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# Determining effective socio-economic factors in rangeland degradation: A case study of Tehran province, Iran

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**Abstract**
The research was conducted to determine effective socio-economic factors in the degradation of rangeland. Range condition of the study area was compared during 1955 and 2005. Different data sources were used, analyzed and interpreted. Findings showed that decrement of forage production were higher in mountainous rangelands than plain areas. In plain areas, land use change in rangeland to civil and agricultural lands was identified as the most important destructive factor. There was an inverse relationship between the size of ranchers' agricultural areas and the rate of rangeland degradation.

**Keywords:** Degradation, Forage, Pastoralism, Rancher, Rangeland, Socio-economic factors

## Introduction

Rangeland degradation is defined as the reduction or temporary loss of the biological and economic productivity of grasslands in arid, semi-arid, and dry sub-humid areas (UNCCD, 1995). Currently, rangeland degradation has been identified as one of the most serious global environmental issues (Wessels *et al.*, 2007). Land degradation is one of the most pressing environmental issues facing the world's drylands (Reed and Dougill, 2009; Solomon *et al.,* 2007). Approximately over 250 million people in over 100 countries are directly affected by rangeland degradation (Wessels *et al.*, 2007).

The cause of rangeland desertification has been attributed to a combination of climatic and anthropic factors (Hill, 2006; Geist and Lambin, 2004). There is a potential relationship between the rate of destruction and global climate change (Hill, 2006). Also, geomorphic processes, such as gully formation, may have significant effects on vegetation productivity and creating rangeland degradation (Stavi *et al.,* 2010). One of the approaches in conservation plans of natural environment is the separation of local people from the area that is under conservation, but this measure is a potential degrading factor (Homewood, 2004; Goldman, 2003).

Another rangeland degradation factor cited is the role of policies and regulations *i.e.,* land management or land tenure and the hypothesis that environmental sustainability is inversely related to the levels of hierarchy and dissociation present in the governing body (Hill, 2006). Another form of rangeland degradation is rangeland fragmentation, and there are three general categories of processes causing fragmentation of rangelands worldwide: dissection, decoupling, and compression (Hobbs *et al.,* 2008). Management methods also plays an important role in the sustainable use of rangelands, and different studies have been conducted for surveying efficacy of different rangeland management methods (Verdoodt *et al.,* 2009; Batabyal, 2004)
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This paper presents findings of a study about factors of rangeland degradation based on socio-economic conditions. Reviewing the related literature, one can conclude that most researchers have studied ecological or technical degradation factors. Some questions arise such as which factors are destructive for ranges? Which of them are the most important? Obtaining the questions' response is very important in rangelands management and planning section. In the present research, we have investigated socio-economic conditions and factors related to range users (ranchers) that may be degradable or destructive for rangeland. In this study, such socio-economic factors were studied and determined. Tehran province (in Iran) was selected as the case study. Based on primary observations, Tehran province's rangelands were changed to other land uses, and there is degradable condition for the rangelands.

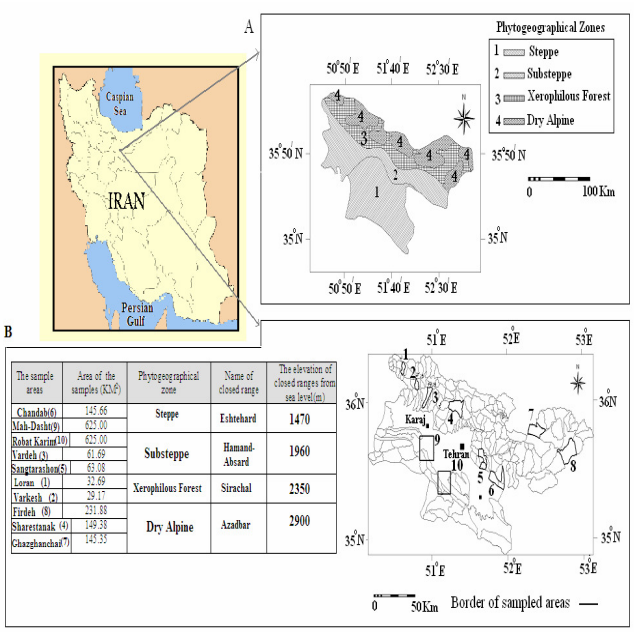
## Materials and Methods

This study was performed in Tehran province with an area of 19,000 square kilometers. There are 13 districts, 40 cities and 894 villages in the Tehran province. In Iran, proprietress of country's rangelands is central government, and ranchers must receive permit for livestock grazing in specified period. They use rangeland for grazing in form of pastoralism yearly.

The research method was a descriptive method based on survey and analysis attempts. Data were gathered from three sources: Ranchers, Range management experts in public sector, and Research and professional reports, maps and field surveys. After determining the area under study, a degradation index of rangeland was prepared for presentation of decreasing forage production in studied areas (Formula 1). The steps taken were as follow:

**1-Determination of sample and reference areas**: At first, the study area was classified based on Henry Pabot's provisional phytogeographical classification (Pabot, 1967). The study area (Tehran province) is in Irano-Turanian zone which has four sub-zones: (i) Steppe zone (ii) Substeppe zone (iii) Xerophilous forest zone and (iv) Dry Alpine zone (Figure 1).

This classification was used, because similar ranges based on ecological criteria can be identified, and interpretation of results can be made more precisely in homologous rangelands. Based on the area of every phytogeographical zone, 10 sample areas were selected as catchments and sheets of 1:50000 topographic maps and all steps of the study were taken in these selected areas (Fig 1). Selection of the sample areas was performed based on area of every phytogeographical zone and its ratio to the provincial area, diversity of vegetation cover types and some existing villages (ranchers' location). In steppe zone, border of two sheets of 1:50000 topographic maps were selected as sample areas (instead of selecting catchments because of plain conditions). Also, for the determination of the degradation indices in the sampled areas (determination of decreasing forage production), four closed ranges in every climatic zone was selected as reference areas. Forage production was then estimated in these areas. Eshtehard closed range (Steppe zone), Homand closed range (Substeppe zone), Sirachal closed range (Xerophilous forest zone) and Azadbar closed range (Dry alpine zone) were selected as the closed ranges. Grazing and other uses have been prohibited in these areas for about 20 years. The ecological condition of the area is near to climax, and forage production is in the highest level. In every sub-zone, there are uniform ecological conditions for growing range plants, and it was possible to compare of forage production in the sample and reference (range closed) areas.




| The sample areas | Area of the samples (KM²) | Phytogeographical zone | Name of closed range | The elevation of closed ranges from sea level(m) |
|---|---|---|---|---|
| Chandab(6) | 145.66 | Steppe | Eshtehard | 1470 |
| Mah-Dasht(9) | 625.00 | | | |
| Robat Karim(10) | 625.00 | Substeppe | Hamand-Absard | 1960 |
| Vardeh (3) | 61.69 | | | |
| Sangtarashan(5) | 63.08 | | | |
| Loran (1) | 32.69 | Xerophilous Forest | Sirachal | 2350 |
| Varkesh (2) | 29.17 | | | |
| Firdeh (8) | 231.88 | Dry Alpine | Azadbar | 2900 |
| Shareetanak (4) | 149.38 | | | |
| Ghazghanchaf(7) | 145.35 | | | |

**Figure 1:** Geographical location of Tehran province (the study area). Map A presents the zones of phytogeographical classification in the studied area. Map B presents the sample areas (bold lines) based on the selected catchments and map sheets in Tehran province's catchments map. Also, the table presents specification of the sample areas and closed areas.

Irano-Turanian zone is a term used for the large eastern zone which has a very dry summer and a temperate continental climate; it extends from Syria and Anatolia to Turkestan and the Pamirs. Precipitation is variable (usually less than 500 mm), with drought for at least three summer months.

**2- Survey of changing rangelands areas:** Areas of different landuses of the sample areas were estimated in 1950 and 2005, and their maps were prepared; therefore, the rangelands' quantitative destructive (changed range use) was obtained in the past years. To determine different landuses in 1950 and 2005, the 1:50000 topographic maps of Iran were used in the two years. Farming, horticulture, forest and woodlands, artificial forests, structured areas, water bodies and rangeland uses were determined in the maps. The areas of landuses change were determined by comparing areas of the land uses in those two years.

**3- Preparation of the degradation index:** To determine the rate of rangeland's qualitative degradation, rangelands' forage production change was considered. Forage production as a quantitative criterion can show qualitative condition of rangelands. Forage production of rangeland in the sample areas and the reference area (the range closed) were compared in every phytogeographical zone, and an index was obtained for the study of degradation of range forage production.

**Formula 1**: The degradation index of rangeland

$$\text{Degradation Index} = \frac{\text{Forage production per hectare in closed range- Forage production per hectare in sample area}}{\text{Forage production per hectare in closed range}} \times 100$$

(1 hectare = 10, 000 square meters)
The index value is between 0 to 100 percent, and 100% shows maximum degrading or losing of forage production.

In every closed range, because of small area and uniformity of the areas, 5 to 10 plots (1×1 meter) were put, and produced forage was estimated every year after cutting, drying in air and weighting forage. In the sample areas, forage production was calculated per year in area unit while putting adequate plots in every sample area.

**4 – Data gathering from ranchers:** In the sample areas (the selected catchments and map sheets), several villages were selected so that necessary data about ranchers' families and socio-economic conditions and their opinions about the rangeland degradation factors could be gathered. For this purpose, a questionnaire was prepared and distributed among the ranchers. The villages were selected because they are places where those ranchers live in. Only villages with proper distribution in every sample area were selected. About 10% of all villages in every sample area, and 5% of every village's ranchers were selected. The number of selected villages and the ranchers were respectively 6 and 27 in the Steppe zones, 3 and 10 in the Substeppe zone, 5 and 16 in Xerophilous forest zone, and 5 and 16 in Dry Alpine zone. The questions about range degradation are presented in table 2. Also, there were other questions in field of impacts of range degradation on ranching and socio-economical conditions, kind of livestock of rangeland, and ranchers' resources of fuel**.** In general, close-ended questions were used. The qualitative data was changed to proper quantitative codes for descriptive statistical analysis. The gathered data (about the villages and ranchers) were analyzed in SPSS programme.

**5- Data gathering from range management's experts:** Another information resource of the study was the data gathered from experts about the degradation factors and condition of the rangelands. Tehran province is divided into 13 counties, each managed by the 'Natural Resources Department' under the supervision of the 'National Rangelands and Forest Areas Organization'. Related questionnaires were completed by the department's experts. Responses were limited to the state of every county. In sum, 47 questionnaires were completed by the experts. Based on the questionnaire, the data were gathered about the most important factors such as the rules and structural factors, the most effective social groups (villagers, nomads and urbanites), and the share of poor and rich ranchers in the rangelands degradation. Close- and open-ended questions were used.

**6- Analysis:** The data was analyzed based on descriptive statistical methods, and results were interpreted. Between the values of the degradation index and quantitative socio-economic data of the ranchers, correlation coefficients were calculated. By this analysis, the main degradable factors in some cases can be determined statistically. The correlation coefficients can present direction and relation's strength of two variables based on the number of data. The correlation coefficients were calculated by Pearson and Spearman methods.

**Results and Discussion**

The areas of climatic zones based on the phyto-geographical classification are (i) Steppe zone: 626037.7ha, (ii) Substeppe zone: 542342.2 ha, (iii) Xerophilous forest zone: 395363.5 ha and (iv) Dry Alpine zone: 418712.1 ha.

Changes in the rangelands' areas and percentage of changes in the areas or the decreasing percentage of rangelands in the sample areas in 1950 and 2005, degradation indices are presented in Table 1. In these circumstances, the forage production of the sample areas (kg/ha) is compared with the forage production of closed ranges (kg/ha) in the same phytogeographical zone. The highest values of degradation indices are 80.78 % and 66.36% for Firdeh and Looran sample areas in Xerophilous forest zone. The average degradation indices in every four climatic regions are 77.32 in Xerophilous forest zone, 62.25 in Dry Alpine zone, 59.63 in Substeppe zone and 44.94 in Steppe zone.

**Table 1:** The changes of rangelands areas and indices of degradation in the sample areas

| Name of sample area | area of rangelands (ha) | | Percent of decreasing rangeland area | Forage production of the sample areas (kg/ha) | Forage production of the closed range (kg/ha) for every zone | Index of degradation |
|---|---|---|---|---|---|---|
| | 1950 | 2005 | | | | |
| Looran (Xerophilous forest) | 2622.5 | 2606.3 | 0.6 | 224 | 666 | 66.36 |
| Firdeh (Xerophilous forest) | 23682.0 | 22419.0 | 1.12 | 128 | 666 | 80.78 |
| Varkesh (Xerophilous forest) | 1779.0 | 1439.7 | 19.1 | 241 | 666 | 63.81 |
| Gazganchai (Dry Alpine) | 14360.1 | 10223.0 | 28.81 | 150 | 392 | 61.73 |
| Shahrestanak (Dry Alpine) | 14755.6 | 14679.4 | 0.5 | 144.5 | 392 | 63.14 |
| Vardeh (Substeppe) | 6095.1 | 5988.4 | 1.75 | 125.2 | 300 | 58.26 |
| Sangtrashoon (Substeppe) | 4877.2 | 4269.0 | 12.5 | 117 | 300 | 61.00 |
| Chand-ab (Steppe) | 14241.4 | 12261.6 | 14 | 108 | 174.5 | 38.10 |
| Roobat-Karim sheet (Steppe) | 12920.9 | 10465.1 | 19 | 64.2 | 174.5 | 63.21 |
| Moh-Dasht (Steppe) | 14527.5 | 7391.6 | 49 | 116 | 174.5 | 33.52 |

**Table 2:** The responses of ranchers about the rangeland degradation

| Subject of questions | Subjects of ranchers' responds | | Percent of responds to the every factors | | | | |
|---|---|---|---|---|---|---|---|
| | | | Steppe Zone | Sub steppe zone | Xerophilous forest zone | Dry Alpine zone | Average |
| **The most important factors of rangeland degradation** | The factors related to Livestock | Premature livestock grazing | 12.50 | 6.70 | 14.80 | 14.30 | 12.10 |
| | | Increasing livestock numbers | 12.50 | 6.70 | 11.10 | 14.30 | 11.10 |
| | | Long grazing | 12.50 | 13.30 | 3.70 | - | 7.40 |
| | The factors related to land use changes and developmental projects | Heavy grazing | 12.50 | 13.30 | 14.80 | 12.50 | 13.30 |
| | | Changing rangelands to agricultural land use | 12.50 | 6.70 | 11.10 | 42.90 | 18.00 |
| | | Changing rangelands to civil land use | 12.50 | 6.70 | 7.40 | 14.30 | 10.20 |
| | The factors related to vegetation cover | Military maneuvers | 6.30 | 6.70 | - | - | 3.25 |
| | | Constructing mines | 6.30 | 6.70 | - | - | 3.25 |
| | | Cutoff of trees for fuel and so on | 12.50 | 6.70 | 7.40 | - | 6.65 |
| | | Rangeland firing | 6.30 | 6.70 | 3.70 | - | 4.17 |
| **Presented approaches for improvement of rangeland state** | Financial aid by the government | | 20.00 | 20.00 | 14.80 | 37.50 | 20.58 |
| | Only ranchers can improve rangelands | | 20.00 | 20.00 | 14.80 | 12.50 | 16.82 |
| | presentation of expert guides by public sector | | 16.00 | 16.00 | 14.80 | 12.50 | 14.82 |
| | Increasing penalty fee for violations by government | | 4.00 | - | 3.70 | 12.50 | 5.05 |
| | There is no need to government supervision | | 8.00 | - | - | - | 2.00 |
| | Every measures is useless | | 8.00 | 8.00 | 3.70 | - | 4.93 |
| | Establishment of cooperation with company of ranchers | | 4.00 | 4.00 | 7.40 | 12.50 | 6.98 |
| | Ranchers themselves to work together | | 12.00 | 12.00 | 14.80 | 12.50 | 12.82 |
| | Reinforcement of village councils | | - | 12.5.0 | 11.10 | 12.50 | 9.28 |

**Table 3:** The response of experts in the study area

| Subject of question | Subjects of the experts' responds | | Percent of responds to the every factors | | | | |
|---|---|---|---|---|---|---|---|
| | | | Steppe Zone | Sub steppe zone | Xeroph -ilous forest zone | Dry Alpine zone | Average |
| **The most important factors of rangeland degradation** | The factors related to Livestock | Premature grazing | 8.00 | 8.70 | 5.90 | 17.60 | 10.05 |
| | | Increasing stock numbers | 16.00 | 21.70 | 17.60 | 14.70 | 17.50 |
| | | Long grazing | 12.00 | 13.00 | 11.80 | 8.80 | 11.40 |
| | | Heavy grazing | 12.00 | 17.40 | 11.80 | 11.80 | 13.25 |
| | | Increasing rancher number | - | 17.40 | 5.90 | 2.90 | 6.55 |
| | The factors related to land use changes and developmental projects | Contest in grazing | - | - | 5.80 | 2.90 | 2.18 |
| | | Changing rangelands to agricultural land use | 12.00 | 4.30 | 5.90 | 5.90 | 7.02 |
| | | Changing rangelands to civil land use | 20.00 | 8.70 | 5.90 | 11.80 | 11.60 |
| | The factors related to vegetation cover | Military maneuvers | - | - | - | 2.90 | 0.73 |
| | | Range plans | - | 4.30 | 11.80 | - | 4.03 |
| | | Cutting of trees for fuel | 8.00 | 4.30 | 17.60 | 8.80 | 9.68 |
| | | Shrub cutting | 4.00 | - | - | - | 1.00 |
| | | Contraband of wood | 4.00 | - | - | - | 1.00 |
| | | Obtaining secondary products form rangeland | - | - | - | 2.90 | 0.73 |
| | | Rangeland firing | 4.00 | - | - | 8.80 | 3.20 |
| **The law and structural effective factors that have the most effect on rangeland degradation** | Lack of laws for punishmentof delinquents | | 14.10 | 11.80 | 15.20 | 20.20 | 15.30 |
| | Shortage of personals and facilities for controlling rangelands | | 16.30 | 16.20 | 18.20 | 18.60 | 17.08 |
| | Lack of delinquents punishment by judges | | 15.20 | 14.70 | 15.20 | 13.60 | 14.68 |
| | Attention deficit of governmental staffs in reason of motiveless | | 14.10 | 14.70 | 12.10 | 10.20 | 12.78 |
| | Shortage of laws about rangelands | | 13.00 | 13.20 | 9.10 | 11.90 | 11.80 |
| | Lack of clarity of laws and prescriptions | | 13.00 | 13.20 | 12.10 | 11.90 | 12.55 |
| | Low related penalties value | | 12.00 | 13.20 | 18.20 | 11.90 | 13.83 |
| | Other factors | | 2.20 | 2.90 | - | 1.70 | 1.70 |
| **The best approach for rangeland ownership** | Governmental ownership | | 18.90 | 15.10 | 20.00 | 13.70 | 16.93 |
| | Public ranchers ownership | | 11.30 | 13.20 | 8.00 | 9.80 | 10.58 |
| | Private ownership of non-rancher | | 13.20 | 13.20 | 12.00 | 9.80 | 12.05 |
| | Private ownership of every rancher | | 20.80 | 18.90 | 16.00 | 17.60 | 18.33 |
| | Cooperative company of ranchers | | 11.30 | 15.10 | 16.00 | 7.00 | 12.35 |
| | Public ownership based on range plans | | 15.10 | 13.20 | 16.00 | 15.70 | 15.00 |
| | Other forms of ownership | | 1.90 | - | - | 3.90 | 1.45 |

In this study, changes in rangeland's area are obvious. Changing rangelands to agricultural and civil landuses can also be seen in all the sample areas. In plain areas, degradation of rangeland is higher (based on landuse changes), and about 50% of the rangelands were changed to another landuse in 1950 and 2005 in the sample areas. In the sample areas, about 49% of Mahdasht sheet's rangeland and forest areas (Steppe zone) were changed to another land use, the greatest change. In comparison, Homewood (2004) has mentioned privatization of formerly communal rangeland, and its conversion to commercial monoculture, have driven drastic land cover and wildlife declines in Kenya.

The Xerophilous Forest and Dry Alpine zones have the highest degradation indices respectively. In sum, the degradation index of rangeland (decreasing forage production) is increased from plain areas to mountainous areas. This result indicates that the ranchers have lesser financial resources in

mountainous areas; therefore, they exploit the rangelands more than the plain area's ranchers.

Statistically, correlation coefficients between the degradation indices of rangelands and the socio- economic quantitative data of the rangeland's ranchers were calculated. The correlation coefficients that are meaningful between 10% and 1% are considered. The correlation coefficients are between the degradation indexes and ranchers' rangeland area, ranchers' agricultural land area, ranchers' debt value, stock number of every rancher, ranchers' cost of living per year, agricultural cost of every rancher per year, and agricultural gross income of every rancher per year.

In steppe zone, correlation coefficients between the degradation indices and the debt value of ranchers (Pierson: 0.416 - Correlation is meaningful in 10% level), the number of ranchers' stock (Spearman: 0.576 - Correlation is meaningful in 5% level) and ranchers' fuel expenditure (Spearman: -0.344 - Correlation is meaningful in 10% level) are significant in 5 and 10 percent levels. Thus these correlations are correct in 95 and 90 percent level of confidence (Moore and Cobby, 1998). In sub-steppe zone, correlation between the degradation indices and ranchers' debt value (spearman: 0.674 - Correlation is meaningful in 10% level), fuel expenditure (Pierson: 0.628 - Correlation is meaningful in 10% level) and agricultural lands area (Pierson: -0.779 - Correlation is meaningful in 5% level and spearman: -0.90 - Correlation is meaningful in 1% level) are significant in 10 percent level and less.

The correlation coefficients of the degradation indices with the ranchers' gross agricultural income (Pierson: -0.556) and land areas (Spearman:-0.433) are significant in 10% level in Xerophilous Forest zone. In Dry Alpine zone, the correlation coefficients of the degradation indices with ranchers' expenditure for life (Pierson: -0.579), agricultural land area (Spearman: -0.861) and cultivation expenditure (Spearman: -0.692) are significant in 10% level.

In all zones, the degradation index and ranchers' agricultural land area have negative correlation. This means that increasing one factor decreases another one and vice versa. Therefore, the rangeland degradation index is decreased with engagement of ranchers in cultivation activities and obtaining revenue in this way.

In tables 2 and 3, responses of ranchers to the questions and their socio-economic specifications are presented. In table 2, the opinions of ranchers about the effective factors of rangeland degradation are presented. In the last column of the table, the average of percents of ranchers' answers is presented for every item in the phytogeographic zones. The sum of percentages in every column in range of subjects of questions (first column) is 100%.

The ranchers have mentioned that changing rangeland to farming landuse, heavy grazing and premature livestock grazing are the most important degradation factors. They mentioned that financial aid and technical advises offered by the government and ranchers management on the rangeland are the best measures for the rehabilitation of rangeland. Emigration, departure from villages, changing ranching job and low financial return from rangelands are the most important impacts of rangeland degradation. Sheep, cow and goat have the most shares in the herds respectively. Kerosene and gas have maximum shares in ranchers' fuel basket.

Based on the experts' responses, increasing stock numbers, heavy grazing and changing rangelands to civil lands are the most effective factors in the rangeland degradation. Cutting shrubs and contraband of wood are only in the Steppe zone and military maneuver and obtaining secondary products from rangelands are in the Dry Alpine zone as the most important degradation factors. Generally, in mountainous areas, the problems of stock and management of grazing, and in plain areas, changing the landuses is presented as the main degradable factors. These results have similarity with the results of the study's fieldworks. In rangeland ownership section, the private ownership of rangelands and governmental ownership have received the highest number of responses. The experts have mentioned that "poor ranchers" play the greatest role in the degradation of rangelands.

The study of ranchers' responses indicates that they need financial assistance and technical advice of the public sector. In general, they are dependent on the public sector assistance because of difficult economic conditions.

In the phytogeographical zones, the ranchers have different livelihoods and income. With regards to fuel consumption, kerosene occupies the main portion in plain areas, and kerosene and firewood have the main portion in the mountainous areas. Firewood was not mentioned as consumed fuel in Steppe and

Substeppe zones. Also, sheep portion in herds decreased from Steppe zone to Dry Alpine zone, and cow portion in herds increased in the same manner. The plain ranchers have better financial status than the mountainous ranchers. The number of stock, household expenses, income from agriculture and so on is higher in plain areas.

Comparison of the experts' and ranchers' responses indicate that experts have mentioned that the increasing stocking number is the most important degradation factor; but the ranchers cite landuse change of range and forest to agricultural landuse as the most important degradation factor. Based on the expert's opinions, heavy grazing, changing range and forest lands to civil landuse, and long grazing are other important factors respectively. Based on results of other studies, grazing by livestock and over-stocking are the most important factors in rangelands' destruction (Harris, 2010; Zhao *et al*., 2005) Experts stated that poor ranchers play a greater role in the range and forest destruction. The main source of forage for the poor ranchers' stock is rangelands. Poor ranchers also exploit trees to cut timber and make coal. They also tend to sell the trees.

In areas that ranchers have more agricultural lands, the degradation indices decreased. Therefore, other means of revenue generation for ranchers should be found if managers want to decrease rangeland degradation. An important factor in the rangeland degradation is bush and tree cutting to be used as firewood in mountainous areas. Firewood has important portion in supplying fuel, especially in nomad groups. Therefore, it is necessary that fuels such as kerosene and gas are supplied to ranchers in order to decrease tree and bush cutting.

Based on the study's results, lack of a land use plan has also an important role in rangeland degradation in the study area. This problem is more serious in Steppe and Substeppe zones especially. As the most important factor in rangeland degradation is changing the landuse of rangelands to civil and agricultural uses, proper landuse planning is important to decrease degradation in the rangelands.

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