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Hazard assessment of livestock pressure in Fars Province, Iran

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ABSTRACT

Overgrazing accelerates soil and vegetation degradation in Rangelands. So, Livestock Population Density- i.e., allocated number of sheep per ha- can serve as an index for measuring pressure on range environment. For this purpose, FARS province has been selected as the study area, where it is located in the southern part of Iran. The required data has been extracted from existed records and published reports in ministry of Agriculture, ministry of Energy, Iran Statistics Center and Meteorology Organization. This study is to assess livestock pressure on rangeland in the study area, using Geographic Information System (GIS) tools and a model based procedure. FAO/UNEP Model has been selected for this purpose, which uses a ratio of potential carrying capacity of region to current Livestock Population Density as an Index for livestock Pressure. However, the model has been modified in this study to achieve a better estimation of pressure index according to the actual conditions of the region. Parameters which have been used to modify this methodology are: Topographic and Local parameters. Local parameters are annual consumption for livestock unit in the study area, dependency of each livestock to pasture, number of livestock unit for each animal and land use map. Also due to the difference livestock pressure in mountainous, plain and hilly areas, in order to calculate the adjusted ADL in the altitude of mountain range, the mountainous area in each sub-region was divided into three parts. Hazard map of pressure of livestock was prepared after overlying and calculating the different parameters in a GIS. According to the results, hazard classes of severe and very severe include about 28% of the study area. Areas, including higher classes of hazard severity have been identified in the Northeast part of the region. It is because of low potential of natural rangeland to grow enough forage and also a high number of livestock. Poor soil and harsh climate decrease natural potential of rangeland to grow more forage and to support livestock efficiently.

Key words *: Livestock pressure, Livestock unit, Natural resources, FAO/UNEP, GIS*

Introduction

Desertification and biodiversity loss have been serious environmental problems influencing people's lives, economical development and political stability (Warren *et al.,* 1996). Vegetation destruction resulting from overgrazing and other unsuitable use of rangeland is one of the most common causes of desertification and biodiversity loss. There are numerous desertified lands over the world, especially in arid and semiarid zones (Dregne 2002), resulting from human over-exploitation such as mining, clear-cutting, and overgrazing. Livestock grazing is a dominant land-use activity in semi-natural and managed rangelands (Soderstrom *et al.*, 2001). Heavy grazing can disturb rangeland (Yates *et al.*, 2000). A study of grazing effects on species diversity and richness of rangeland vegetation has reported that grazing impacts on species composition, vegetation cover, canopy height, biomass and soil environment were sensitive to grazing rate in the rangeland (Pour and Ejtehadi 1997).

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Rangeland ecosystems have been grazed by small ruminants mainly sheep and goats, for more than 5000 years (Noy-Meir and Seligman 1979, Perevolotsky and Seligman 1998). Arid and semi-arid grasslands in the Middle East also have been evolved for more than 8000–9000 years (Smith 1995). Livestock play an important role in human-being livelihood. Nowadays, livestock have been grown generally to satisfy the same ancient demands- e.g. milk, meat, wool and manure. As shown in Fig.1, livestock in the area grew in big herds. Today, It is also as a saving-account for villagers and nomads' family as so they sell livestock at local markets, whenever they are in an urgent need of money.

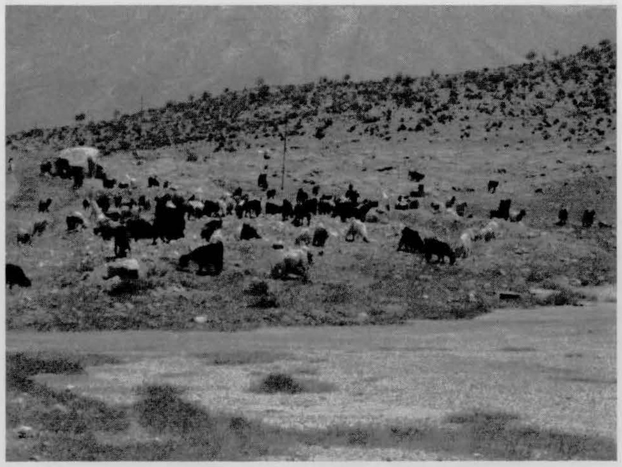

Fig. 1. Goat is one kind of livestock in the study area, grew in big herds.

Heavy grazing can cause soil erosion, loss of soil structure, and deterioration of soil environment (Faraggitaki 1985). Apart from key role of livestock in local and national economy, it has always been blamed for its effects on accelerating land degradation. It is while environmental degradation, caused by human pressure and land use changes, has become a major problem worldly-wide (Erlich 1988, Wilson 1992). Grazing with heavy stocking has also multiple effects on agro-ecosystems by defoliating plants and consequently influencing their growth, strength and regeneration processes. Besides, it reduces diversity of plant species as well as vegetation crown cover and amount of biomass. By reducing vegetation crown cover, water infiltration rate decreases and wind/water soil erosion also increases (Mwendera and Mohamed Saleem 1996, Le Houerou 1996, Asadu *et al.*, 1999, Taddese 2001). Compacted soil caused by herd, becomes strong, making it difficult for new shoots both to penetrate roots in and to emerge stems out of the soil. Such a soil is unlikely to drain well and will pond after a moderate rainfall. Soil particles from these zones will be susceptible to erosion carrying particles, organic matter and phosphorus to surface waters.

When a region is affected by heavy stocking grazing, recovery will occur within a long period of time. The consequences are minor and reversible if grazing intensity is either low or moderate. Conversely, they become major and irreversible if it is very high. So it is very important to have a general view about grazing intensity, degradation hazard and the consequences to plan natural rangeland accurately.

The main objective of the study is to evaluate pressure of livestock in the region according to classification of hazard severity, while number and type of livestock has been considered as the key factors to determine the hazard classes. In this research, a model of assessing for livestock pressure has been proposed, using two types of data including thematic maps and attributions which has been stored, processed and analyzed within ArcMap GIS environment. All the data obtained from the local offices and checked through intensive field work.

Study Area

Fars Province located in the southern Iran (Fig. 2) was selected to be a study area for a test assessment of livestock pressure. Fars region is one of the oldest centers of civilization (Fig. 2) It covers an area of

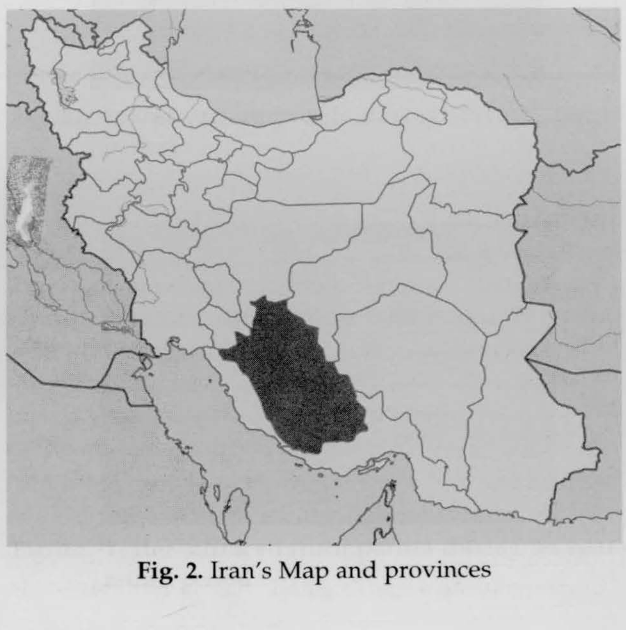

Fig. 2. Iran's Map and provinces

about 12 million ha, which lies between the latitudes of 27° 02′ and 31° 43′ N and the longitudes of 50° 42′ and 55° 36′ E. Precipitation changes between 100 to 600 mm showing an average of 330 mm in the region. Fars province is surrounded by Isfahan province in the north, Yazd and Kerman provinces in the east, Kohkiluyeh boyerahmad province in the west, Boushehr province in the south and southwest, Kerman province in the south and southeast of Iran. This province has 8.6 million hectares of rangeland, 1.2 million hectares of forest and 1.6 million hectares of cropland. The climate in north of this province is cold, in central part it has mild and rainy winters and dry summers, and in south and south-east winters are mild and summers are hot.

Method

FAO/UNEP Model of Livestock pressure assessment (FAO/UNEP 1984) has been recommended the main framework to assess Livestock pressure on the natural Rangeland. The model has been adopted for the current study, considering some modifications to produce a hazard map, presenting a better estimation of pressure index according to the actual conditions of the region. To assess the pressure index of livestock the following steps have been taken:

(1) Estimating Potential Productivity of Rangeland

Potential productivity has been used as an indicator to classify rangelands. It indicates that how much a rangeland is able to produce forage (dry matter in Kilogram per year in ha) in a given climate condition without considering impact of anthropogenic activity. It has been calculated in following steps:

(1.1) Assessing Consumable Dry Matter (CDM)

The following equation has been employed to assess consumable dry matter. It is based on amount of annual rainfall (R) for zones with winter rainfall (Le Houerou and Le Hoste 1977), adopted by FAO/UNEP (FAO/UNEP 1984).

$$\text{CDM (kg / ha)} = 2.17 \times \text{R (mm)} - 103.7$$

Applying the equation the map of the annual rainfall for the region has been turned into CMD map in ArcMap GIS software.

(1.2) Assessing CMD

The method uses soil conditions to achieve a better and more probable estimation of CMD than the above equation provides. It emphasizes on the influence of soil conditions- its capability and suitability- to produce biomass and annual dry matter of forage consequently. Hereby, a new value of CDM has been demonstrated by CMD′ which is calculated from equations, presented in Table 1, offered by FAO/UNEP (1984) and Kharin (1986). The soil condition of the region has been extracted from existing reports (Research Institute of Planning and Agricultural economics 2000). Finally, CDM′ map of the region has been produced by overlaying map of land units, including attributes of soil suitability, on the CDM map and applying equations of Table 1 in ArcMap GIS.

(2) Assessing Potential of Carrying Capacity (PCC)

To assess this a ratio of CDM′ to 440 is used:
Potential of Carrying Capacity (PCC) = CDM′ ÷ 440
the number 440 is the amount of the dried forage (kg) needed for each livestock unit (sheep) per year (1.2 kg per day; Report, Research Institute of Planning and Agricultural economics, 1998) while the forage need of each livestock unit (cow) per annum is estimated as 2000 kg in FAO/UNEP (1984) method.

So, the PCC indicates number of livestock unit (L.U.), can be supported by a (ha) of a certain rangeland annually. In this study "sheep" has been considered as the livestock unit, however, "cow" is the unit in FAO/UNEP method.

(3) Assessing Actual Density of Livestock (ADL)

To assess ADL, first, equivalent livestock units are defined for various animals (Natural Resources Bureau of Fars Province, 2003). It has been indicated in Table 2 for the animals in the study area. Then ani-

Table 1. CDM's modified Equations, based on soil suitability for Natural Resources in the land units.

CDM's modified Equations	Soil Suitability for natural resources		Soil Limitations
CDM′ = CDM + 0.25 CDM	Good	S1, S2	No limitations
CDM′= CDM - 0.25 CDM	Medium	S3	Medium limitations
CDM′= CDM - 0.50 CDM	Low	S4, S5	Severe limitations
CDM′= CDM - 0.75 CDM	Poor, very poor	N1, N2	Absolute Non-suitable soils

mal dependencies on natural resources area are considered, because farmers use some other complementary food resources such as agricultural debris, to feed their animals. It has been also demonstrated in Table 2 for different animal types of the region. So Active Livestock Unit (ALU), depend on natural resources area, has been calculated by multiplying the number of the animals in each sub-region (Table 3) by the equivalent animal unit by the corresponding dependency rate. Total number of sub-regions which indicates sub divisions of townships in the province is 80. Then, total number of ALU has been divided to the area of natural resources in each sub-region to calculate actual density of livestock in the natural resources area per ha. After calculating the Actual Density of Livestock (ADL), due to the difference livestock pressure in mountainous, plain and hilly areas in order to calculate the adjusted ADL in the altitude of mountain range, the mountainous area in each sub-region was divided into three parts. The class of the highest elevation parts in the mountainous area due to lack of grazing because of difficulty to access was considered none or no risk. The livestock pressure class in middle range of mountainous area depending on the extent of the mountain was divided into 1.5 to 2. The livestock pressure

Table 2. Equivalent Animal Unit and Dependencies on Range(%) livestock units

	Sheep	Goat	Cattle			Buffalo	Camel	Others (like donkey)
			Endemic	Hybrid	Exotic			
Equivalent Animal Unit	1	0.75	4	6.5	9.5	6.5	5.5	4.5
Dependencies on Range(%)	60	70	26	20	5	75	90	75

Table 3. Local Statistics for Livestock in the regions (Jahade-Agriculture Organization of Fars 2012)

Townships	Number of livestock				
	Cattle	Sheep	Goat	Camel	Others (like donkey)
Abadeh	12674	551900	224900	25	1197
Arsenjan	2577	83480	82795	0	501
Bavanat	1855	236560	193660	60	1282
Darab	10109	92270	220980	200	1171
Eqlid	11816	596545	247772	75	2590
Estahban	4316	66150	49120	10	1370
Farashband	2349	149300	182700	300	1270
Fasa	16334	141120	166395	0	1089
Firozabad	4484	99700	166760	8	805
Ghirokarzin	1259	79980	49640	0	756
Jahrom	10426	237783	264591	60	1055
Kazeron	20464	508118	254619	0	1847
Khonj	3938	93650	69900	12	988
Khorambid	1487	260300	137500	0	398
Lamerd	3034	6450	53455	420	433
Lar	5427	72659	204957	136	442
Mamasani	5887	194463	244115	5	1994
Marvdasht	54956	205358	133953	20	1505
Mohr	2669	8760	136360	100	486
Neyriz	1157	142460	116775	0	32
Pasargad	3937	146680	44370	0	68
Sarvestan	2606	29700	75400	0	90
Sepidan	18955	173696	141734	0	129
Shiraz	71072	364863	310819	10	4556
Zarindasht	2016	76200	109650	580	829
Total	314818	4696015	4001602	2021	26883

class in the lowest elevation of mountainous area was assumed constant or with no change. In other parts of the plains or hills the actual density was multiplied 1.5 to 2. The maps of ALU and adjusted ADL have been produced for the region, including all sub-regions in ArcMap GIS.

(4) Assessing Livestock Pressure (LP)

Comparing the map of potential carrying capacity (PCC) with the actual density of livestock (adjusted ADL) presents the difference between natural potential of rangeland to supply forage sustainably and actual demands that there is for. To produce a hazard map of degradation, the maps (the PCC and the ADL) have been overlaid (dividè) to present weights of Potential conditions against actual one. Then, the final map has been classified by adopted FAO/UNEP pre-defined categories to produce classified hazard map of the region. The categories, employed in this research, have been demonstrated in Table 4.

Table 4. Severity classes defined for livestock Pressure assessment

Severity Classes of Livestock Pressure*				
None	Slight	Moderate	Severe	Very Severe
≥ 5	1.5 – 5	1.0 – 1.5	0.5 – 1.0	< 0.5

*Severity classes defined for livestock pressure assessment.

Results and Discussion

The natural vegetation cover reflects the climatic and soil conditions but is affected also by anthropogenic activity like encroachment for cultivation and grazing. As a result, encroachment of the marginally hilly areas that were formerly the best grazing lands has become a high risk land use. At the same time, over grazing in the remaining rangelands gets accelerated by the ever increasing concentration of the livestock on rangelands. This replacement has been fast in the recent decade. Often all the woody plants, not leaving even the small sub shrubs, have been cut and have disappeared around the villages. Also grazing pressure seems to have become much intensive in the past couple of decades than it was before. It urgently requires proper 'rangeland management', based on grazing capacity. The implementation of management strategies is, of course, very difficult to introduce because of the socio-economic compulsions of the rural population.

The hazard map, shown in Fig.3, presents the livestock pressure in the region. It reveals "very severe" condition of degradation hazard in the most parts of north east in Fars province, which is only about 14.15% of total area (Fig. 4). The "Severe" condition of degradation hazard is observed in 14.4 % of total area. The high pressure in the northeast part is related to the both lower potential of forage production and also numbers of livestock.

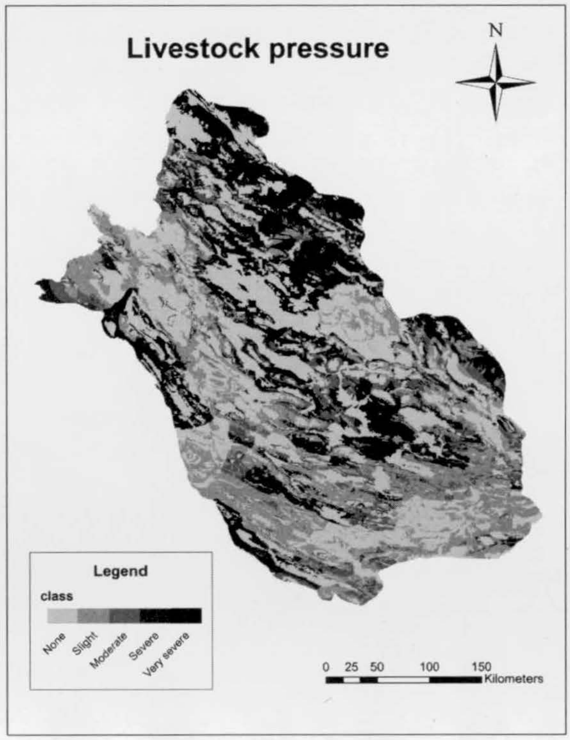

Fig. 3. The hazard classes of livestock pressure in the region.

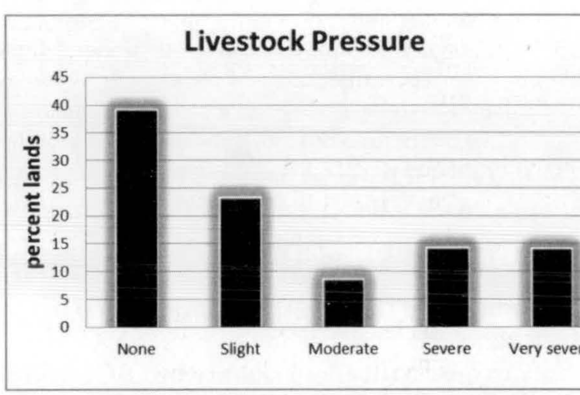

Fig. 4. Percentage of land under different hazard severity classes of pressure of livestock in Fars province

The "Moderate" degradation hazard conditions are observed in 8.8 % of total area and it covers only small parts of the area. The hazard map shows most parts of the province (about 63%) belong to the least hazardous condition, which is located in the southern and the northwest parts.

In this method the hazard class of non-natural resources lands like garden, farm and residential lands is assigned none or with no risk. If we consider the expansion of hazard classes just in natural resources lands the percentage of severe and very severe classes increased. According to this viewpoint the "Severe" and "very severe" conditions of degradation hazard is observed in 35.1 % of total rangeland. This result is in good agreement with other results regarding livestock pressure in different regions of Southern parts of Iran indicating high pressure is observed on the natural resource area (Masoudi *et al.* 2005, Masoudi and Asrari 2006, Amiri *et al.*, 2008). The percentage graph of natural resource lands under different hazard severity classes of pressure of livestock in Fars province presented in Fig 5.

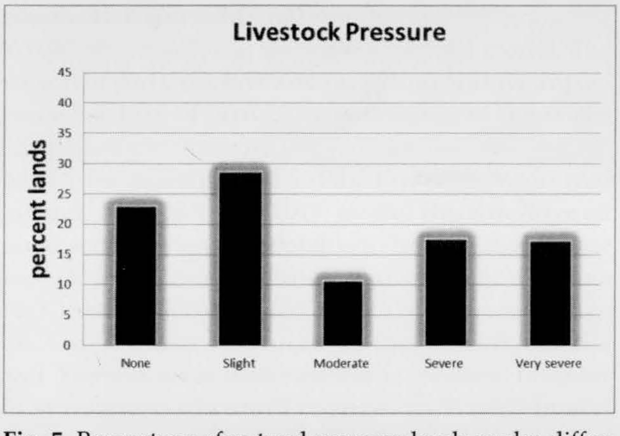

Fig. 5. Percentage of natural resource lands under different hazard severity classes of pressure of livestock in Fars province

The FAO/UNEP model has been modified in this study to achieve a better estimation of pressure index according to the actual conditions of the region. Parameters which have been used to modify this methodology are: Topographic and Local parameters. A ratio and classification of potential carrying capacity to present livestock density by FAO/UNEP (1984) method can be adopted for assessing livestock pressure in this region.

Local parameters, which have been used to modify the method, are: annual consumption for livestock unit in the study area, number of livestock unit for each animal, dependency of each livestock to pasture and land use map which both last parameters have not been used in the FAO/UNEP model. Other works in Iran also suggested using these parameters to achieve more real results about livestock pressure (Research Institute of Planning and Agricultural economics 1998; Natural Resources Bureau of Fars Province 2003; Amiri *et al.*, 2008). So the study has employed criteria for assessing animal pressure, which are not universal and they have been elaborated on the basis of the local conditions.

Topography can be one of the effective factors in livestock pressure. In low elevation and gentle areas, easily accessible topography, the shrub steppe site likely received the greatest grazing pressure of all our sites (Masoudi *et al.*, 2005, Masoudi and Asrari 2006). Seasonal migration to make use of natural resources at different altitudinal belts is a basic feature of Tibetan- style transhumance in the Hengduan Ranges of China. In this production system, resources in alpine areas are often underused, while low-elevation resources are seriously overused. Low-elevation shrubs and the capacity to provide supplements in winter time are the bottle-neck in successful livestock production. A shift in grazing activities to areas at low elevations has increased the pressure on already fragile ecosystems and intensified shortages of fodder in winter. The ecological and socioeconomic consequences of such changes need to be closely monitored (Shaoliang *et al.*, 2007). Therefore evaluating the livestock pressure, due to the difference livestock pressure in mountainous, plain and hilly areas in order to calculate the more accurate ADL in the altitude mountainous ranges and plains can help us to increase the accuracy and attain better results. So the hazard classification performed with GIS model showed high accuracy if topographic and local aspects considered.

Conclusion

Hazard analysis of livestock pressure is as a prerequisite of conserving and improving natural rangelands. Conserving and reclaiming rangeland in Southern Iran, highly threatened by overgrazing, is the need of the day. Hazard map using different data in the GIS together gives a far better opportunity to distinguish severity classes of livestock pressure. The study has employed criteria for assessing animal pressure, which are not universal and they have been elaborated on the basis of the local conditions. A ratio and classification of potential carrying capacity to present livestock density by FAO/UNEP (1984) method can be adopted for assessing livestock pressure in this region. However, some modifications, based on the local data, are needed to achieve a better estimate of the pressure. Local parameters, which have been used to modify the method, are: annual consumption dry matter for livestock unit, livestock dependency on natural rangeland and number of livestock unit for each animal. Moreover evaluating the livestock pressure, due to the difference livestock pressure in mountainous, plain and hilly areas in order to calculate the more accurate ADL in the altitude mountain range and plain can help us to increase the accuracy and attain better results. The hazard map shows that the areas under severe and very severe classes cover about 28% of the study area.

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References

Amiri, E., Masoudi, M., Fallah Shamsi, S.R. and Taghvaei, M. 2008. Hazard evaluation of livestock Pressure on natural rangeland of Iran. *International Pollution Research.* 27 (4): 611–615.

Asadu, C.L.A., Ike, O.O. and Ugwuoke, B.O. 1999. Cattle grazing and environment in eastern Nigeria: Impact on soil physical properties. *Outlook on Agriculture* 28: 103-107.

Dregne, H.E. 2002. Land degradation in dry lands. *Arid Land Research and Management* 16 : 99-132.

Erlich, P.R. 1988. The loss of diversity: causes and consequences. In: Wilson, E.O., Peter, F.M. (Eds.), *Biodiversity.* National Academic Press, Washington, DC, pp. 21–27.

FAO/UNEP. 1984. Provisional methodology for assessment and mapping of desertification. Food and Agriculture Organization of the United Nations, Rome, 84p.

Faraggitaki, M.A. 1985. Desertication by heavy grazing in Greece: the case of Lesvos island. *Journal of Arid Environments.* 9 : 237–242.

Jahad-e-Keshavarzi Organization of Fars. 2007. Statistics of Livestock in Fars Province. Ministry of Jahade Agriculture, Shiraz, Iran.

Kharin, N.G. 1986. Desertification assessment and mapping: a case study of Turkmenistan, USSR. *Annals of Arid Zone.* 25 : 1-17.

Le Houerou, H.N. 1996. Climate change, drought and desertification. *Journal of Arid Environments* 34 : 133-185.

Le Houerou, H.N. and Hoste, C.H. 1977. Rangeland production and annual rainfall relations in the Mediterranean Basin and in the African Sahelo- Sudanian zone. *Jr. of Range Management.* 30 : 181-189.

Masoudi, M. and Asrari, E. 2006. A new model for assessing of livestock pressure: a case study- Southern Iran. *Ecology Environment and Conservation* 12(3) : 391-398.

Masoudi, M., Gore, S.D. and Alavi Panah, S.K. 2005. A new methodology using GIS for assessing of livestock pressure in the Qareh Aghaj Sub Basin, Southern Iran. *Nature, Environment and Pollution Technology* 4(4): 561-566.

Mwendra, E.J. and Mohammad Saleem, M.A. 1996. Infiltration rates surface runoff and soil loss as influenced by grazing pressure in the Ethiopian highlands. *Soil Use and Management* 13: 29-35.

Natural Resources Bureau of Fars Province. 2003. Livestock report. Ministry of Jahade Agriculture, Shiraz, Iran.

Noy-Meir and Seligman. 1979. Management of semi-arid ecosystems in Israel. In: Walker, B.H. (Ed.), Management of Semi-arid Ecosystems. Elsevier, Amsterdam, pp. 113–160.

Perevolotsky, A. and Seligman, N.G. 1998. Role of grazing in Mediterranean rangeland ecosystems. *BioScience* 48 : 1007–1017.

Pour, H.Z. and Ejtehadi, H. 1997. Grazing effects on diversity of rangeland vegetation: a case study in MoutehPlain, Iran. *Acta Botanica Hungarica.* 40 (1-4): 271–280.

Research Institute of Planning and Agricultural economics 1998. Complete studies for rehabilitation and development of agriculture and natural resource in the basins of rivers of Kor and Sivand, Shapur and Dalaki, Mond and Saheli of Persian Gulf: Livestock report. Ministry of Agriculture, Iran.

Shaoliang, Y.I., Ning, W.U., Peng, L., Qian, W., Fusun, S., Geng, S. and Jianzhong, M. 2007. Changes in Livestock Migration Patterns in a Tibetan-style Agropastoral System. *Journal of Mountain Research and Development.* 27(2) : 138-145.

Smith, B.D. 1995. The Emergence of Agriculture. Scientific American Library, New York, NY.

Snyman, H.A. 1999. Short-term effect of soil-water, defoliation and rangeland condition on productivity of a semi-arid rangeland in South Africa. *Journal of Arid Environments.* 43: 47–62.

Soderstrom, B., Part, T. and Linnarsson, E. 2001. Grazing effects on between-year variations of farmland bird communities. *Ecological Applications* 11(4) : 1141–1150.

Taddese, Y. 2001. Land degradation: A challenge to Ethiopia. *Environmental Management* 27 : 815-824.

Warren, A., Sud, Y.C., Rozamov, B. 1996. The future of deserts. *Journal of Arid Environments* 32 : 75-89.

Wilson, E.O. 1992. The Diversity of Life. Belknap Press, Cambridge, MA, USA.

Yates, C.J., Norton, D.A. and Hobbs, R.J. 2000. Grazing effects on plant cover, soil and microclimate in fragmented woodlands in southwest Australia: implications for restoration. *Austral Ecology.* 25 (1): 36–47.