Defining the Ecological Site Descriptions and its Use as a Rangeland Management Tool in Mongolia

Bulgamaa Densambuu[1,2], Budbaatar Ulambayar[3,4], Ankhtsetseg Battur[3], Sunjidmaa Sainnemekh[5,6], Gankhuyag Nyam-Ochir[3], Brandon Bestelmeier[7,8]

[1]Swiss Agency for Development and Cooperation, Green Gold Project, Mongolia
[2]<Bulgamaa@greengold.mn>
[3]Research Team of Agency of Land Affairs, Geodesy and Cartography,
[4]<ubudbaatar.ub@gmail.com>
*5*Institute of Meteorology, Hydrology and Environment, Mongolia
[6]<Sumjidmaa@gmail.com>
[7]USDA-ARS Jornada Experimental Range, New Mexico, USA
[8]<bbestelm@ad.nmsu.edu>

ABSTRACT

The concept of classifying any area into ecological sites, according to that area's productivity, based on varying soil, climatic and hydrological conditions, and its capacity to endure different intensities of use and to recover from degradation, and of using this classification as a basis of rational use of natural resources is more and more recognized internationally.

Since 2009, the Green Gold Project funded by the Swiss Agency for Development and Cooperation (SDC) has been exploring opportunities to develop the ecological site description (ESD) concept for Mongolian rangelands and use it as an essential tool of rangeland management. Based on soil, vegetation and geomorphological data collected from approximately 500 points representing nationwide environmental zones, we developed the ESD concept for the Mongolian context. According to this concept Mongolian rangelands are divided into some 20 zones, representing distinct ecological potentials. Based on these plot data and state and transition models a preliminary conclusion is made that over 65 percent of Mongolian rangeland has, with varying degrees, altered from its reference state, and 80 percent of this area has potential to recover through changes in rangeland management.

The main objective of this research was to identify, for each environmental zone, the main factors that determine rangeland ecological potential, to develop the ESD concept and to test the possibility of using it in rangeland management. The novelty of this study, as well as its scientific and practical significance, lie in development and testing of a more detailed classification based on ecological potential within Mongolian ecological zones and geo botanical regions. This approach is significant because the classification may be used as an essential tool for rangeland use planning, implementation and monitoring, as well as for regulating rangeland use agreements.

Keywords: rangeland ecological potential, rangeland state and transition models, rangeland recovery class classification

STUDY SITES

Field research for determining rangeland ecological potential (ESDs) and the main defining factors was conducted between 2009-2012, at approximately 500 points representing nationwide ecological zones. The monitoring research for the purpose of testing proposed versions of the concept of ecological capacity was undertaken between 2012-2014, in four *soums* representing a range of environmental zones in Mongolia, under the auspices of Pasture Users Groups or PUGs formed in the frame of Green Gold Project.

METHODS

At each point we collected data on soil (soil texture, clay content, color, texture and carbon property, and gravel stone content), vegetation data (coverage and species composition, the basal cover, ground cover, basal gap of perennial vegetation, and harvest) using line-point intercept and perennial vegetation basal gap methods, and geomorphological data (altitude, slope, aspect, landform and geographic location) (Herrick et al., 2009; Guideline for meteorology and environmental monitoring, 2011; Caudle et al., 2013).

Topsoil structure, water holding capacity and exposure to erosion were evaluated separately using rangeland health assessment methodology.

We analyzed soil and vegetation data using Detrended Correspondence Analysis (DCA) and Principal Components Analysis (PCA). The classification by division into ecological zones for every environmental region was reflected into a Mongolian soil and vegetation map and "Rangeland monitoring validation" reports and was brought up for discussion by researchers, rangeland specialists and herdes representatives. This classification is currently in the finalizing stage.

The opportunity to use rangeland ecological capacity data as a basis for rangeland management was experimentaly researched in four *soums* representing a range of ecological zones. The following indicators were studied: 1) PUG herders' and local specialists' participation and initiative, 2) rangeland use plan realization rate, 3) impact of rangeland management on total and dominant plant species' cover, and 4) the budget amount invested in rangelands locally.

RESULTS

The results of statistical analysis show that the main factor of determining Mongolian rangeland ecological capacity is the level of moisture in the soil used by vegetation. The principal factors that define soil moisture levels include soil texture, elevation, and landform. These in turn strongly influence vegetation community structure and productivity (Bulgamaa et al., 2013; Budbaatar et al., 2014).

According to the DCA analysis, most of the variation in plant species was explained by first two axes (Figure 1), with eigenvalues of 0.56 and 0.27 respectively. In the first axis the variation in plant species is the most dependent on elevation according to which the points differ from each other. From the Figure 1, it is seen that the major indicators of determining vegetation structure and composition (capacity) of points are soil texture and land form, the indicators which actually define rangeland ecological capacity (Sumjidmaa, 2014).

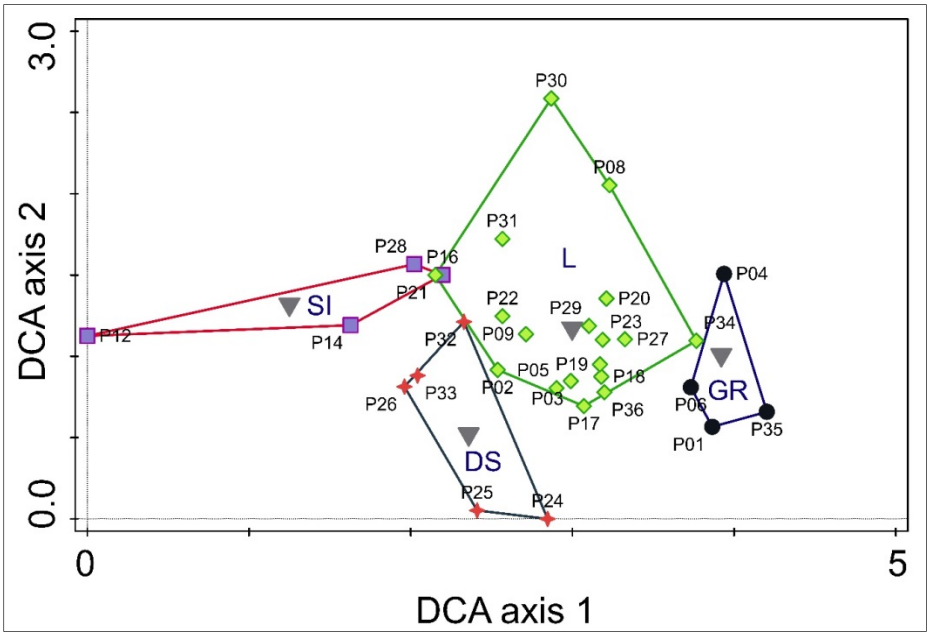

Figure 1. The results of DCA analysis that was done using vegetation cover and ecological site groups classification of the research of steppe zones representative points. In the diagram points marked with circle shapes represent Gravelly hills ecological site group, diamond shapes represent Loamy fan and mountain valley ecological site group star shapes represent Deep sandy ecological site group in mountain valley, and square shapes represenent high water table ecological site group. Downward triangle shapes represent ecological sets as follows: SI = Meadow, moist soil set; DS = Mountain lower slope and valley, grainy sand soil set; GR = Mountain and hill, stony soil set; L = Mountain lower slope and valley, clay soil set.

Mongolian rangeland, based on its ecological potential is classified into following ecological site groups (ESGs):

1. Gravelly hills ESG (in the forest steppe and the steppe zones)
2. Loamy fan and mountain valley (in the forest steppe and the steppe zones)
3. Sandy loam plain ESG (in the forest steppe zone)
4. High water table ESG (in the forest steppe and the steppe zones)
5. Deep sandy alluvial plain ESG (in the steppe zone)
6. Sandy plain ESG (in the desert and semi-desert steppe zones)
7. Gravelly hills ESG (in the desert and semi-desert steppe zones)
8. Lowland meadow salt marsh soil set (in the desert and semi-desert steppe zones)
9. Salt marshes (in the desert and semi-desert steppe zones)
10. Wet depressions (in the desert and semi-desert steppe zones)

From the ecological site groups' rangeland state and transition patterns we observed that in the forest steppe and steppe zones, relatively many ecologically unstable systems emerge, while in the desert and semi-desert zones, there are relatively few variations in systems. In other words, the forest steppe and steppe zones state shows that these zones are highly influenced by use, and consequently show more change.

According to the results of PCA analysis, based on four vegetation species cover, which are the dominant species in Mountain lower slope and valley, clay soil zone where the Krylov's feather grass community is present, the first two axes explain the most variation (Figure 2). Also according to the second axis, the livestock grazing is likely to

influence, and as a result of the cover of main community function plants, such as *Stipa krylovii, Artemisia frigida, Carex duriuscula* and *Artemisia adamsii*, and their involvement particular rangeland state is being changed and transformed (Chognii, 1978; Ankhtsetseg et al., 2014; Sumjidmaa, 2014).

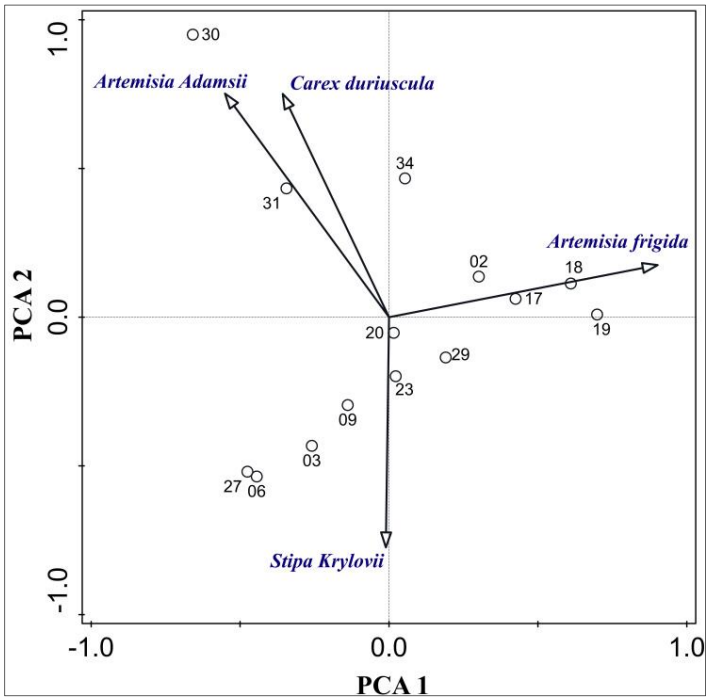

Figure 2. The results of Principal Correspondence Analysis (PCA), based on four vegetation species cover which are dominant in the Steppe zone with Krylov's feather grass community.

Based on the assessment all points of rangeland monitoring according to the concept of rangeland ecological capacity, and transition patterns, the preliminary conclusion is made that over 90 percent of the Mongolian rangeland has shifted from its original state, most of which has high capacity to naturally recover and regrow, having not yet crossed an ecological threshold (National Report of Mongolian rangeland state, B.Bestelmeyer, 2014).

The research of opportunity to use rangeland ecological capacity data as a basis for rangeland management was done and according to its results, the participation and initiative of local specialists and herders, that are involved in planning, implementation and monitoring of the impact of implementation works, have substantially increased. Also along with it the rate of realization of rangeland use plans, compared to the previous years, has grown up to 35-43 percent, and budget amount invested into rangeland locally equaled 30-80.0 million tugriks. This suggests a beginning of a positive tendency which provides hope of rangeland ecological capacity data being used as a basis for rangeland management.

IMPLICATIONS

Mongolian rangelands are divided into around 20 ecological site groups, based on their productivity and capacity to endure different intensities of use, and to recover and regrow

after being used. In general the Mongolian rangeland has considerably high capacity to recover and regrow.

Rangeland ecological capacity data is not only an essential tool used in rangeland management, but also can be an instrument for the establishment of appropriate natural resource use, protection and restoration.

The rangeland ecological capacity, including rangeland state, transition patterns can be used as a basic document for regulating relationships between rangeland users and lessee parties.

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