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Assessing the Environmental Impacts of Forest Management Plan Based on Matrix and Landscape Degradation Model

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ABSTRACT

Management of the forest resources and related activities has significant effects on the environment. Applying the environmental impact assessment (EIA) provides a basis for improving forest management plans. However, in the developing countries such as Iran, there have been so far no serious endeavors and research to undertake the EIA of the various practices affecting the forest resources, despite the enormous negative impacts of forestry practices on environmental quality. Hence, the main objective of the present study was to address the effects of the human activities on forest ecosystem and their consequences, and to assess the environmental quality of Patom Forest Management Plan through the application of landscape degradation model (LDM) and the matrix method. Decision making based on LDM indicated that all compartment of Patom District have high degradation coefficient and need rehabilitating practices. Furthermore, application of the matrix method revealed that forest roads, logging operations, and other activities needed modification and mitigation plans. Also, forestry activities have had 25.8 and 35.5% positive impacts and consequences in contrast with 74.2 and 64.5% negative impact and consequences on the environment. Hence, in order to improve forest management plans and reduce the negative effects of forestry activities in Iran, forest managers should apply environmental impact assessment with quantitative EIA instruments before the design and implementation of the forest management plans and forestry activities.

Keywords: Degradation coefficient, EIA, Matrix method, Patom forest management plan.

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INTRODUCTION

The original old-growth northern forests of Iran are essential source of genetic variation, biodiversity, commercial wooden products, and various ecosystem services. The Hyrcanian forests were estimated to be 3.4 million ha in the past; however, they have decreased to 1.8 million ha today (Marvie Mohajer, 2006). Forest management plans in Iran begun in 1959 (Shamekhi, 2011). More than 100 forest management plans have prepared since 1959, but the review of the forest management plans indicates that, in many of the plans, the importance of ecosystems was ignored and most decisions were made without considering the environmental values (Monavvari, 2001). Forestry activities programmed in the forest management plans mainly include: construction and use of forest roads and skid routes, logging, log hauling, afforestation, tending operation, etc. (Department of Forestry, University of Tehran, 1995). Management of the forest resources and related activities has significant effects on the environment (Seppala *et al*., 1998; Michelsen *et al*., 2008; Hanna *et al*., 2011). EIA in forestry aims to identify the

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environmental consequences of actions, and to assess if these actions are to have serious environmental and economic consequences. However, in the developing countries such as Iran, there have been so far no serious endeavors and research to undertake the EIA of the various practices affecting the forest resources. Consequence of this mismanagement has led to various drastic degradations of forests in the country (Monavvari, 2001). EIA as a substantial instrument for environmental management and sustainable development is to recognize and assess systematic impacts of projects and programs on physical, biological, cultural, economic, and social phenomena in the environment. In other words, it is a way or method to determine the direction or predict and assess the environmental impacts of activities on the environment and the health of ecosystem affecting human lives, but it is hampered when quantitative measures for decision-making are needed (Makhdoum, 2002). To address the above shortcomings and ongoing problems of decision-making in Iran, the landscape degradation model (LDM) was introduced by Makhdoum in 1993 as an instrument for EIA for development plans to act as a decision support system (DSS) for managers (Makhdoum, 1993). By applying the LDM results, occurrence of the degradation will be prevented and the new ways for preventing repeated destructions in short time period will be specified (Makhdoum, 2002). Another method that is suitable for Iran conditions is the matrix method. Leopold matrix (Leopold *et al*., 1971) was modified by Makhdoum and has been known as Iranian matrix (Makhdoum, 1982). The Iranian experts commonly use Matrix methods for EIA because of the time limitation and common tendencies (Mahiny *et al*., 2011). Additionally, Iranian version of Leopold matrix has proven its efficiency in many studies (Jafari and Lotfi Jalalabadi, 2005). Some studies have investigated the effects of human activities on forests using LDM (Safaian *et al*., 2004; Yazdian *et al*., 2012) and other researches have studied the effects of activities of forest management plans using the matrix methods (Makhdoum, 1982; Jafari *et al*., 2010). Therefore, there was an obvious need for a study to assess the environmental impacts and to identify needs and options for the environmental improvements in the forest sector. The main objective of present study was to address the effects of forest management plan on forest ecosystem and their consequences in Iran.

MATERIALS AND METHODS

Study Area

The study area was located at educational and research forest of Faculty of Natural Resources of the University of Tehran in the north of Iran between 51°33’12” and 51°39’56” E longitude and 36°32’08” and 36°36’45 5” N latitude. The study was conducted in Patom District (about 900 hectares), with an altitude between 10 m to 930 m (above sea level). In this study, 13 “compartments” in which forest management plan had been implemented (Department of Forestry of University of Tehran, 1995) were considered.

Landscape Degradation Model

The LDM is expressed as: $H= (\sum I + DP)/V$, where H= Degradation coefficient per impact unit, $\sum I$= The cumulative past-to-present impact (total severity of the landscape degradation per impact unit), DP= Physiographic density of population, and V= Ecological vulnerability. Degradation coefficient is classified according to fuzzy model (Table 1) (Makhdoum, 2002). The unit area of H may be a set of catchment areas, suburbs, factories, arbitrary ecosystems, or sets of the grid system depending on the level of decision-making (Makhdoum, 2002). Considering the fact that forest management plans were implemented in compartments of forests in

Table 1. Classes for decision-making.

Class	Categories of degradation coefficient	Criteria for decision-making
1	1.33-4.99	Prone to further development
2	5-14.99	Noncritically impacted Areas (Need rehabilitation)
3	15-19.99	
4	20.56-29.98	
5	30-47	Critically impacted areas (need conservation)
6	47.21-73.49	

Iran, the compartments were chosen as impact units.

Landscape Degrading Factors (∑I)

In this part of the LDM 20, landscape degrading factors were identified in compartments of Patom District based on fieldwork, advice of experts and analysis of data and maps. Then, their severities were determined based on classification of severity of environmental quality degradation (Makhdoum, 2002). Degradation severity levels are: code (1) low degradation, code (2) mild degradation, code (3) high degradation and code (4) very high degradation (Makhdoum, 2002). The checklist of the 20 landscape degrading factors and their abbreviations for all uses that cause forest degradations are as follows: Irrational utilization(IU), Poor management of the main and secondary road (R), Cut and fill (CF), Skid road (S), Conversion of forest to shrub (XF), Conversion of forest land to garden and villa (XV), Dying of Afforestation (DA), Livestock route (LR), Landing yard (LY), grazing (G), Illegal hunting (IH), Soil compaction (SC), Garbage(GG), Scenic disorder (YL), Cattle House (CH), Coal Stove (CS), Landslide (LS), Destruction of creek road (CR), Construction of water channel (W), Power lines (PL).

Physiographic Density of Population (DP)

The physiographic density is calculated through dividing human population by arable land per impact unit (Makhdoum, 2002). Considering that the study area was a forest ecosystem and there was no living population in this area, livestock population (Animal Unit) per compartment was divided by its area and, finally, physiographic density was computed.

Ecological Vulnerability (V)

Ecological vulnerability was computed based on the object-oriented ecological vulnerability method (Jabbarian Amiri, 1999). Ecological factors including slope, aspect, elevation, geology, climate, soil, soil erosion, and vegetation were classified based on susceptibility and limitation codes were then calculated for every impact unit (Table 2). Then, the degree of importance of each ecological factor was computed by the interaction matrix method (Jabbarian Amiri, 1999) and ecological Vulnerability Index was computed by the following formula (Jabbarian Amiri, 1999) and the study area was classified based on ecological vulnerability.

$$EQI = \sum_{1}^{n} K_i X_i$$

Where, EQI= Ecological Vulnerability Index; K_i= Degree of importance of ecological factor i, X_i= Vulnerability of ecological factor i.

Matrix Method

Iranian matrix analyzes the relationship between project activities and environmental components as proposed by Leopold

Table 2. Classification of Ecological factors based on susceptibility.

Elevation (m)	Code	Slope (%)	Code	Aspect	Code	Erosion	Code
0-100	1	0-2	1	Plateau	1	Light	1
100-200	2	2-5	2	South	2	Medium	2
200-400	3	5-8	3	West	2	Severe	3
400-600	4	8-12	4	North	3	Very severe	4
600-800	5	12-15	5	East	3		
➢ 800	6	15-30	6				
		30-65	7				
		➢ 65	8				
Climate	Code	Vegetation%	Code	Soil(cm)	Code	Geology	Code
Very humid	1	75-100	1	>120	1	Very resistant	1
Humid	2	50-75	2	80-120	2	Resistant	2
Semi-humid	3	25-50	3	50-80	3	Not resistant	3
Semi-arid	4	0-25	4	25-50	4	Susceptible	4
Arid	5			<25	5	Very susceptible	5

(Makhdoum, 1982). The Leopold Matrix describes the interaction in terms of its magnitude (M) and importance (I) (Leopold *et al*., 1971).In Iranian matrix the importance (I) of an environmental impact has been eliminated and the magnitude of an interaction is described by the assignment of a numerical value from one to five. In this study, after the fieldworks, advice of the experts, and using extensive data, information about all the implementing activities, from past to present, in connection with the Patom Forest Management Plan (PFMP) was collected. The activities were divided into four general sections including: forest roads construction and use (tree clearances, blasting, cut and fill, infrastructure and pavement, forest road maintenance, and machinery traffic); logging (clear cutting, other cutting, skid roads, machine skidding, traditional skidding, depot of wood, log hauling, wood transformation); afforestation and tending operation (monoculture, planting of non-native species, seeding and planting, fencing, tending operation and maintenance of dead trees); and other activities (cattle house, grazing, livestock route, girdling (girdling is the complete removal of a strip of bark around the tree by some shepherds to damage cork cambium, phloem, cambium and sometimes going into the xylem) forest conservation, construction of buildings, tourism, garbage, scientific research works). Then, a list of environmental factors including physical (microclimate, air quality, noise, water resources/quality, flood/ runoff, soil erosion, soil structure, slope stability); biological (vegetation, species diversity, forest regeneration, rare and endangered species, population/habitats animals, influx of weeds, food chains); economic, social, and cultural factors (population/migration, occupation/ income, cultural characteristics, facilities/transportation, tourism, landscape and scenery) was prepared according to existing resources (FAO, 1992; Monavvari, 2001). By consulting the pertinent experts, the magnitude of interaction or impact of any activity on environment was determined based on numerical values varying from -5 to +5 (-5= Very high negative impact, +5= Very high positive impact). If any activity had no effect on environment, the corresponding matrix cell would remain empty (Makhdoum, 1982).

Decision Making

For decision making, five columns and rows were added to the matrix including total number of values (number of matrix

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cells that had value), number of positive values, values ratio (division of number of positive values by the total number of values), algebraic sum, ranking average (division of algebraic sum by the total number of values). Final decision was based on the ranking average (Table 3). Also, the ranking average in columns was defined as the impacts on environmental factors and the ranking average in rows was defined as the consequences of forestry activities (Makhdoum, 1982).

RESULTS

Landscape Degradation Model

Compartment 101 had the highest number of the human degradation activities (Table 4). Compartments 101 and 102 had the highest physiographic density (5 animal Units ha^{-1}). Compartments 101,102,108,112, 113, 117, and 118 were more susceptible than the others. Compartment 101 had the highest degradation coefficient (H), while compartment 111 had the lowest *H* value. Decision-making based on the fuzzy set theoretic approach showed that 100% of the study area had been non-critically impacted and needed rehabilitating practices (Table 4).

The Matrix Method

The results of the mathematical conclusion of the negative and positive impacts and consequences of the matrices showed that afforestation and tending operations were accepted unconditionally, while forest roads, logging operations, and other activities were accepted with the modification and mitigation plans. The ranking averages of

Table 3. Decision making based on ranking average.

Ranking average	Decision making
There is no ranking average < -3/1 in columns and rows	Project is accepted
There is ranking average < -3/1, more than 50% in columns and rows	Project is rejected
There is no ranking average < -3/1 in rows, but there is less than 50% in columns	Need modification plans
There is no ranking average < -3/1 in columns, but there is less than 50% in rows	Need mitigation plans
there is ranking average < -3/1, less than 50% in columns and rows	need modification and mitigation plans

Table 4. Degradation coefficients and figures used for calculation.

Compartment	∑I	DP	V	H	Decision making (Class)
101	42	5	2	23.5	4 (Need rehabilitation)
102	15	5	2	10	2 (Need rehabilitation)
108	14	4	2	9	2 (Need rehabilitation)
109	28	1	3	9.66	2 (Need rehabilitation)
110	21	1	3	7.33	2 (Need rehabilitation)
111	16	1	3	5.66	2 (Need rehabilitation)
112	14	1	2	7.5	2 (Need rehabilitation)
113	20	1	2	10.5	2 (Need rehabilitation)
114	20	1	3	7	2(need rehabilitation)
115	23	1	3	8	2(need rehabilitation)
116	21	1	3	7.33	2(need rehabilitation)
117	21	1	2	11	2(need rehabilitation)
118	16	1	2	8.5	2(need rehabilitation)

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columns and rows of matrices indicated that 35% of the total negative environmental impacts and consequences were caused by the logging operation in Patom District, while afforestation and tending operation caused 50% of the positive impacts and 62% of the positive consequences on the environments (Figures 1 and 2). Comparison between the environments illustrated that social, economic, and cultural environment together had the highest positive consequences, and the physical environment had comparatively the highest negative consequences (Figure 3). Furthermore, the qualitative changes of impacts and consequnces indicated that PFMP did not have very high harmful impacts and consequnces, but the percentage of low

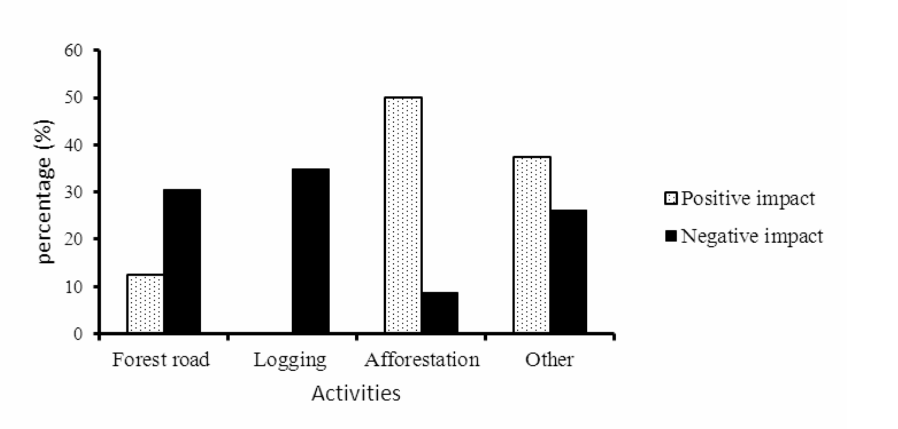

Figure 1. The percentage of the environmental impacts of forestry activities.

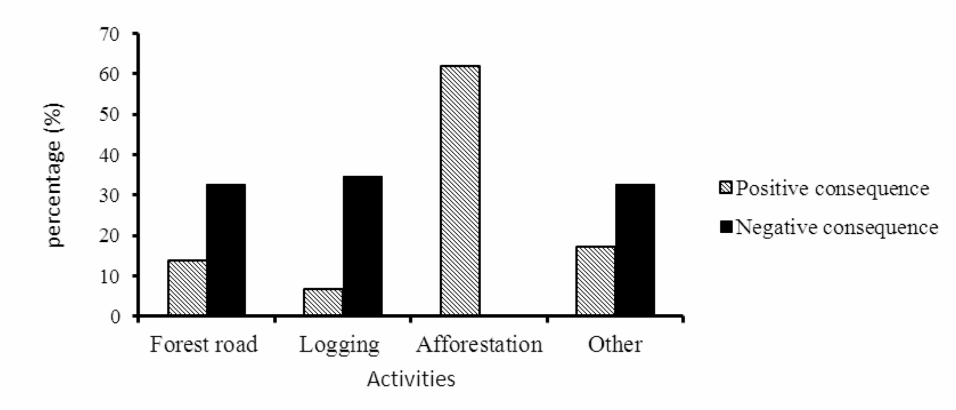

Figure 2. The percentage of the environmental consequences of forestry activities.

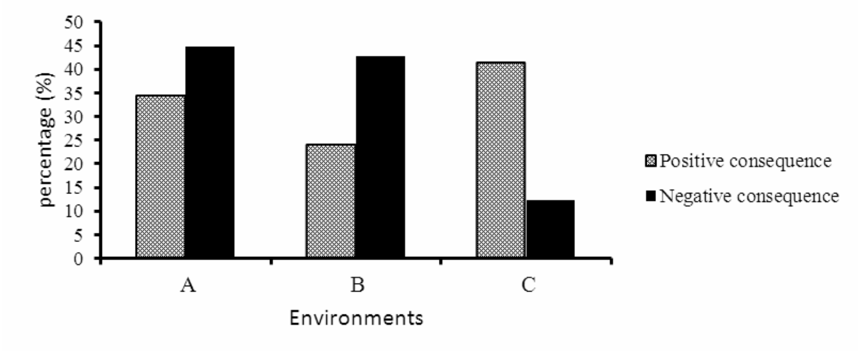

Figure 3. The percentage of environmental consequences on environments
A: Physical environment, B: Biological environment, C: Social, economic, cultural. environment)

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harmful impacts and low harmful consequnces were higher than the other impacts and consequences. Generally, the results of the ranking averages of the four matrices illustrated that PFMP have caused 25.8 and 35.5% positive impacts and consequences and 74.2 and 64.5% negative impacts and consequences on the forest ecosystem. According to the ranking averages of columns of the matrices, activities that need modification plans include: tree clearance (-3.4), cut and fill (-3.3), skid roads (-3.4), and grazing (-3.6). Additionally, according to the ranking averages of the rows of matrices, environmental component that need mitigation plans include: flood/runoff (-3.2), slope stability (-3.3), soil structure (-3.5), and forest regeneration (-3.4).

DISCUSSION

Based on the results of the landscape degradation model, degrading factors such as grazing, livestock routs, skid roads, soil compaction and poor management of the main and secondary roads were common in all compartments of Patom District. According to Hasanzad *et al*. (2009), grazing, authorized and unauthorized uses of the forest dwellers, and illegal cuttings were the most important degrading factors in Janbesara District of Gilan Forest. High coefficient of the degradation in compartment 101, which has high ecological vulnerability, is expected because there are large numbers of livestock on it in all seasons. Furthermore, destructive impacts such as construction of water channel, Power lines (PL), conversion of forest to shrub, and conversion of forest to gardens and villas are common in this compartment. Classification of destructive impacts based on fuzzy model revealed that all the compartments needed rehabilitation and mitigation measures in this district. According to Yazdian *et al*. (2012), Namak-Abrod Forest was divided into two parts, namely, those needing rehabilitation and those needing conservation, by fuzzy set logic.

Iranian version of Leopold matrix method illustrated that negative impacts and consequences of PFMP were much more than its positive impacts and consequences. According to Makhdoum (1982), Kheyrud Forest Management Plan had negative impacts (-392) on the environment. Meanwhile, some researchers (Makhdoum, 1982; Khalili *et al*, 2010; Jafari *et al*, 2010) have reported that activities of forest management plans have had positive impacts on social, economic, and cultural environment. The present study, also, has revealed that the most positive consequences of forestry practices in Patom District are on social, economic, and cultural environment. Comparison between different forestry activities demonstrated that most of the negative impacts and consequences have been caused by the logging operation. Michelsen *et al*. (2008) have also mentioned that 85% of the total environmental impacts were mainly caused by logging, transport by forwarders, and transport by truck in a Norwegian forest.

Additionally, none of forestry activities have had a ranking average more than -4. Grazing, with the ranking average of -3.6, was detected as one of the most destructive activities in Patom District. Belsky and Blumenthal (1997) found out that grazing in forest areas lead to changes in variety, density, and abundance of plant species and have negative effects on soil. Yosefi *et al*. (2002) investigated the impacts of grazing on the oak forests of Yasuj. They found out that, due to permanent grazing of animals and their presence in oak forests of Pataveh region, regeneration process of trees had been reduced. Hence, for rehabilitation of the degraded areas in compartments that have high ecological vulnerability and degradation coefficient, avoidance of the presence of livestock is proposed. Tree clearance with the ranking average of -3.4 and cut and fill with the ranking average of -3.3 illustrated that these activities had more destructive impacts than the others in the stage of construction of forest roads. According to Jafari *et al*. (2010), tree clearance had the most negative impacts on biological environment in forest road construction of Tarbiat Modares educational forest. Jafari *et al*. (2010) mentioned that most of the negative effects and changes during the forest road construction stage on physical environment were related to cut and fill. Also, road construction and maintenance operations are the most destructive activities in forestry (Hayati *et al*., 2013). Appropriate planning, design, construction, and maintenance of the roads based on the environmental principles can be useful in preventing the negative impacts of road construction in forests. Skid roads with the ranking average of -3.4 had the most negative impacts on the environments in the logging operations. Lotfalian *et al*. (2009) has also declared that skid roads have been built without considering the environmental values in the northern forests of Iran and have increased the rate of soil erosion in these areas. According to some studies, using skidding systems has tended to cause great environmental problems such as soil compaction and disturbance, water erosion, damage on tress and seedlings, etc. (Jourgholami and Majnounian, 2011; Majnounian *et al*., 2009). Forest regeneration with the ranking average of -3.4 illustrated that Patom District had an unfavorable conditions for regeneration and seedling. Therefore, artificial revitalization is the most important measure that can be applied in the degraded areas such as skid roads and landing yards, the surrounding areas of cattle houses and other degraded areas. Fencing of the plantation pieces can then protect them against grazing or wildlife. Cultivating the nurse plant species along with the main species can improve the physical characteristics of the soil and protect the main species from unfavorable environmental factors. Gorji Bahri *et al*. (2009), Rahmani and Mohamadnejad Kiasari (2003) also proposed artificial revitalization for the rehabilitation of the degraded forest areas.

CONCLUSIONS

In the present study, the vulnerable areas, degraded areas, and impacts and consequences of forestry activities were investigated. The evaluation of the environmental quality of Patom District of Kheyrud Forest using landscape degradation model has revealed that the Patom forest management plan (PFMP) has been implemented without considering the environmental values, because the research results indicated that 100% of the study area needed rehabilitating practices. Also, application of the matrix method demonstrated that the negative environmental impacts and consequences of forestry activities were much more than their positive impacts and consequences in the study area. Therefore, forest managers in Kheyrud Forest can use the results of this study for decision-making purposes and degraded areas should be rehabilitated using modification and mitigation plans. In addition to that, the mitigation of negative impacts and consequences should be also considered in the design process by avoidance, elimination, or reduction of their sources together with the enhancement of positive effects. These results will help decision-makers significantly in the development of strategies for improving the forest management plans. Hence, in order to improve forest management plans in Iran, the forest managers should apply environmental impact assessment with the quantitative EIA instruments such as landscape degradation model and matrix methods simultaneously, before the design and the implementation stages of the forest management plans and forestry activities.

REFERENCES

1. Anonymous 1995. *Patom Forest Management Plan*. Department of Forestry, University of Tehran, PP 111.
2. Belsky, A. J. and Blumenthal, D. M. 1997. Effect of Livestock Grazing on Stand

Dynamics and Soil in Upland Forests of the Interior West. *Conserve. Biol.,* **11(2):** 315-327.

3. FAO. 1992. *Environmental Impact of Forestry*. FAO Conservation Guide 7, "Guidelines for Its Assessment in Development Countries", FAO Forestry Department, Rome, Italy.
4. Gorji Bahri, Y., Kiadaliri, SH., Faraji, R., Mahdavi, R., Moossavi Mirkalai, R. and poormoradi, S. 2009. Study of Sapling Establishment Methods in Degraded Regeneration Area of Shoorab Forest Region. *Iran. J. Forest.,* **1(3):** 253-264.
5. Hanna, K. S., Polonen, I. and Raitio, K. 2011. A Potential Role for EIA in Finnish Forest Planning: Learning from Experiences in Ontario, Canada. *Impact. Assess. Proj. Apprais.,* **29(2):** 99-108.
6. Hasanzad Navrodi, H., Seyyedi, N. and Seifolahian, H. 2009. Evaluation of Quantitative and Qualitative Forest Stands Changes during a Period of Forest Management Plan. *Iran. J. Forest.,* **1(4):** 301-311.
7. Hayati, E., Abdi, E., Majnounian, B. and Makhdoum, M. 2013. Application of Sensitivity Analysis in Forest Road Networks Planning and Assessment. *J. Agr. Sci. Tech.,* **15:** 781-792.
8. Jabbarian Amiri, B. 1999. Introducing an Objective Method for Determination of Ecological Susceptibilities of Terrestrial Ecosystems. *J. Environ. Stud.,* **21(1):** 57-68.
9. Jafari, A., Najafi, A. and Mafi Gholami, D. 2010. Environmental Impact Assessment of Construction and Utilization of Forest Roads. *J. Environ. Develop.,* **1(2):** 71-78.
10. Jafari, H. R. and Lotfi Jalalabadi, A. 2005. Environmental Impact Assessment of Oil Continental Shell Region. *J. Environ. Stud.,* **30(34):** 55-63.
11. Jourgholami, M. and Majnounian, B. 2011. Soil Compaction and Disturbance from Logging with a Wheeled Skidder. *Iran. J. Forest.,* **2(4):** 287-298.
12. Khalili, M. E., Hosseini, S. A., Pourmajidian, M. R. and Fallah, A. 2010. Effect of Forest Road Construction on Forest Villages Development. *J. Wood. Forest. Sci. Tech.,* **17(3):** 19-36.
13. Leopold, L. B., Clarke, F. E., Hanshaw, B. B. and Balsley, J. R. 1971. A Procedure for Evaluating Environmental Impact. Geological Survey Circular 645, Washington, DC.
14. Lotfalian, M. Shirvani, Z. and Naghavi, H. 2009. Investigation of Effective Factors on Skid Roads Erosion. *Iran. J. Forest.,* **1(2):** 115-124.
15. Mahiny, A. S. Momeni, I. and Karimi, S. 2011. Towards Improvement of Environmental Impact Assessment Methods: A Case Study in Golestan Province, *Iran. World. Appl. Sci. J.,* **15(1):** 151-159
16. Majnounian, B., Jourgholami, M., Zobeiri, M. and Feghhi, J. 2009. Assessment of Forest Harvesting Damage to Residual Stands and Regenerations. *J. Environ. Sci.,* **7(1):** 33-44.
17. Makhdoum, M. 1982. Evaluation Model for Environmental Changes. *J. Environ. Stud.,* **11:** 25-34.
18. Makhdoum, M. F. 1993. Environment and Development in East-Azerbaijan Province. *1st Seminar Development in the East-Azerbaijan Province*, Tabriz 1993, 40pp.
19. Makhdoum, M. F. 2002. Degradation Model: A Quantitative EIA Instrument, Acting as a Decision Support System (DSS) for Environmental Management. *Environ. Manage.,* **30(1):** 151-156.
20. Marvie Mohajer, M. R. 2006. *Silviculture*. 2nd Edition, University of Tehran Press, Tehran, 384 PP.
21. Michelsen, O., Solli, C. and Stromman, A. H. 2008. Environmental Impact and Added Value in Forestry Operations in Norway. *J. Ind. Ecol.,* **12(1):** 69-81.
22. Monavvari, M. 2001. The Manual for Environmental Impact Assessment of Forestry Projects. The Environmental Protection Agency.
23. Rahmani, R. and Mohammadnejad Kiasari, Sh. 2003. Relation between Millipedes Abundance and Litter Nutritional Elements Composition in Afforested and Disturbed Sites. *Iran. J. Natural Res.,* **56(3):** 201-212.
24. Safaian, N., Shokri, M. and Jabbarian Amiri, B. 2004. Environmental Impact Assessment of Development in the Southern Coast of the Caspian Sea (Northern Iran). *Pol. J. Environ. Stud.,* **13(3):** 319-323.
25. Seppala, J., Melanen, M., Jouttijarvi, T., Kauppi, L. and Leikola, N. 1998. Forest Industry and the Environment: A Life Cycle Assessment Study from Finland. *Resour. Conserv. Recy.,* **23:** 87-105.

26. Shamekhi, T. 2011. Regulation and Management of Natural Resources (Forests and Rangeland), 2nd Ed. Tehran University Press.
27. Yazdian, F., Faghih Nasiri, L. and Kiapasha, KH. 2012. The Tourism Environmental Impact Assessment on Namak-Abrod Forest Using Degradation Model. Iranian. J. Forest., **4(2):** 113-121.
28. Yosefi, M., Jalali, GH. and Fattahi, M. 2002. An Assessment of the Impact of Human and Animal Encroachments on the Structure of Oak Forests of Yasuj (Pataveh Region). *J. Res. Dev.,* **(56 and 57):** 28-37.

ارزیابی اثرات زیست محیطی طرح جنگلداری با استفاده از ماتریس و مدل تخریب

م. اقنوم، ج. فقهی، م. مخدوم، و ب. جباریان امیری

چکیده

مدیریت منابع جنگلی و فعالیت‌های مرتبط با آن اثرات بسیار مهمی را بر محیط زیست وارد می‌کند. ارزیابی اثرات زیست محیطی پتانسیل بهبود مدیریت جنگلها را فراهم می‌کند اما تاکنون در کشورهای در حال توسعه از جمله ایران، ارزیابی اثرات محیط زیستی فعالیتهای مختلف بر روی منابع جنگلی انجام نشده است با اینکه اثرات منفی زیادی ناشی از اجرای فعالیت‌های جنگلداری بر کیفیت محیط زیست وارد شده است. بنابراین هدف اصلی مطالعه حاضر بررسی اثرات و پیامدهای فعالیت‌های انسانی بر اکوسیستم جنگل و ارزیابی کیفیت محیط زیست طرح جنگلداری پاتم با استفاده از روش ماتریس و مدل تخریب می‌باشد. نتایج حاصل از مدل تخریب نشان داد که تمام پارسل‌های بخش پاتم از ضریب تخریب بالایی برخوردار هستند و نیازمند اقدامات بازسازی هستند. علاوه‌براین نتایج حاصل از روش ماتریس نشان داد که جاده‌های جنگلی، فعالیت‌های بهره‌برداری و دیگر فعالیت‌ها در جنگل نیازمند اجرای طرح‌های بهسازی و اصلاحی هستند. همچنین فعالیت‌های جنگلداری ۲۵/۸ درصد و ۳۵/۵ درصد اثرات و پیامدهای مثبت و ۷۴/۲ درصد و ۶۴/۵ درصد اثرات و پیامدهای منفی را بر محیط جنگل وارد کرده‌اند. بنابراین به منظور بهبود مدیریت طرح‌های جنگلداری و کاهش اثرات منفی فعالیت‌های جنگلداری، باید قبل از طراحی و اجرای طرح‌های جنگلداری ارزیابی اثرات محیط‌زیستی با استفاده از ابزارهای کمی ارزیابی بر روی منابع جنگلی انجام شود.

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