RANGE SUITABILITY MODEL FOR LIVESTOCK GRAZING

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Abstract

This paper follows FAO model of suitability analysis. Influential factors affecting extensive grazing were determined and converted into a model. Taleghan rangelands were examined for common types of grazing animals as an example. Advantages and limitations were elicited. All range ecosystems' components affect range suitability but due to the time and money restrictions, the most important and feasible elements were investigated. From which three sub models including water accessibility, forage production and erosion sensitivity were considered. Suitable areas in four levels of suitability were calculated using GIS. This suitability modeling approach was adopted due to its simplicity and the minimal time that is required for transforming and analyzing the data sets. Managers could be benefited from the model to devise the measures more wisely to cope with the limitations and enhance the rangelands health and condition.

Keywords: extensive grazing, land evaluation, modeling, range suitability, Taleghan.

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INTRODUCTION

Rangelands have different functions like forage and by-products supply, wildlife habitat function, regulative function, recreation, non-use / Intangible values including preservation of endangered species and anthropological sites. These different types of land-use are often mentioned as multiple-use (Heady & Dennis Child, 1994). Meanwhile, allocation of limited rangeland resources to various land uses, lack of sufficient environmental policies for sustainable use of rangelands as well as degradation of these areas have caused increasing concern among managers and revealed the importance of land suitability analysis (Jafari & Zaredar, 2010).

Combining land and land use in a land evaluation procedure gives land suitability, defined as the fitness of a land unit for a land use type which is assessed by comparing land use requirements of each land utilization type with land (FAO, 1991). Land suitability analysis is one of the most important tools in making locational and siting decisions as a part of planning studies (Ricketts *et al.*, 2004). Broadly defined, land-use suitability analysis aims at identifying the most appropriate spatial pattern for future land uses according to specify requirements, preferences, or predictors of some activities (Hopkins, 1977; Collins *et al*., 2001).

In this study, rangeland suitability for extensive grazing was considered as one of the most rampant uses of rangelands. Assessing suitability for grazing not only decreases the risk of degradation but also could open a space for debating other usages of rangeland for range managers.

In most of the cases studied, the criteria for rangeland suitability assumed for livestock grazing are categorized into 3 sub-models of forage production, water (accessibility, quantity and quality) and soil erosion vulnerability (Arzani *et al.*, 2006; Javadi *et al.*, 2008; Amiri, 2008, 2009). Ayoubi and Alizadeh (2006) evaluated range suitability for livestock grazing qualitatively (plant access to moisture, saltiness and the amount of sodium, physical hampers against root expansion, range accessibility and water accessibility) and found that slope, moisture accessibility, outcrops and water accessibility were the limiting factors. Dvaran *et al.* (2009) analyzed goat production suitability in Turkey and explain that erosion, destruction of shoots and branches and forest degradation are the most important limiting factors. Javadi *et al.* (2008) assessed rangeland suitability for camel grazing and found that water accessibility, severe erosion and low forage production as the most effective factors on suitability. Arzani *et al.* (2006) studied sheep grazing suitability in four regions and found that slope, water accessibility and erosion mostly affected range suitability within these regions. Oberlie and Bishop (2009) presented a model for cattle grazing suitability, including slope and water remoteness as the important factors.
This study is about to define influential factors on rangeland suitability for extensive grazing, proposing a model, and classifying rangelands suitability and finally define declining and limiting factors for extensive grazing.

MATERIALS AND METHODS

Study area

Taleghan as a semi-humid region was selected to conduct this research. Sheep grazing was considered. Taleghan is located between 36°5´19" to 36°19´19" north latitude and 50°36´43" to 50°53´20" east longitude.

Methods

This study is based on FAO (1991) model for extensive grazing evaluation. The main steps of this suitability assessment model are as below:

Defining land requirements

The land conditions necessary for successful implementation of land utilization types are known as land use requirements, and are expressed in terms of land qualities or in a negative manner as land use limitations. These are conditions that adversely affect the potential of the land for supporting a certain utilization type.

Table.1 Land requirements, studied in this paper

	Land qualities	Studied characteristics
1	Erosion vulnerability	Slope, land-use, petrology, pedology, soil erosion, range condition
2	Forage production	Allowable forage, grazing capacity, range condition, range trend
3	Water resources	Water accessibility, quantity and quality

Factors rating

A factor rating is usually given in terms of four classes with critical values attached to each, as follow:

Table.2 Factor rating of land characteristics

No	**Rates**	**Meaning**
1	S1	Highly suitable
2	S2	Moderately suitable
3	S3	Marginally suitable
4	N	Not suitable

Combining land suitability ratings and determination of final suitability

There are three different methods of combining land characteristics ratings, but in this study the limiting condition assessment was considered. The simplest method and often the most appropriate, is provisional classification. In this method, land requirement that took the lowest suitability, would be the overall suitability for that land unit.

Soil erosion Sub-**model**
Most of soil erosion studies use empirical models owing to the insufficient data availability. MPSIAC method was used for soil erosion assessment (Amiri, 2008). In the MPSIAC method, nine factors are evaluated including surface geology, soils, climate runoff, topography, ground cover, land type, upland erosion and channel erosion/sediment transport in each catchment. Each factor is evaluated independently and assigned a rate. The nine values are then summed up for a total rate. Arzani *et al.* (2006, 2008) in their studies revealed that MPSIAC method is more beneficial and practical in Iran owing to considering more influential factors than EPM method. Askari *et al.* (2007) found that MPSIAC method's result were more precise than EPM method in Konjancham watershed.

Water accessibility Sub-**model**
Water resources suitability consists of 3 sub-models including: water remoteness, quality and quantity. In this study, location, quantity, quality and remoteness of water resources in each traditional boundaries were determined.

Water accessibility sub-model
Firstly, slope maps of the study areas were classified and water remoteness in each slope class was calculated and the related map was extracted using GIS (ArcGIS 9.3). Overlaying both maps led to the final water accessibility model.

Water quantity sub-model
In this step, location and discharge of water resources was determined and summed up within each traditional boundary to calculate water availability. Comparing animal water demand and available water in each traditional boundary, results in the water quantity suitability sub-model. Animal water demand was estimated according to the climatic conditions, vegetation characteristics, grazing season and animal type.

Water quality sub-model
Water quality data of water resources (EC, TDS[1], Mg, SO_4, TH[2], NO_3) was acquired from local office and compared with standards to determine water quality suitability within each traditional boundary. Finally these three sub-models were integrated to make the final water resources suitability Sub-model for extensive grazing.

Forage production Sub-**model**
In the study area, forage production (with double-sampling method) and rangeland condition and trend were determined. With respect to field studies, the plants of floristic list of the vegetation types were assigned a palatability class for sheep grazing. Combining range condition, trend and erosion state in each vegetation type resulted in forage allowable use coefficient. The available forage in each type was calculated as follow (Eq. 1):
Available forage for animal (Kg DM*/ ha) = Forage Production (Kg/ha) × Palatability or Allowable use coef. (%) (1)

(* Dry matter)
Finally comparing the available forage with required forage level shows the forage production suitability.

RESULTS AND DISCUSSION

In this study which covers a wide climatic area, topographic and geographic conditions, a model for range suitability assessment for extensive grazing of sheep as dominated grazing animal in Iran was elicited. Three limiting conditions for extensive grazing according to FAO (1991) have been taken into account as pointed out. For each given criteria, a Sub-model is proposed. Fig. 2 to 5 shows the relative components and final suitability model.

[1] Total Dissolved Salts
[2] Total Hardness

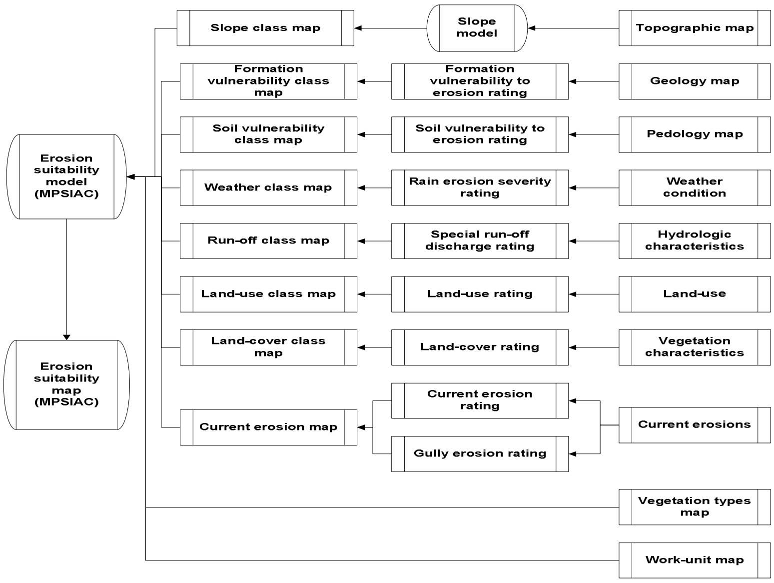

Fig 2: Erosion evaluation Sub-model based on MPSIAC method

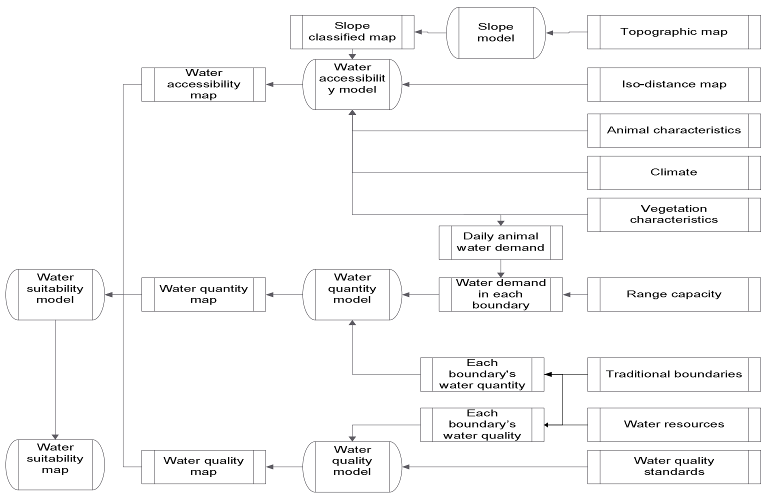

Fig 3: Water accessibility Sub-model

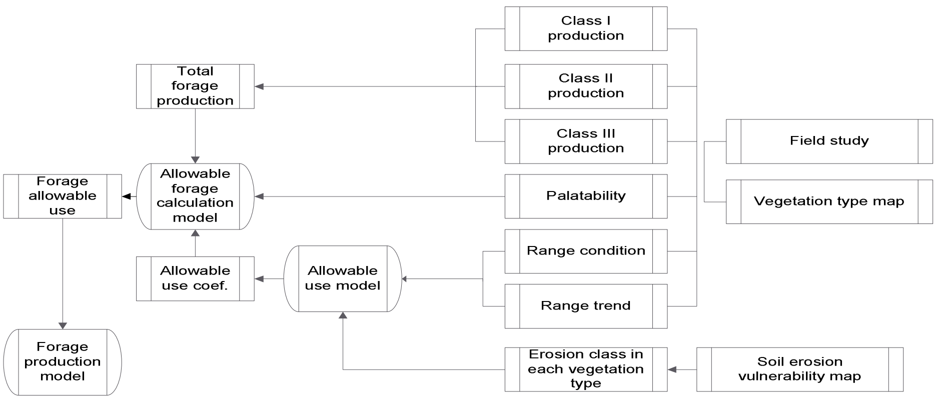

Fig 4: Forage production Sub-model

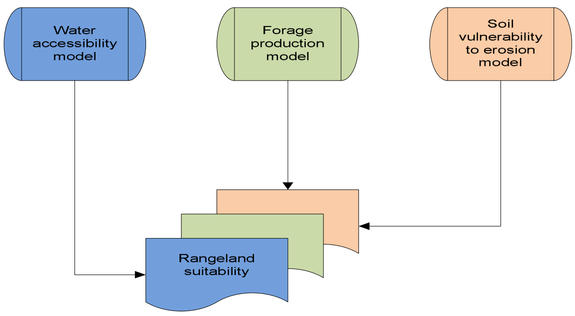

Fig 5: Final suitability model

Results of integrating three sub-models of erosion vulnerability, water resources suitability and forage production suitability are summarized in table 2.

Table 2: Final suitability results according to the presented models in Taleghan regions

Suitability class	Taleghan (Hectares)
Livestock	Sheep
S1	690.48(2.7%)
S2	13228.02(51.6%)
S3	7328.52(28.6%)
N	4327.92(17.1%)
Total	25575(100%)

The model applied in the region and the suitability maps were produced. ArcGIS 9.3 was used to produce suitability maps. Figure 6 show the three sub-models of erosion, water and forage suitability those were combined to produce final suitability map.

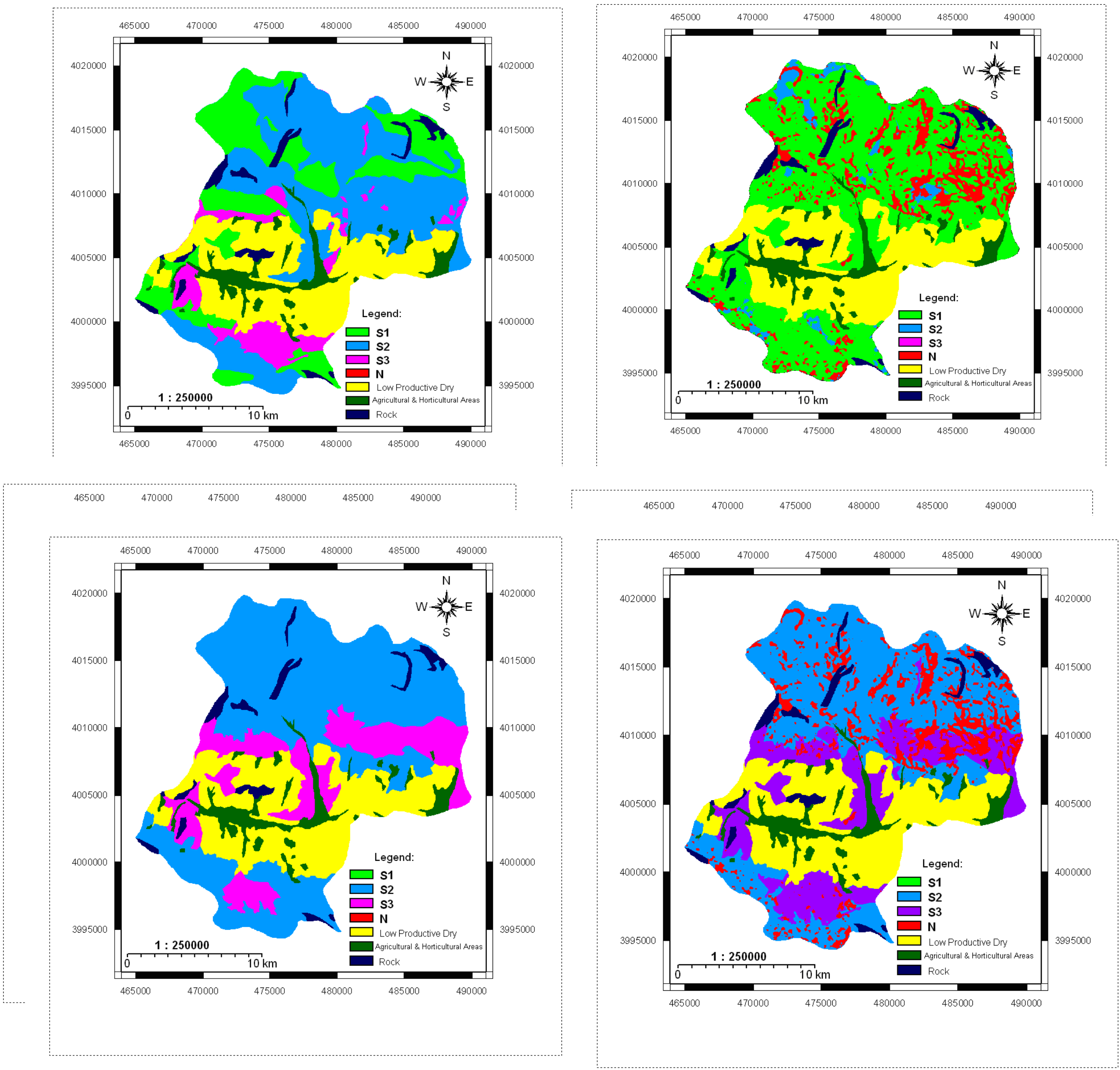

Fig. 6: Taleghan region sub and final models for extensive sheep grazing suitability

In terms of forage production there is no order of no-suitability in the area. More than 53% of the region is devoted to the suitability classes of S1 and S2. This shows the potentials of the region for sheep extensive grazing. Beside, climatic condition and following utilization level help the matter. The only limitation in forage productivity was early grazing. This is in agreement with findings of Arzani (2008). There was no limitation in terms of water quantity and quality in the area. All water resources were in the suitability class of S1. The only limitation of water resources was accessibility limitation in steeped areas. Similar problem was reported by Jankjue (1996) and Fashtami (2002) for central areas of Alborz in Iran. In this region the most pertinent limiting factor for erosion vulnerability was slope, convering rangelands into dry farming and presence of geologic formations sensitive to erosion. Most areas are classified as S2. So grazing limitation is not serious in the region. As early grazing was recognized as a problem, grazing management could be the solution, as Curran and Grice (1992) suggested. Also appropriate grazing systems should be applied to reduce undesirable species in vegetation composition.

In this study different limitations and opportunities for extensive grazing were examined. Meanwhile, we represented a comprehensive attitude towards extensive grazing, but one should know that grazing is one of the uses readily available for rangelands. As FAO (1991) argues, different land units have different qualities for certain utilizations. As might be understood, rangelands' utilizations comprise certain qualities and criteria that the model prepared to assess suitability, must consider. Moreover, multiple uses could be substituted with single utilization in order to gain sustainability in resources and gain ultimate but sustainable benefit.

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