G-1.6 Evaluation of indicators for the monitoring and assessment of desertification in China

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Abstract The objectives of this study are to evaluate the reliability of vegetation indicators of *Leymus chinensis* grassland, a typical grazingland in Inner Mongolia of China. Extensive literature reviews and field investigations were carried out. Results show that the degree of desertification of *Leymus chinensis* grassland can be divided into 4 stages: non-, slight, medium, and serious. As the development of desertification, biomass, quality of grassland, and other parameters changed greatly. The results showed that the desertification causes a significant change on the grazingland, which is mainly due to the change of dominant plant species. Therefore, variation of dominant plant species can be applied as indictors for determining the degree of grazingland desertification. The advantages of this indicator are sensitive, simple, and direct applicable.

Key words Assessment indicator, China, Desertification, Grasslands, *Leymus chinensis*

1. Introduction

To effectively control the expansion of desertification over the world, a practically applicable and sensitive indicator for determine the degree of desertification is highly required, because it is an important issue not only for making policy, evaluating environmental quality, and land management, but also for judging the effects of measures to combat desertification. In addition, indicator of desertification can be used to monitor the effect of policy change on nature resources in a country level. In an international level, the comparison of the indicator among different countries can provide a way for evaluate the environmental quality. Therefore, indicator of desertification is an important factor for the policy-maker, scientist, and the peoples who are suffering damages from desertification.

2. Research Objective

The objectives of this study are to further evaluate the reliability of vegetation indicators of *Leymus chinensis* grassland, a typical grazingland in Inner Mongolia, China.

3. Research Methods

Field experiments were conducted in *Leymus chinensis* grassland in Inner Mongolia plateau, China. Route vegetation investigations were carried out by the methods of random sampling. The sampling areas were 1 m^2 and 100 m^2. Every investigation type had several repeats. The investigation parameters were: composition of plant species, individual number, average plant height, vegetation coverage, percentage of bare land, landform type, current situation of land use.

For several species, the plant individual could not be distinguished easily. Therefore, "plant individual" for these species referred the plant clump. These species were: *Leymus chinensis*, *Artemisia frigida*, *Stipa grandis*, *Cleistogenes squarrosa*, *Koeleria cristata*, *Allium bidentatum*, *Agropyron michnoi*, and *Artemisia commutata*.

All of the plant species in this grassland were divided into 4 groups according to their quality: high, medium, low, and inferior. The group of high quality plant was mainly the large grasses of Gramineae (such as *Leymus chinensis* and *Stipa grandis*), *Allium* spp., and herbs in Leguminose. The group of medium quality plant was mainly the small grass in Gramineae, *Carex* spp., and small bushes. The group of low quality mainly included of *Artemisia* spp. and weeds. The group of inferior quality included the uneatable plants.

4. Results and Discussion

4.1 Evaluation of the indicators

The indicator of desertification has been studied for several decades. In the 1930's and 1950's, researchers in United States, Australia, and other countries attempted to propose indicators for grazingland degradation[1], which could be regarded as one kind of indicator of desertification. After the conference of United Nations on desertification in 1977, researches on the indicator of desertification started to increase[2-5]. However, many of these indicators were liable to be practically ineffective, mainly because these indicator systems were too complex for application purposes[6]. Moreover, these indicators differed greatly according to researcher's different background and different understanding to desertification. Generally, all of them has the following common features: (1) researchers are looking for an indicator system that should be perfect in theory. As a result, their practices value is poor because the suggested indicator systems are too complex for application purpose; (2) these indicators did not take account the relativity of desertification enough. Many indicators only give an absolute value as a threshold to evaluate the degree of desertification. A practically applicable and sensitive indicator to determine the degree of desertification is not yet available.

4.2 Analysis of desertification process in a typical grassland in China

Based on field data, the relationships among community type, plant individual, and environmental factors were analyzed. Then, samples were arranged according to environmental gradient and change of plant species. Finally, the process of desertification of *Leymus chinensis* grassland was divided into 4 stages: non-, slight, medium, and serious. The results obtained from this analysis were summarized as follows:

(1) Changes in dominant species with the process of desertification

We used relative biomass (the ratio of the biomass of each species to the total biomass of the community) as an indicator to measure changes in vegetation. The relative biomass of high-quality plants (*Leymus chinensis* and *Stipa grandis*) decreased continuously as desertification developed. On the other hand, the relative biomass of low-quality herbs (*e.g. Artemisia frigida* and *Cleistogenes squarrosa*) increased.

At the moderate and serious desertification stages, instead of *Leymus chinensis* and *Stipa grandis*, *Artemisia frigida* became dominant. *A. frigida* tolerates grazing because it can form adventitious roots from branches after it is trodden by livestock. Therefore, grassland dominated by *A. frigida* is clearly overgrazed. If it continues to be overgrazed, it will degrade to a poor state with an extremely low utilization value. Therefore, the dominant species can be considered to be indicators of the degree of desertification.

(2) Changes in size of individuals of dominant species with the process of desertification

If grassland was heavily overgrazed over a long period, the height and size of individual plants decreased. The average height of *Leymus chinensis* decreased from 15 cm at the non-desertification stage to 8 cm at the serious stage (approximately 50%). Other species show a similar trend: 33% decrease for *Stipa grandis*, 32% for *Artemisia frigida*, 50% for *Cleistogenes squarrosa*, and 61% for *Artemisia commutata*.

Conversely, the average height of plants gradually increases if the land is allowed to rehabilitate. The recovery of the average height of a whole community during 7 years without grazing: the average height increased by 150%.

A decrease in height and size causes a decrease in biomass. We measured biomass ratios (biomass of minimized individual over biomass of normal individual) of 21.8% for *Leymus chinensis*, 11.4% for *Stipa grandis*, 8.4% for *Artemisia frigida*, 36.5% for *Cleistogenes squarrosa*, and 20.5% for *Artemisia commutata*.

(3) Changes in grassland quality with the process of desertification

As desertification develops, the proportion of high-quality plants decreases and that of low-quality plants increases. This changes grassland quality. We used the synthetic dominant ratio [SDR = (relative coverage + relative biomass) / 2 × 100%] to indicate the characteristics of grassland at each stage of desertification. The SDR of high- and medium-quality plants decreased with increasing desertification. The SDR of medium-quality plants was generally 5% larger than that of high-quality plants. This fact shows that medium-quality plants are the most important component of this grassland. The SDR of low- and inferior-quality herbs increased with increasing desertification. However, because the SDR of inferior-quality plants was <10%, this component would not significantly affect the grassland.

At the moderately and seriously desertified stages, the SDR of low-quality plants became larger than that of high- and medium-quality plants. Because the main species in the low-quality group is *Artemisia frigida*, this species can be used as an indicator of grassland desertification.

(4) Conclusion

The degree of desertification of *Leymus chinensis* grassland was divided into 4 stages: non-, slight, moderate, and serious. As desertification developed, biomass, average plant height, size of individuals of dominant species, and quality of grassland decreased significantly. In addition, the proportion of high-quality plants decreased and that of low-quality plants increased. The dominant species were *L. chinensis* in non- and slightly desertified grassland and *Artemisia frigida* in moderately and seriously desertified grassland. The results show that the quality of the *L. chinensis* grassland degraded seriously and its value as grazing land became very low. This is due mainly to the change in the dominant plant species. Therefore, variation in dominant plant species can be used to determine the degree of desertification of grazing land. The advantages of this indicator are that it is sensitive, simple, and directly applicable.

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