Assessment of water resource potential for common use of cow and goat by GIS (Case study: Boroujerd Rangeland, Sarab Sefid, Iran)

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Abstract. One of the most important factors to sustainability utilization of natural potential by rangeland grazing suitability is water resources suitability. This study is a model for quantitative, qualitative and spatial distance assessment of water resource's propriety for goat and cow grazing based on geographic information systems (GIS) in Boroujerd Sarab Sefid rangeland, Lorestan province, Iran 2013. In this research from combining three factors such as quantity, quality and water resource's distances; the final model of degree of propriety of water resources for goat and cow grazing is characterized. Results showed that slope factor was the reason of limitation, and it is considered as a limiting factor in propriety of water resources, so in terms of access to water resources for goat grazing, 4856.4 ha (100%) located in S1 classes and for cow grazing, 4023.14 ha (68.6%) located in S1(suitability) classes, 1,187 ha (20.24%) in S2 classes and 654.8 ha (11.16%) located in S3 classes, respectively for both. So according to the results the rangelands in this region are most suitable for goat because of terrain and weather but this, in combination with, cow hasbandry will allow diversity of economic production and stability of incomes.

1. Introduction

Correct management in rangeland ecosystem needs recognizing water, soil and plant resources, which are basic resources for production. So, one of the most important factors in analysis and evaluation of rangelands is utilization based on those potential and abilities. Recognition of factors affects those, and has crucial importance to desirable suitable management of rangeland. One of the main problems of developing countries such as Iran is utilization of natural resources area without ecological situation and its potentials consequently destruction of soil, water and plant as the most significant basis of suitable production. Most areas of Zagros Mountains include rangelands which most of them have not suitable quality and quantity forage, also access to water resources, cause more erosion for requirement of providing water and forage of livestock. These factors affected by rangeland utilization history [25]. FAO guided a standard evaluation system for assessment of land. In 1972 its background prepared and in the next year the first format was written, then final format of land evaluation issued in 1976. Subsequent issued guides of land for different land usages such as dry farming [11], forestry [9], dry land farming cultivation [12] and expanded grazing evaluated [10]. First of all need to suitable uses and land resources balancing, more information and its utility to different systems relevant to the earth such as natural resources in the FAO guides then nature of dynamic and those changeable, cause human to use new methods and electronically instruments [22]. RS and GIS methods are the new
sciences as well as nano technology that are vastly used in natural science [23]. Suitable utilization of rangeland need to recognize its parameters, therefore determination of rangeland suitability is one of the most significant factors and more difficult to rangeland analysis [26]. 70 percent of Iranian livestock rely on rangeland, so for better using of rangeland potential, it is needed to investigate the limitation and none limitation of animal grazing in rangeland suitable determination which one of them is water resource, therefore Boroujerd Sarab Sefid region is selected according to more number of livestock like cow and goat. Besides in using rangeland forage for grazing of livestock there must be enough water to drink during grazing season that causes maximizes using of forage by livestock for producing animal products [29]. In some cases there is enough water but its propagation is not good, therefore animal cannot use all of the forage in rangeland [28]. In fact it is important to provide enough water for drinking livestock and wildlife. As a general rule one of the effective factors in site selection of grazing is water distance [20]. Livestock and wildlife often more graze plants in the vicinity of water [7]. When water is the most significant limited factor for using forage, it affects on animal movement, so it is important for management of rangeland to find distance of animal to water resource which must cover the distance and amount of forage uses in the course of movement [30]. Generally access ability to water resource depends on maximum distance where livestock can be far away from water resource to forage grazing. The distance depends on topography, utilization season, age and kind of animal and plant coverage [3]. Several factors affect on water consumption such as kind, age and breed, topography, quality and quantity of forage accessibility, grazing season and distance from water [6]. Water with more salinity or with poisonous elements may endanger animal health or make meat and milk uneatable. Also water with unsuitable quality affects on forage productivity. To determine usable water we must consider area situation, age and breed of animal and nutrition composition [21]. In fact animals prefer to drink fresh water [25]. The aim of this study was conducted to preparing water resource sustainable model to cow and goat based on FAO method (1991).

2. Materials and Methods

2.1. Study area
Sarab Sefid rangeland under study is located in west of Boroujerd city in Lorestan province, Iran (48° 27’ 46” to 48° 36’ 30” E and 31° 53’ 33” to 33° 58’ 24” N) comprises of 5,864 ha (58.6 Km2) of which 3.78% of Boroujerd township (Figure 1). The average mean of annual precipitation (20 years) of the area is 450.9 mm, falling mainly in the autumn and winter. The average minimum and maximum temperatures are 11.5°C and 39.2°C, respectively. Its climate based on Henry Pabo (Senior expert of FAO) is located in Iran-Toran (High Mountain Region). The mean height at the sea level is 2,744 m and the minimum and maximum are 1,947 and 3,451 m, respectively.

2.2. Water resources of the area
Permanent river in the basin is Sarab Sefid, that is categorized too many main secondary rivers. Its direction is from south west to north. Seasonal springs in the area are so many. To determine contour distance map from water resources first, distance from water resources map was prepared (Figure 2).
2.3. Criteria of water resources suitability

Three sub models such as: distance, quality and quantity were used (Figure 3). According to these sub models in each types of rangeland and combine them together, water resource suitability in the area for goats and cows grazing determined.

2.3.1. Water accessibility sub-model

The slope map of the study areas was classified and extracted by using ArcGIS®9.3. Overlaying both maps (slope and distance) led to the final water accessibility model. The distance from water resources suitability classes in livestock (goats and cows) usage are illustrated in ‘table 1-2 and (Figure 4-5).

| Suitability class | Slope class (%) |
|------------------|----------------|
|                  | 0-15 | 15-30 | 30-45 | >45 |
| S1               | >3000| >2000 | >800  | N   |
| S2               | 3000-4000 | 2000-3000 | 800-1500 | N   |
| S3               | 4000-5000 | 3000-4000 | 1500-2200 | N   |
| N                | >5000 | >4000 | >2200 | N   |
Table 2. Water Resources distances (m) and its suitability for grazing goats classes.

| Suitability class | Slope class (%) |
|-------------------|-----------------|
|                   | 0-15 | 15-40 | 40-75 | >75  |
| S1                | 0-4200 | 0-3700 | 0-1200 | N    |
| S2                | 4200-6200 | 3700-6000 | 1200-4500 | N    |
| S3                | 6200-8000 | 6000-7500 | 4500-5100 | N    |
| N                 | >8000  | >7500  | >5100  | N    |

2.3.2. Water quantity sub-model
Water resources were determined and summed up within each types of plant boundary to calculate water availability. For each livestock water demand with available water indicates the results in the water quantity suitability sub-model. Based on climatic conditions, vegetation characteristics, grazing season and animal type such as goat and cow water demand were estimated. Categories were determined by comparison of the available water with the water needed by the livestock (Table 3).

Table 3. Water resource suitability classes.

| Available water in pasture ration to livestock need (%) | >76 | 51-75 | 26-50 | <25 |
|-------------------------------------------------------|-----|-------|-------|-----|
| Suitability classes                                   | S1  | S2    | S3    | N   |

2.3.3. Water quality sub-model
Water quality data of water resources such as: [Acidity (pH), Electrically conductive (EC), Total Dissolved Salts (TDS), Sodium (Na), Claire (Cl), Bicarbonate (HCO3-), Magnesium (Mg), Sulphate (SO4), Calcium (Ca), Total Hardness (TH), Sodium absorption ratio (S.A.R), Potassium (K+)] were acquired from local offices, Boroujerd water management and other researches and compared with standards to determine water quality suitability.

3. Results
Based on previous studies and field experiences, three limiting conditions for grazing (FAO 1991) were taken into account.
Results show that based on the water resources quality and considering the water quality, there were no limitation in the range area in question, and the whole range area fell within the S1 suitability category. Also results show that Total Hardness (TH) based on standard is good for cows and goats. These results are similar to Cl, pH (7/8), NO3 (4/4), EC (235mimhos per cm), TDS (140/8 mg/lit) and other factors except SO4. For the last factor (SO4) there is a little limitation for drinking by goat and cow. The results revealed that there were no limitations for the amount of water in the region, so all of
them fell into the S1 suitability category, because of high precipitation of the region which is more than 700 mm per year (annually) and it has good intensity during year. In mountain and high elevations precipitations are most as snow and cause to save it, and its result is producing spring in the basin which is suitable water quantity for cows and goats local breed. In this basin there is enough water during grazing season for livestock and wildlife and it is more than water needed based on determined grazing capacity.

The results of the sub-model on the distance from water resources suitability for goats grazing revealed that 5864.8 ha (100%) located in S1 classes and about cow grazing, 4023.14 ha (68.6%) located in S1 classes, 1187 ha (20.24%) in S2 classes and 654.8 ha (11.16%) located in S3 classes, respectively (Figure 6-7) and Table 4.

Table 4. Area of categorize of distance form water resources suitability for cows and goats.

| Categorize of suitability | Area (ha) | Area (%) |
|--------------------------|-----------|----------|
| For goats                |           |          |
| S1                       | 5864.8    | 100      |
| S1                       | 4023      | 68.6     |
| For cows                 |           |          |
| S2                       | 1187      | 20.24    |
| S3                       | 654.8     | 11.16    |

Final water resources suitability
Results show that there is no problems regarding the quantity and quality of the water resources; it was only the distance from the resources that mainly determined the suitability of the rangeland with respect to water resources for cow (Figure 7).

Figure 6. The model of water resource suitability for goats.

Figure 7. The model of water resource suitability for cows (final model).

4. Discussion
Iran is one of the dry countries that medium precipitation in annual is about 230mm, so water is important for agriculture and renewable resource management. Zagros Mountains chain is main resource for animal husbandry. Keit (2000) showed that for determining water resource suitability for cattle grazing assessment of two factors is needed such as slope, number of water resources, steep slope and suitable distance from water resource. Result of present study was similar to Keit research in which his study pointed out to significant factors to suitability. In studies of Jangjoo Borzelabadi (1996), Mohtashamnia (2000), Yoosefi khanghah (2004), Arzani and Yoosefi (2006), for determining animal grazing suitability carried out three factors such as forage production, water resource and soil sensibility based on FAO (1991) method that the present research path same method and showed the same results. Minor (2002) for determining rangeland grazing capacity of Fergosen-California region used RS and GIS abilities. He applied three sub-models such as plant coverage, slope and precipitation.
for determination of final model of grazing capacity and declared that the results by GIS had acceptable accuracy for management of rangeland. The results are based on Paul Tueller and Reno Nevada (2001) opinion in for using RS technique to investigate rangeland forage production. The results of the study showed that the quantity (number of permanent water resources), quality and the distance from the water resources did not impose many limitations on the rangelands suitability for grazing livestock. However, the steep slopes along the livestock path to the water resources resulted in the formation of an ‘unsuitability’ category for livestock. Valentine (2001) reported on the importance of the slope factor in reaching the water resources, and declared that by increasing the slope the ability to graze decreases and increases the livestock demand to expend lots of energy. The quality and quantity of the water resources in the rangeland did not impose any limitations. The result of the research indicates the slope as the reducing and sometimes limiting factor in the range suitability. Hence, the slope factor is of considerable importance in determining the suitability of the pasture for grazing. As slope increases the water retention time on the ground decreases, the rate of penetration decreases, and the amount of water run-off increases. Cook (1954) explained that on slopes of more than 60 degrees little forage is grazed. Amiri (2009) and Gavili et al., (2011) defined the slopes with more than 60 percent as useless for all kinds of livestock, while [17] reported slopes of more than 60 percent, and Arzani et al., (2006) defined slopes of more than 60 percent as useless for livestock grazing. On such steep slopes wild animals would graze better than livestock. Guenther et al., (2000) in determining the suitability of a rangeland in Australia noted the two factors of slope and water resources as the suitability limiting factors of rangeland for grazing cattle. Due to the existence of numerous permanent water resources in Sarab Sefid rangelands, the water resources factor does not impose many limitations on the suitability of the rangeland. However, the slope factor in reaching the water resources in limited areas of the rangeland was a suitability limiting factor. It should be noted that the present study was similar to results reported by [16]. Finally should told that water is first factor to development of livestock husbandry that the study area is most suitable for goat.

5. Reference

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