Some pasture changes in the Eastern Steppe of Mongolia

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Abstract. Significant vegetation changes have been recorded in Mongolian steppe types such as Speargrass- *Cleistogenes*, *Cleistogenes*-Forbs and *Filifolim sibiricum*-Speargrass and these changes have been attributed to climate factors rather than human activity. Species dominance in those pasture types exhibited change that was linearly related to the degradation ratio. For example, Speargrass, which is a dominant species in the steppe and is seen as a preferred species for building sustainable grasslands, is slowly losing dominance in the eastern steppe grassland type due to heavy degradation and is replaced by a range of sedges. During the years of this study (2000 to 2008), records from the nearby weather stations of Matad, Choibalsan and Dashbalvar showed a warming and drying trend with a 2-4^{o}C increase in mean annual temperatures, an increase in maximum and minimum temperature extremes, and delays of rains during the summer growth season. Pasture type changes included: shift in species dominance from healthy grassland to degraded plots (low, medium and heavy) as indicated by changes in species diversity, species frequency, decreased land cover, canopy cover, basal cover, plant height and biomass. Vegetation changes or degradation is most pronounced around settlements (2-3 km radius), but degradation is less severe with increasing distance from the settlements. This study defines the measurement criteria most suited to detecting degradation in the Eastern Steppe grasslands.

Keywords: Rangeland health, degradation, species frequency, canopy cover, basal cover, vegetation changes.

Introduction

The minimum standard for rangeland management should prevent human-induced loss of rangeland health. Rangeland health can be defined as the degree to which the integrity of the soil and the ecological processes of rangeland ecosystems are ensured (Chognii 2001). Mandakh *et al.* (2007) report that currently 72% of the total area of Mongolia has been degraded due to the combined effects of climatic change (*e.g.* increasing temperature, decreasing amounts of precipitation) and human impacts (*e.g.* increased numbers of livestock which are mainly concentrated around the settlements and water bodies). These factors are believed to be the main reasons for rangeland degradation in the Steppe.

The area within 2-5 km of the main settlements support unique steppe communities and occupy 25.6 % of the total territory of Mongolia (Dashnaym 1974). While the evaluation of these degraded areas has been undertaken using many different methods for many years, no single method stands out as being the best to identify benchmarks for detecting degradation and monitoring grassland rehabilitation. Consequently, the main goal of this study was to define benchmarks for degradation using key characteristics of rangeland health, including species composition, species frequency, basal, canopy, and vegetation covers, plant height, phytomass and soil surface characteristics (soil movement, litter accumulate-ion and pedestalisation). The study also examined the usefulness of the Step-point method (Evans and Love 1957) for evaluating rangeland changes as one option of the Line-point methods.

Material and methods

This study was undertaken in three plant communities classified by their dominant species present in their less degraded state: (1) Speargrass-*Cleistogenes*; (2) *Cleistogenes*-forb and (3) *Filifolium sibiricum*-Spear-grass. These communities were located in the steppe zone in Eastern Mongolia at Matad, Herlen and Dashbalvar districts (or soums) of Dornod Province (or aimag). The study locations were characterised by black brown, brown, and light brown soils with humus layers between 2-50 cm deep.

Field surveys were carried out during the 2000, 2003, 2004 and 2008. Each monitoring site was set up within 2-5 km of major settlements, and consisted of three transects each 150m long. The data was collected along transects using a step-point method derived from line-point intercept (Heady *et al.* 1959). Five steps from the start of each transect a 1 m length stick (with 25cm increments marked on it) was used to measure canopy cover (no canopy, grass, sedge, forbs, and shrubs), and basal cover (bare ground, litter, grass, forbs, sedge and shrubs) at each increment. Darts were laid on the ground perpendicular to the meter stick and species height and species frequency was also measured. After each 20 entries, a 50x50 cm grid-frame quadrat was laid down on the ground to the right side of the meter stick, between 25 cm and 75 cm marks along the stick. In this frame-quadrat we measured vegetation cover (bare ground cover, cover of green plants, litter/other) and then counted the number of plant species present.

At each site, monitoring sites were selected to represent a range of conditions within the grassland types, namely, controls where the original species of the grassland type were still dominant to heavily degraded areas where the grassland was dominated by species either not present or present only as minor components in the control areas. Areas of low and medium degradation were identified between these extremes.

Summary of findings and results

Species number

Across transects within plant community types we found a wide range of species diversity. For the Speargrass-*Cleistogenes* grassland type, there were 63 species present, representing 24 families which was similar to the *Cleistogenes*-forbs where there were 60 species representing 25 families. However, *Filifolium sibiricum*-Speargrass grassland type was more biodiverse with a total of 99 species identified as belonging to 28 families. However, in terms of the number of species present there was little difference between the relatively ungrazed control sites and those categorized as heavily degraded. Therefore, an enumeration of species alone was a poor indicator of either the level or rate of degradation in these three grassland types.

Frequency, cover, biomass and height

Analysis was undertaken to assess the efficacy of species frequency, canopy and basal frequency and biomass for plant functional groups or individual species to delineate stages of grassland degradation. Only results for the Speargrass-*Cleistogenes* grassland type are presented here.

Species frequency emerged as a better measure of grassland degradation rate. For example, in the Speargrass-*Cleistogenes* grassland, species frequency effectively delineated grassland condition within the type. In control plots, *Stipa krylovii* which accounted for 34% of species frequency contributed only 9% to 5% to species frequency in grasslands that were low to heavily degraded (Fig. 1). Figure 1 also shows that degradation can be effectively tracked by using species frequency to identify the dominant species with *Cleistogenes squarrosa* (17%) dominant at low degradation, *Leymus chinensis* (23%) at medium degradation and *Carex duriuscula* (21%) at heavy degradation. In effect, these species become the indicator of change that readily equate with the level of degradation.

Overall, canopy cover based on plant functional groups (*e.g.* perennial grass, annual grass, perennial forbs, annual forbs, sedges and shrubs) were not reliable at delineating the stages of degradation in the Speargrass-*Cleistogenes* grassland. For example, the results showed that perennial grass canopy cover ranged from 50% in the control plot to 30% in the heavy degraded plot with low and medium averaging 40%. Analysis of this data detected no significant difference between perennial grass cover between the three degraded sites but did

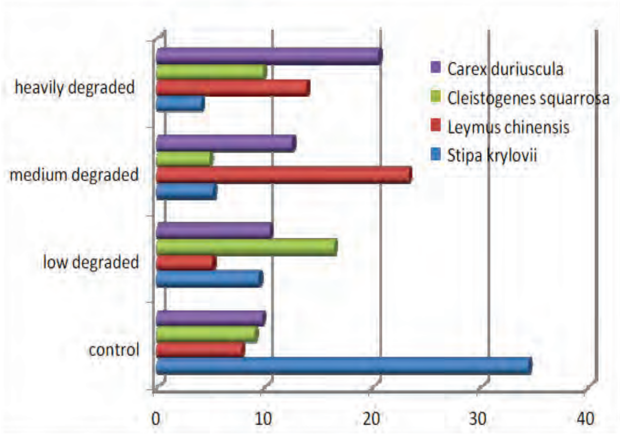

Figure 1. Species frequency (%) in the Speargrass-*Cleistogenes* community.

detect a difference between the good condition control plots and the most degraded areas. However, in general the results indicate that reliance on canopy cover to define the degradation continuum is risky since canopy cover is too dependent on the level of precipitation or temperature conditions experienced within a single growing season or part thereof. Shrub canopy and basal cover (frequency), both of which respond slower to incident climatic conditions may provide a better measure of degradation.

Like canopy cover, increases and decreases in biomass of plant functional groups reflect annual precipitation, rather than long there shifts in grassland composition and diversity. For example: in the dry year (2004), the contribution of perennial grass to total sward biomass in the control plot was 40% whereas in more normal years perennial grass accounted for 70-80% of total sward biomass. Although biomass is a crucial factor in determining annual and season carrying capacity, it has proved to be a poor determinant of the level or rate of degradation irrespective of whether it is based on plant functional group or dominant species due to confounding effects caused by precipitation.

Plant height and soil surface changes did not appear to be relevant variables to detect changes between healthy and degraded plots.

Conclusions

One of the major challenges with early detection of the degradation pathways in grasslands is to use simple methodology that can used with confidence on a range of grassland types and by operators with limited knowledge of ecology. This is certainly the case in Mongolia where it is an imperative that livestock households have sufficient skills to detect both degradation and improvement in their grazing lands. Step-point sampling is a method that requires little equipment (a simple "pointed stick" or a mark on the point of one's shoe). As applied in this study, step-point sampling proved to be a reliable method to collect the grassland data needed to delineate levels of degradation. In particular, species frequency emerged as the parameter most able to describe the level and rate of degradation rate in the Eastern Mongolian steppe grassland types using a dominant species approach. However, canopy and basal covers biomass, plant height and soil features were not good variables to measure differences between healthy and degraded plots. We believe that step-point sampling combined with tutorials in identification of the most important species present in the three grassland types study would empower herders with tools to assess changes in grassland condition using species frequency. However, we acknowledge that since step point sampling is based on assessment at a minute point rather than a quadrat it is not a suitable technique to use for repeated measurement of the same quadrat. However, provided sufficient points are sampled, change in composition can be assessed over time by returning to the same general area using a GPS reference point.

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