Rangeland Sustainability Modeling Using Soil Exposure and Soil Moisture Parameters

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Introduction In semi-arid rangelands such as the sagebrush-steppe of southeastern Idaho, USA, the limiting factor for range productivity is moisture, specifically soil moisture (Thomas and Squires 1991). Furthermore, the degree of soil exposure is a driving indicator of rangeland health (O'Brien et al. 2003). Modeling rangeland sustainability then requires the use of reliable soil moisture and soil exposure component models as the foundation for all subsequent work. The goal of this study was to develop and assess these soil moisture and soil exposure component models using field observations and measurements coupled with satellite remote sensing classification and geostatistical interpolation techniques.

Materials and methods The study area is located in the semi-arid sagebrush-steppe rangelands of southeastern Idaho, USA. Percent cover estimates and soil moisture measurements were acquired for 150 stratified random sampling points using a point-intercept method. SPOT5 satellite imagery (acquired concurrent with field sampling) was classified using Idrisi Andes software to produce a soil exposure component model using maximum likelihood classification. To be considered a bare ground presence training site, the field sample had to contain >50% bare soil exposure. ArcGIS 9.2 Geostatistical Analyst was used to produce the soil moisture component model using ordinary kriging interpolation.

Results The bare soil component model achieved 71.28% overall accuracy with Kappa index of agreement of 0.3246. The soil moisture model (Figure 1) cross validation statistics are summarized in Table 1.

Table 1 *Error matrix for the bare soil exposure model developed using maximum likelihood classification.*

	Bare soil Exposure ≥50%	Bare Soil Exposure <50%	Total	User Accuracy	Commission Error
Bare soil Exposure ≥50%	15	17	32	0.4687	0.5313
Bare Soil Exposure <50%	10	52	62	0.8387	0.1613
Total	25	69	94		
Producer's Accuracy	0.6000	0.7536		0.7128 (Overall Accuracy)	
Omission Error	0.4000	0.2464			0.2872 (Overall Error)

Table 2 *Cross validation statistics of soil moisture model developed using ordinary kriging.*

Mean Error	-0.00793
Mean Standardized Error	-0.003888
Root-Mean-Square Error	0.8259
Error Regression	0.665
Average Standard Error	0.7682
Root-Mean-Square Standardized Error	1.134

Conclusions Results indicate that soil moisture can be estimated and modeled relatively accurately using ordinary kriging. To accurately model bare soil exposure (>70% overall accuracy) using maximum likelihood classification requires training sites with relatively high amounts of bare soil exposure (>50%). Maximum likelihood classification used to model bare soil exposure from satellite remote sensing images may not be the best classification method.

References

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