Supporting Mongolian pastoralists by using GIS to identify grazing limitations and opportunities from livestock census and remote sensing data

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Abstract

Since 1990, Mongolia has experienced a radical change away from centralized livestock production to more traditional rangeland management practices. As the herders now have increased access to the pastures, they need to be able to evaluate the sustainable level of exploitation of the rangeland. This paper demonstrates how pertinent information on the state of the rangeland resources can be made available to herdsmen by using a Geographical Information System (GIS). The focus is on the importance of having a sound data and information framework when assessing rangeland resources. The three main requirements are: first, knowledge of the production system; second, a natural resource inventory; and third, an assessment of the natural resource exploitation. Workshops held in the field brought together herdsmen, administrators, scientists and project personnel to identify and discuss issues of range management. From topographic maps, a digital elevation model was created using GIS, which together with a recent land-cover map elaborated from a SPOT satellite image made it possible to map the important areas suitable for winter grazing. The exact locations of the family winter settlements were recorded and linked to annual livestock statistics using GIS to identify the areas being grazed and to calculate the stocking rates by household. It was shown for the administrative unit of Arbayasgalan that the ratio of stocking rates to carrying capacity exceeded one, which indicates overstocking. However, the uneven distribution of grazing pressure over the study area enabled the proposal of actions to mitigate serious overgrazing. A discussion of range management practices was facilitated by providing the herdsmen with information on the extent and location of the problem.

Introduction

The Mongolians have exploited the vast grazing resources of their country for the past 4–5000 years through extensive livestock production managed under semi-nomadic conditions. During the 20th century, the agricultural sector has become increasingly important and by 1990 it accounted for 20% of the national income and 30% of employment, with the most important sub-sector being pastoral livestock production, that contributed with 73% of the gross agricultural output (Danagro, 1992). Under the socialist period, from 1921 to 1990, a collective farm system was introduced to maximize productivity. Supplementary winter and spring forage was used in certain areas as a means to boost the production of livestock and hence respond to the rising urban and industrial demands. This strategy allowed stocking rates to exceed the carrying capacity of the land.

In 1990, the Mongolians began to move away from a command to a market economy. This has radically changed the livestock production system from being centralized, state controlled and highly subsidised, to traditional pasture management practices based on the natural resource base. One of the challenges currently faced by the government, is how to support the herdsmen in the co-ordination of their production and land management activities in order to achieve the sustainable use of the grazing areas (Danagro, 1992).

In 1995, the Mongolian Ministry of Nature and Environment (MNE) and Danida (Danish Development Assistance) established a joint project to strengthen the availability and quality of information and data on pastoral resources. The overall objective was to support the pastoralists to enable them to maintain or intensify their production through informed decisions. The strategy was to exploit existing data, remote sensing data and to use Geographical Information Systems (GIS) to compile and analyse the natural resources versus the demand (Danagro 1995). Pilot studies were conducted in two Mongolian aimags (counties) namely Arkhangai and Dornongobi, and within these in two
soums (municipalities). This paper reports the findings from Arkhangai aimag.

The immediate objectives of this paper are: first, to propose a framework for analysing rangeland information and data; second, to demonstrate the usefulness of GIS tools and remote sensing data to locate opportunities and potential problems related to the management of the pastures.

Methods

The method adopted was to compare the availability of resources versus the demand by using the concept of carrying capacity (CC). Since any estimate of the CC is based on conditions found within a production system at a given time and place, the use of CC figures must be accompanied by an assessment of their validity.

An in-depth knowledge of a production system is inevitably necessary prior to any estimation of resources versus their exploitation. Although this may appear obvious, it is far from generally observed when GIS tools and remote sensing data are exploited for natural resource management purposes. Attractive and convincing maps and figures are often produced using GIS despite their having little or no relevance to the problem in question. The reason for this is that the broad community of map users are not yet accustomed to the opportunities of easy map creation offered by GIS.

This potential pitfall can be circumvented by placing emphasis on having an in-depth knowledge of the production system, which can guide the analytical work and hence improve the reliability of the results. The following three key requirements were necessary for the information and data framework:

1. knowledge of the production system,
2. natural resource inventory,
3. inventory of the natural resource exploitation.

When this information is presented spatially, a GIS can be used to identify and locate the limitations and opportunities of livestock production by combining layers of data. These layers are digital maps where data files are attached to points, lines or polygons, each representing different map elements (Chrisman, 1997). The advantage of a GIS compared to traditional statistical methods is the capacity to handle abundant spatial data and its flexibility to change and the ability to update various conditions, parameters etc. The same type of analysis is equally possible using paper maps and data. Due to the tedious nature of the work, however, traditional map analysis is often based on summarized statistics covering a larger area, from which it is impossible to identify exact geographical locations of resource opportunities or problems.

The study area

The aimag of Arkhangai is located in the mountainous area of the central part of Mongolia, and is subdivided into 18 soums. Each soum is further subdivided into bags, which correspond to the area exploited and managed by a group of herders. The study area is located within the soum of Khangai, and more specifically in the bug of Arbayasgalan; this covers an area of 366 km² and had a population of 535 with 23,472 sheep units in 1996. The yearly rainfall is 272 mm with 82% falling from May to October. The first snowfall occurs in September, and during winter the snow reaches an average height of 20 to 30 cm. The average temperature in January is −23 deg, with −47 deg being the absolute minimum. In July, the average temperature is 13 deg with an absolute maximum of 36 deg (HEMC, unpublished). Arbayasgalan bug is characterised by a valley running north-northwest to south-southeast some 2100 m above sea-level, with mountains reaching up to 2800 m on either side. The late melting of the snow in the spring contributes to the soil moisture, which results in the northern slopes being partially forested (see Figures 1 and 5).

Data and information

The production system

Information on the production system was obtained by consulting the herders, the soum authorities and national resource people dealing with livestock resources. A workshop was held in the field where a number of gers (traditional Mongolian woollen tents) were set up to accommodate the above mentioned people along with the project personnel for 5 days. During the workshop, formal presentations were made covering a range of different aspects of livestock production. Excursions around the terrain were also made which contributed greatly to the discussions and provided a good understanding of the functioning of the production system. The herders’ movements throughout the year, the characteristics of the seasonal grazing areas, and the constraints and the limiting factors of livestock production will be briefly presented below.

By moving around throughout the year, herders are able to optimize their exploitation of the available grazing resources and gain protection from the severe weather conditions during winter. In the summer, the herders choose to use the pastures located in the valley plain where the wind is mild and access to water is not a problem. They often move from place to place in order to profit from the abundant resources and to avoid the disadvantages of staying in one place for longer time (such as the accumulation of murrine which attracts flies). In the autumn, the herders usually move to the mountains for the first time between September 10 and October 15, and may move as many as three times during autumn. The moves enable them to gain shelter from the increasingly strong, cold northwesterly winds while still benefitting from exposure to the sun on the southern slopes. During the winter period, from November 15 to April 15, the herders move further up the southern slopes of the mountains to a narrower zone (aspect of 90–225 degrees), to gain shelter from the increasingly cold north-westerly winds which are especially severe from December 15 to March 15. The herders prefer slopes of 12 to 15 degrees as they provide