

## CVOR model for assessing the steppe ecosystem health—a case study on the typical steppe in Inner Mongolia , China

WANG Li-Xin , LIU Hua-Min , LIU Zhong-Ling , WANG Wei , LIANG Cun-Zhu , YANG Jie  
 College of Life Sciences , Inner Mongolia University , Huhhot 010021 , Inner Mongolia , P . R . China .  
 E-mail : lx\_wimu@yeah.net

**Key word :** typical steppe , ecosystem health , model , graze , vigor , organization , resilience

**Introduction** The typical steppe region of Inner Mongolia , China extends across 41° to 47° north latitude and 109° to 117° east longitude . C<sub>3</sub> grasses , which include *Leymus chinensis* and *stipa grandis* are dominant species without disturbance . While with the grazing pressure increasing , the number of *Leymus chinensis* and *stipa grandis* decrease , else *Artemisia frigida* and *Cleistogenes squarrosa* increase (Liu et al . 1998) . Based on the concept of "Ecosystem Health" , "Ecological Integrity" , and the theory of information (Ulanowicz 2000) and community characteristics under different grazing pressure , we explored a model for assessing the steppe ecosystem health . This model combines the function , or vigor (V) , structure , or organization (O) and resilience to perturbation (R) of steppe ecosystem and its environmental conditions (C) , which we call it CVOR model . The objective of this study was to provide a synthetic , simple , accurate and suitable method for grassland ecosystem health assessment and management .

**Materials and methods** The site was on the permanent field sites of the Inner Mongolia Grassland Ecosystem Research Station (IMGERS) , located in the Xilin River Basin , Inner Mongolia Autonomous Region , China (1168420 E , 438380 N) . The sites have been fenced-off since 1979 , preventing grazing by large animals . But out of the fence , there is still large animals grazing . Except this site , with contrast , we also select a rangeland which named Xilinhua Pasture located on the southwestern of Dowuzhumuqin County . Firstly , we used *Leymus chinensis* steppe in 1981 as a reference ecosystem which can be representative of undisturbed , climax steppe communities , and then established the calculation formulae for simulating the vigor , organization and resilience of steppe communities . In this model , we used the direct effective precipitation as index reflecting the environmental conditions . Finally , the feasibility of CVOR model was tested by analyzing the influence of grazing pressure and fencing protection on the health of typical steppe ecosystem .

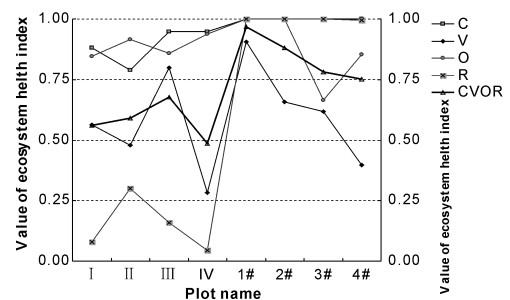
**Results and discussion** In order to compare the CVOR value and reflect the ecosystem health conditions , we used the quartation to distinguish the health condition of different ecosystems (Table 1) . Through analyzing the correlation between CVOR value and other independent index including C , V , O , and R , it shows 0 . 650 ( $p < 0 . 05$ ) , 0 . 710 ( $p < 0 . 05$ ) , 0 . 184 ( $p < 0 . 05$ ) , and 0 . 876 ( $p < 0 . 01$ ) , respectively . Grazing , especially persistent grazing incurs the decrease of biomass production and the change of dominant species in the communities . So it leads to the ecosystem health on the condition of unhealth or alarm . Fencing and cutting also have effects on the condition of steppe ecosystem health . In this study , fencing and mild cutting have the positive effects on the ecosystem health (Figure 1) . This model was developed on the data collected from typical steppe , so it limits to assess this ecosystem . But the method and the calculation formulae can also be used on other steppe ecosystem if selecting the relevant plant species .

**Table 1** Condition of ecosystem health .

CVOR Value	Condition of health	CVOR Value	Condition of health
[0 , 0.25]	Crash	[0.50 , 0.75]	Alarm
[0.25 , 0.50]	Unhealth	[0.75 , 1]	Health

### Reference

Liu Z L , Wang W , Liang C Z et al . (1998) . The Regressive Succession Pattern and its Diagnostic of Inner Mongolia Steppe in Sustained and Superstrong Grazing . *Acta A grestia Sinica* 6 , 244-251 .



**Figure 1** CVOR of the typical steppe ecosystems .

(I ~ III Field site on 1984 , 1994 , and 2004 , respectively ; IV outside of fence on 2004 still free grazing ; 1 # ~ 4 # plots number in Xilinhua Pasture) .