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Landscape Ecological Metrics-Based Investigation of Land Cover/Use Changes in Khojir National Park

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Abstract: The national parks are as symbol of conservation worldwide. This ecological susceptible regions must steady be monitored and protect because informing of their situation is essential for having a suitable management method and prevention of destruction trend. The landscape ecology as a brand new interrelated field of study presents concepts, theory and conservation methods. Landscape could be quantified by metrics that it´s prerequisite in usage of remote sensing metrics. In this study Khojir national park land use change monitoring were studied by remote sensing and landscape metrics in three terms. For the purpose, landsat images were used to make maps, after landscape analysis was done. Results showed that well range land cover was decreased and poor range land covers have increased during study time and defragmentation has grown in the park. National park has also faced with urban class land use increase, introduction of dam has increased patchiness and totally park has encountered with disruption which is not suitable for park. Decision makers should pay enough attention to long term environmental backwash by having a real sight of created changes, since according to the law any kind of destruction is denied in national parks.

Key words: Landscape Metrics · National Parks · Urban · Land Cover · Remote Sensing

INTRODUCTION

Daily population growth has put an extra pressure on natural arenas and tenet imperial and land use changes has makes different reaction in ecosystems [1]. Human activity such as flora destruction, changes natural mechanisms [2] human activity depth has such an effect that could be feel even in purely natural areas such as national parks [3]. Sometimes these impacts are shown as discordant land uses in natural parks which are opposite to early purposes and destroys structures and suppresses conservational purposes [4]. To obtain suitable management methods and prevention of destructive elements, conservation and steady change detection is extremely essential [5, 6]. Landscape ecology as a science which concentrates creating solidarity within human and wilderness, is used for change detection assessment recently [7, 8]. Metrics are need for quantifying. Landscape metrics are easily study able by satellite images and geographic information system [9, 10]. Thus by studding the criteria's can have some total estimation about ecosystem changes. Satellite images application are accepted for monitoring and analyzing national parks [11, 12]. As most of these methods have been used in climate change process pursue, drought and its effects, shore line changes and its effects, fauna changes of river delta, conserved area changes and so on [13-17]. Purpose of this study was mainly to monitor land use cover changes by remote sensing and landscape metrics in three study period. For the purpose land sat images and air photos of the site was studied to obtain a perspective of the area and suggest solutions to prevent more destruction if be possible.

MATERIALS AND METHODS

Khojr national park with an area of about 9971ha is located in 35°35´- 35°44´north latitude and 51°31´- 51°47´of eastern altitude on east of Tehran in Jajrud protected area. The park had been authorized by supreme environment

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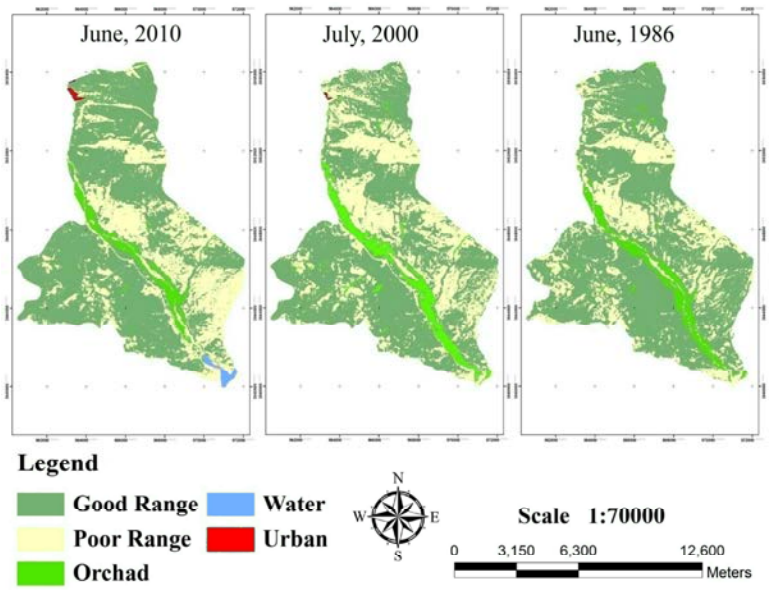

Fig. 1: Prepared land cover/ uses map for Khojir National Park in dates 1986, 2000, 2010.

conservation council on 1979. Totally park is covered by *Artemisia spp. & Astragalus spp.* which are dominant on most areas. In The fauna and flora which are identified this park there are 517 herbaceous species and 38 mammals specious, 118 bird species and 27 reptile species, 2 amphibian and 7 fish species totally [18].

Quantifying landscape structure as a prerequisite of function and landscape change studies [19], demands interpretation or map making. For making land cover map TM detector of land sat 4 and 5 images with 165 path and row 35 was used and seven bands related to dates 18/6/1986 & 26/7/2000 and 4/6/2010 was utilized to analyses changes. Satellite images were geometric corrected utilizing 1:25000 topographic maps by maximum neighborhood correction and then radiometric [20] and atmospheric correction was operated by ERDAS [21]. Then supervised classification and maximum probability was used for image classification [22]. According to the goals 5 land use classes was defined including good range land, poor range land, orchard urban class and water [23] by using 1, 4 and 7 bands in ENVI (Fig. 1). Present land uses are considered as the patches in landscape ecology. Quantifying landscape structure for analyzing, demands landscape metrics. The metrics identify landscape spatial structure region as a single unit which has specific identity in at the same time [24]. Also they are tools which identify geometric and spatial patch/patches position, composition and structure of landscape [25]. Most of the metrics are correlated, almost because there is just a few metrics which others derive from them. So some of metrics are originally excess [26, 27]. Although this study shows that landscape patterns can be described by a limited member complex, but there is not a general settlement on using a single metric complex. In this study by paying attention to the goals, 6 metrics was used according to their potential in interpreting and combining spatial distribution of structural elements in landscape ecology (Table 1).

Results of Landscape Changes Analysis: Analyzing departed patch complexes of landscape, give us quantified information about structural characteristics and dispersion pattern of classes in landscape [28]. So change trend analysis done based on landscape arrangement in the level of cover classes that its results shown in Table 2.

Class Area Metric (CA): According to the results of Table 2, the most cover classes area in 1986 belongs to good and then poor range land, which both were decreased till 2000 and then increases till 2010, also as is shown in the Table we can see no urban class (because of not having the dam) but it is created in image of 2000 and has a three times growth till 2010 and a new class (water) is detected in 2010 because of that damn dam.

Number of Patch Metric (NP): This metric is used as habitat defragmentation index. According to landscape ecology rules the fewer ecosystems patch the less vulnerability [25]. The only patch which is increased in all three periods is good range land which means

Table 1: Used metrics in this study

Metrics	Unit	Formula	Range	References
Class Area	Hectares	$CA = \sum_{j=1}^{n} a_{ij}\left(\frac{1}{10,000}\right)$	CA>0	[24, 38]
Largest patch Index	Percent	$LPI = \frac{\max_{j=1}^{n}(a_{ij})}{A}(100)$	0<LPI£100	[39, 40]
Number of Patch	None	NP = N	NP>1	[24,41]
Mean Patch Size	Hectares	$MPS = \frac{A}{N}\left(\frac{1}{10,000}\right)$	MPS>0	[24, 39, 41]
Effective Mesh Size	Hectares	$MESH = \frac{\sum_{j=1}^{n} a_{ij}^2}{A}\left(\frac{1}{10,000}\right)$	ratio of cell size to landscape area ≤MESH ≤total landscape area (A)	[42, 43]
Interspersion and Juxtaposition Index	Percent	$IJI = \frac{-\sum_{k=1}^{m'}\left[\left(\frac{e_{1k}}{\sum_{k=1}^{m'} e_{1k}}\right) In \left(\frac{e_{1k}}{\sum_{k=1}^{m'} e_{1k}}\right)\right]}{In\,(m'-1)}(100)$	0 < IJI ≤100	[38, 44]

Table 2: Calculated landscape metrics for Khojir National Park

Year	Metric/ Class	CA	NP	MPS	LPI	MESH	IJI
1986	Good Range	6587	471	14	19	1069	59
	Poor Range	2717	1024	2.6	2.3	25	15.5
	Orchard	572	216	2.6	2.2	10	53
	Urban	-	-	-	-	-	-
	water	-	-	-	-	-	-
2000	Good Range	5940	631	9.4	14.4	542	35
	Poor Range	3278	1133	3	4.5	68	14.7
	Orchard	638	279	2.2	1.4	6.2	56
	Urban	6.5	2	3.3	0.03	0.002	56.6
	water	-	-	-	-	-	-
2010	Good Range	6277	639	9.8	15.6	900	26
	Poor Range	3089	912	3.4	5.1	76	14.4
	Orchard	406	155	2.6	1.6	5.4	39
	Urban	22	2	11	0.1	0.02	55
	water	74	15	5	0.3	0.2	47

defragmentation of good rangeland. The maximum increase is seen in water class and it is obvious these disturbing patches are not suitable for a natural park.

Mean Patch Size Metric (MPS): This metrics changes is the direct feedback of changes in area and number of patches in landscape level [19]. The most increase in this metric belongs to urban class and means increasing urban class patch. Also this metric shows a decline trend in good range land, which means continues destruction and defragmentation. Since the bigger patches the higher conservational value this is not a pleasure trend.

Largest Patch Index (LPI): Diminish of this metric means increase of defragmentation in landscape. In the study term this metrics shows diminish in good range land and increase in poor range land. Landscape or good range land defragmentation has a fundamental impact on ecological processes [29].

Effective Mesh Size (MESH): Diminish of this metric shows more disruption and decrease of unity. This metric shows decrease during 1986 till 2000 in good range land and then increases which means during 1986-2000 good range lands has encountered with disruption, but in the same time poor range lands shows increase in the index.

Interspersion and Juxtaposition Index (IJI): Increase of this metric shows different landscape class blending which is suitable for mint environments and has direct relation with biodiversity. But all the classes in this study faced diminish in this metric, which means decrease of habitat diversity which is not suitable for our park.

DISCUSSION

By paying attention to landscape metric analysis from 1986-2010 it shows that maximum land cover area diminish relates to range land and diminish is obvious in orchard land cover. Poor range land and urban class and water shows increase which the most belongs to poor range land. The results express, proficiency of MPS, LPI, NP, CA, metrics in protected area landscape changes analyses which are according to the results explained by various researchers [30, 31, 32, 33]. Also the proficiency of the MESH and IJI are proved by [34, 35] which all of them are about defragmentation and disruption of conserved area. The most increase percentage belongs to poor range land which is due to illegal grazing by rural cattle's. Good range land decrease which we concluded was same as the results of [36]. Increase of urban class land use that park is encountered is due to its neighborhood to Tehran and growth of land price in the area that is sensible in decrease of orchard land use during 25 years [37]. At the end it's useful to mention that Decision makers should pay enough attention to long term environmental backwash, by having a real sight of created changes, since according to the law any kind of destruction is denied in national parks.

REFERENCES

1. Lu, D. and Q. Weng, 2007. A survey of image classification methods and techniques for improving classification performance. Int. J. Remote Sens., 28(5): 823-870.
2. Gobattoni, F., R. Pelorosso and A. Leone, 2009. Assessing the effects of land use changes on soil erosion: a case study in Central Apennine (Italy). XXXIII CIOSTACIGR V Conference 2009, Reggio Calabria (Italy), pp: 1719-1723.
3. Green, D.G., N. Klomp, G. Rimmington and S. Sadedin, 2006. Complexity in Landscape Ecology. Springer, pp: 208.
4. Zeng, H. and X.B. Wu, 2005. Utilities of edge- based metrics for studying landscape fragmentation. Comput. Environ. Urban Syst., 29(2): 159-178.
5. Jones, D.A., A.J. Hansen, K. Bly, K. Doherty, J.P. Verschuyl, J.I. Paugh, R. Carle and S.J. Story, 2009. Monitoring land use and cover around parks: A conceptual approach. Remote Sens. Environ., 113(7): 1346-1356.
6. Wang, Y.Q., B.R. Mitchell, J. Nugranad-Marzilli, G. Bonynge, Y. Zhou and G. Shriver, 2009. Remote sensing of land-cover change and landscape context of the national parks: A case study of the Northeast Temperate Network. Remote Sens. Environ., 113(7): 1453-1461.
7. Agee, J.K. and D.R. Johnson, 1988. Ecosystem Management for Parks and Wilderness. Seattle: University of Washington Press, pp: 237.
8. Christensen, N.L., A. Bartuska, J.H. Brown, S. Carpenter, C. D'Antonio, R. Francis, J.F. Franklin, J.A. MacMahon, R.F. Noss, D.J. Parsons, C.H. Peterson, M.G. Turner and R.G. Moodmansee, 1996. The report of the Ecological Society of America Committee on the scientific basis for ecosystem management. Ecol. Appl., 6: 665-691.
9. Tischendorf, L., 2001. Can landscape indices predict ecological processes consistently? Landscape Ecol., 16(3): 235-254.
10. Lindenmayer, D.B., C.R. Margules and D.B. Botkin, 2000. Indicators of biodiversity for ecologically sustainable forest management. Conserv. Biol., 14(4): 941-950.
11. Gross, J.E., R. Nemani, W. Turner and F. Melton. 2006. Remote sensing for the national parks. Park Science, 24(1): 30-36.
12. Robert, D.A., M. Keller and J.V. Soares, 2003. Studies of land-cover, land-use and biophysical properties of vegetation in the Large Scale Biosphere Atmosphere experiment in Amazˆonia. Remote Sens. Environ., 87(4): 377-388.

13. Reed, B., M. Budde, P. Spencer and A.E. Miller, 2009. Integration of MODIS-derived metrics to assess interannual variability in snowpack, lake ice and NDVI in southwest Alaska. Remote Sens. Environ., 113(7): 1443-1452.
14. Dennison, P.E., P.L. Nagler, K.R. Hultine, E.P. Glenn and J.R. Ehleringer, 2009. Remote monitoring of tamarisk defoliation and evapotranspiration following saltcedar leaf beetle attack. Remote Sens. Environ., 113(7): 1462-1472.
15. Crabtree, R.L., C.S. Potter, R.S. Mullen, J.W. Sheldon, S. Huang and J.A. Harmsen, 2009. Synthesis of ground and remote sensing data for monitoring ecosystem functions in the Colorado River Delta, Mexico. Remote Sens. Environ., 113(7): 1486-1496.
16. Ressl, R., G. Lopez, I. Cruz, R.R. Colditz, M. Schmidt, S. Ressl and R. Jiménez, 2009. Operational active fire mapping and burnt area identification applicable to Mexican nature protection areas using MODIS-DB data. Remote Sens. Environ., 113(6): 1113-1126.
17. Svancara, L., J.M. Scott, T.R. Loveland and A.B. Pidgorma, 2009. Assessing the landscape context and conversion risk of protected areas using remote-sensing derived data. Remote Sens. Environ., 113(7): 1357-1369.
18. Bumabad Consulting engineers, 2001. Study of the environmental management plan for Jajrud, 10th volume, Environmental protection Organization, Office of habitats and areas, pp: 193.
19. McGarigal, K. and B. Marks, 1995. Fragstats: Spatial pattern analysis program for quantifying landscape structure. Reference manual. For. Sci. Dep. Oregon State University. Corvallis Oregon 62 p. + Append.
20. Chander, G. and B. Markham, 2003. Revised Landsat-5 TM Radiometric Calibration Procedures and Postcalibration Dynamic Ranges. IEEE Trans. Geosci. Remote Sens., 41(11): 2674-2677.
21. Chavez, P.S., 1998. An improved dark-object subtraction technique for atmospheric scattering correction of multi-spectral data Remote Sens. Environ., 24(3): 459-479.
22. Ozesmi, S.L. and E.M. Bauer, 2002. Satellite remote sensing of wetlands. Wetl. Ecol. Manag., 10(5): 381-402.
23. Anderson, J.R., E. Hady, E.J. Roach, T. Wetter and E. Richard, 1976. Lands cover classification system for use with remote sensor data. United States Government Printing Office, Washington, pp: 80-85.
24. Botequilha, A. and J. Ahern, 2002. Applying Landscape Ecological Concepts and Metrics in Sustainable Landscape Planning. Landscape Urban Plann., 59(2): 65-93.
25. Gergel, S.E. and M.G. Turner, 2002. Learning Landscape Ecology: A Practical Guide to Concepts and Techniques. New York: Spriger Publisher, pp: 316.
26. Li, H. and J.F. Reynolds, 1995. On definition and quantification of heterogeneity. Oikos, 73(2): 280-284.
27. McGarigal, K. and W.C. McComb, 1995. Relationships between landscape structure and breeding birds in the Oregon Coast Range. Ecol. Monogr., 65(3): 235-260.
28. Wang, Y., J. Li, Z. Fan and X. Wang, 2008. GIS-Based Urban Mosaic and its Gradiant Analysis: A Case Study from Wuhu City, China. The Second International Conferenceon on Bioinformatics and Biomedical Engineering, (ICBBE), pp: 16-18.
29. Veldcamp, A. and E.F. Lambin, 2001. predicting land use change. Agric. Ecosyst. Environ., 85(1-3): 1-6.
30. Tomaselli, V., P. Tenerelli and S. Sciandrello, 2012. Mapping and quantifying habitat fragmentation in small coastal areas: a case study of three protected wetlands in Apulia (Italy). Environ. Monit. Assess., 184(2): 693-713.
31. Frohn, R. and Y. Hao, 2006. Landscape metric performance in analyzing two decades of deforestation in the Amazon Basin of Rondonia, Brazil. Remote Sens. Environ., 100(2): 237-251.
32. Wu, J.G., 2004. Effects of changing scale on landscape pattern analysis: Scaling relations. Landscape Ecol., 19(2): 125-148.
33. Saura, S. and P. Carballal, 2004. Discrimination of native and exotic forest patterns through shape irregularity indices: An analysis in the landscape of Galicia, Spain. Landscape Ecol., 19(6): 647-662.
34. Southworth, J., H. Nagendra, L. Carlson and C. Tucker, 2004. Assessing the impact of Celaque National Park on forest fragmentation in western Honduras, Appl. Geogr., 24(4): 303-322.
35. Cushman, S.A., K. McGarigal and M.C. Neel, 2008. Parsimony in landscape metrics: Strength, universality and consistency. Ecol Indic., 8(5): 691-703.
36. Vasconcelos, M.J.P., J.C.B.A.A. Mussa and M.A. Diniz, 2002. Land cover change in two protected areas of Guinea-Bissau (1956–1998). Appl. Geogr., 22(2): 139-156.

37. Abelairas-Etxebarria, P. and I. Astorkiza, 2012. Farmland prices and land-use changes in periurban protected natural areas. Land Use Policy, 29(3): 674-683.
38. Lausch, A. and F. Herzog, 2002. Applicability of landscape metrics for the monitoring of landscape change: issues of scale, resolution and interpretability. Ecol Indic., 2(1-2): 3-15.
39. Munroe, D.K., H. Nagendra and J. Southworth, 2007. Monitoring landscape fragmentation in an inaccessible mountain area: Celaque National Park, Western Honduras. Landscape Urban Plann., 83(2-3): 154-167.
40. Peng, J., Y. Wang, Y. Zhang, J. Wu, W. Li and Y. Li, 2010. Evaluating the effectiveness of landscape metrics in quantifying spatial patterns. Ecol Indic., 10(2): 217-223.
41. Soverel, N.O., N.C. Coops, J.C. White and M.A. Wulder, 2010. Characterizing the forest fragmentation of Canada's national parks. Environ. Monit. Assess., 164(1-4): 481-499.
42. Moser, B. and J.A.G. Jaeger, 2007. Modification of the effective mesh size for measuring landscape fragmentation to solve the boundary problem. Landscape Ecol., 22(3): 447-459.
43. Girvetz, E.H., H.J. Thorne, A.M. Berry and J.A.G. Jaeger, 2008. Integration of landscape fragmentation analysis into regional planning: A statewide multi-scale case study from California, USA. Landscape Urban Plann., 86(3-4): 205-218.
44. Schindler, S., K. Poirazidis and T. Wrbka, 2008. Towards a core set of landscape metrics for biodiversity assessments: A case study from Dadia National Park, Greece. Ecol Indic., 8(5): 502-514.