case, ED in 2010 is more than 2002. No significant change happened in MPS in studied period.

Table (7) – landscape metrics since 2002-2010 in barren lands usage class

Metrics	NP	CA(ha)	PLAND(%)	TE(m)	ED(m/ha)	MPS(ha)	SDI
2002	٥٩	٢٧٢/٤٤	١٥/٦٠	٤٨٢٨٦/٩٩	١٧٧/٢٣	٤/٦١	٣/٠٧
2010	٨١	٣١٤/١٠	١٦/٥٠	٦٥٠٧٠/٢٨	٢٠٧/١٦	٣/٨٧	٣/٧١

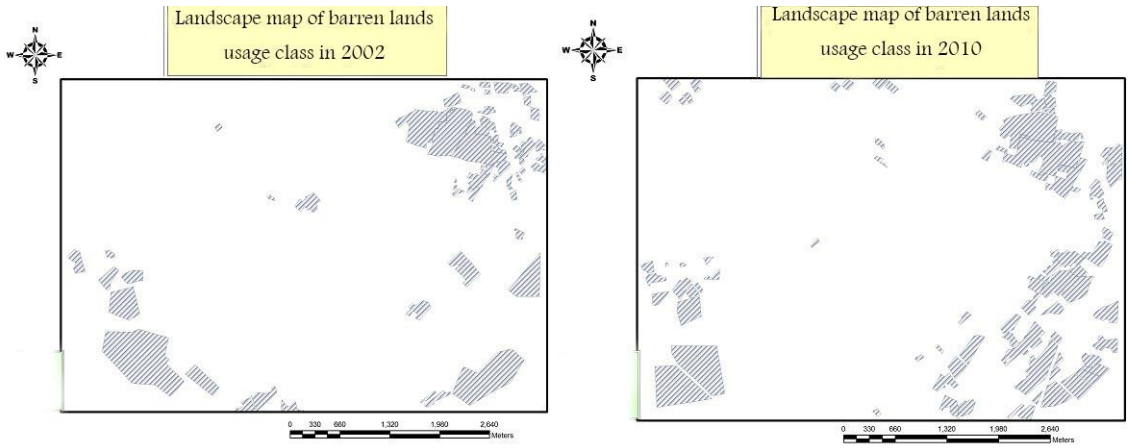

Fig. (7) – landscape map of barren lands usage class since 2002-2010

Discussion and Conclusion

In following, table (8) was estimated including the quantified metrics of all classes. The percentage increased and metrics reduction was calculated in table (9) in 2002-2010. Figure (8) compared two area index and PLAND metrics in 8 years.

According to area, it can be concluded that agricultural lands usage in 2010 increase 4.65% than 2002. It means nearly agricultural lands increase about 30 hectars. Gardens were destructed more and reduced; as though, 50.29% of gardens, about half, reduced. The main reason of this reduction is changing 190 hectars of garden usage to residential usage or other human-made buildings or changing to agricultural lands. By this interpretation, the human-made land usage class significantly increased in 2010 in a way that 265 hectars were added to them. It means it had 70.21%. Fortunately, green spaces and planting trees had good growth. In 2002, green space and plating trees was in 0.1 and 0.3 hectar, respectively which increased to 0.6 and 0.4. It means they grew 471.59% for green spaces and 61.57% for planting trees that shows attention to smoothing performance of air and increase classes of per capita urban green areas. The barren lands extension is considered as the left and unarranged lands. It had 15.29% increased equaling to 41.66 hectar. The diagrams (8) help to understanding them better.

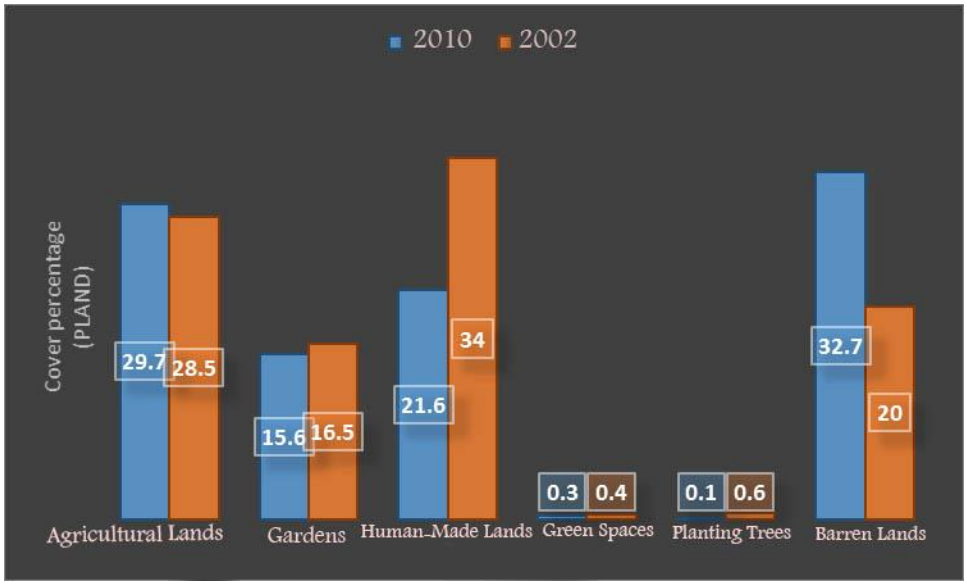

Diagram (8) - comparing PLAND of various usage classes during 2002-2010

Table (8) the quantified metrics of landscape in various PLAND areas during 2002-2010

SDI	MPS (Hec)	ED (Meter/He)	TE(Meter)	PLAND (%)	CA (He)	NP	Metrics / usage classes	Year
٥/٣٠	٠/٩٢	٤٥٤/٨٠	٢٣٥٤٦٠/٣٣	٢٩/٧٠	٥١٧/٧١	٥٦١	Agricultural Lands	٢٠٠٢
٤/٩٠	١/٣٨	٣٦٧/٠٣	٢٠٩٠٢٤/٧٧	٣٢/٧٠	٥٦٩/٥٠	٤١٠	Gardens	
٤/٨٧	١/١٥	٤٠٧/٥٥	١٥٣٨٤٣/٦٥	٢١/٦٠	٣٧٧/٤٧	٣٢٦	Human-Made Lands	
٢/٨١	٠/٠٧	١٥٢٣/٥٤	٢٦٨٤/٨٤	٠/١٠	١/٧٦	٢٥	Green Spaces	
١/٧٧	٠/٥٠	٦٢٢/٩٣	٢٧٧٢/٩٢	٠/٣٠	٤/٤٥	٦	Planting Trees	
٣/٠٧	٤/٦١	١٧٧/٢٣	٤٨٢٨٦/٩٩	١٥/٦٠	٢٧٢/٤٤	٥٩	Barren Lands	
٤/٧٠	١/٥٩	٣٤٣/٩٦	١٨٦٣٧٢/٨٧	٢٨/٥٠	٥٤١/٨٣	٣٣٩	Agricultural Land	٢٠١٠
٤/٦٩	١/٢١	٤٥٨/٤٩	١٧٣٧٣٦/٠١	٢٠	٣٧٨/٩٣	٣١٢	Gardens	
٥/٨٩	٠/٩٠	٤٦٦/١٠	٢٩٩٤٧٥/٠٨	٣٤	٦٤٢/٥٠	٧١٣	Human-Made Lands	
٣/٥١	٠/١٠	١٠٠٦/٠٦	١٠٦٦٤/٣٠	٠/٦٠	١٠/٠٦	٩٩	Green Spaces	
٢/٢٢	٠/٦٥	٦٧٣/١٥	٤٨٣٩/٩٧	٠/٤٠	٧/١٩	١١	Planting Trees	
٣/٧١	٣/٨٧	٢٠٧/١٦	٦٥٠٧٠/٢٨	١٦/٥٠	٣١٤/١٠	٨١	Barren Lands	

According to NP, the agricultural land reduced to 65.48%. Gardens reduced to 31.41%. However, the micro and macro human construction increase human land class to 118.71. Significant increase was seen in green spaces and planting trees and NP 296% and 83%, respectively. The NP in barren lands was also increased to 38.28%.

The ED of green spaces, human-made lands, planting trees, and barren lands had the maximum increase, respectively. Agricultural lands had a little decrease in ED and the maximum reduction in ED was for gardens about 35000 m.

Edge density (ED) that is obtained by edge division of each class on its area is influenced by two metrics of area and edge. Area metric has reverse relationship with ED for being in denominator and edge metric has direct relationship with ED for being in numerator.

It can be found out by exploring the usage classes that plating trees, gardens, human-made lands, and edge density are increasing. Therefore, ED of green spaces and agricultural lands reduced. The maximum increase was related to 70% of planting trees and the maximum reduction was related to green space class with 43%.

The MPS in agricultural land class had significant growth and increased to 72% which shows more integration of patches and changing some gardens to agricultural lands and connection to agricultural lands. The increased value of PMS was 0.67 hectar. The value of this metric for green spaces class also increased to 43%. On the other hand, the maximum related reduction was for planting trees then human-made lands, barren lands, and gardens. 400% reduction in mean size of planting trees was for small patches in 2010 that reduced MP.

The Shannon diversity index with close relationship with NP metric increased near to 98% in planting trees class (diversity increase by increasing NP), because NP changed from 6 to 11. The other increased classes include: green space to 24.91%, human-made lands to 20.94%, and barren lands to 20.84%. The DI in agricultural lands and garden classes reduced to 13% and 4.47%, respectively.

Table (9) – comparing increased percentage (+) and reduced percentage (-) of landscape metrics in various classes of PLAND in 2002-2010

SDI	MPS (Hec)	ED (Meter/He)	TE (Meter)	PLAND (%)	CA (He)	NP	Metrics / usage classes
−١٣/٠٠	+٧٢/٨٢	−٣٢/٢٢	−٢٦/٣٣	−٤/٢١	+٤/٦٥	−٦٥/٤٨	Agricultural Land
−٤/٤٧	−١٤/٠٤	+٢٤/٩١	−٢٠/٣١	−٦٣/٥٠	−٥٠/٢٩	−٣١/٤١	Gardens
+٢٠/٩٤	−٢٧/٧٧	+١٤/٣٦	+٩٤/٦٦	+٥٧/٤٠	+٧٠/٢١	+١١٨/٧١	Human-Made Lands
+٢٤/٩١	+٤٢/٨٥	−٤٣/٨٤	+٢٩٧/٢٠	+٥٠٠/٠٠	+٤٧١/٥٩	+٢٩٦/٠٠	Green Spaces

+۹۸/۳۰	−٤۰۰/۰۰	+۷۰/۰۲	+۷٤/٥٤	+۳۳/۳۳	+٦۱/٥۷	+۸۳/۳۳	Planting Trees
+۲۰/۸٤	−۱۹/۱۲	+۱٦/۸۸	+۳٤/۷٥	+٥/۷٦	+۱٥/۲۹	+۳۷/۲۸	Barren Lands

Finally, the map of landscape in 2002 and 2010 are as following which include land cover classes of agricultural lands, gardens, human-made lands, green space, planting trees, and barren lands.

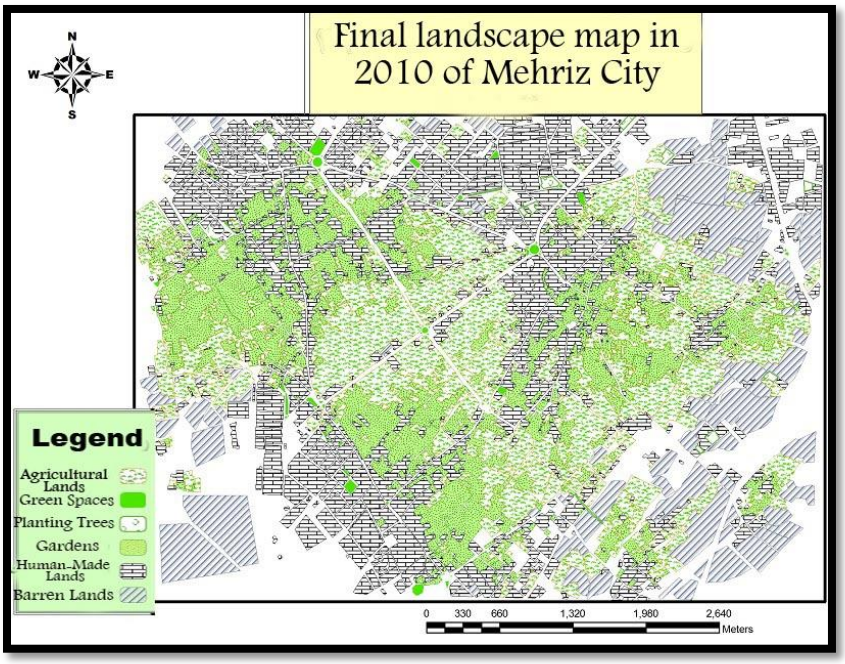

Fig (9) –Final landscape map in 2002 and 2010

Suggestions

Since change in lands usage, particularly gardens to human-made lands to agricultural lands put significant changes in landscape of Mehriz city that is called “Yazd garden city”, significantly reduced gardens classes since 2002 to 2010 to half. In order to prevent from this disaster, the land usage changes without legal permission should seriously be persecuted not to reduce this garden classes in future.

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