There is potential to increase livestock production by threefold if beef cattle are grazed on all the current rangelands in the region.

Photo credit: Turar Kazangapov.

Analysis of field sampling and remote sensing data gives important insights into the potential for expanding beef cattle grazing and the challenges.

Published: 29 July 2022

Introduction

Kazakhstan is the ninth-largest country in the world and has the world's fifth-largest grazing land area. Native rangelands cover approximately 70% of the total land area and are the primary source of forage for livestock production. Knowledge about rangeland health, condition, and carrying capacity is critical for economic planning and development but is currently inconsistent.
While principles and methods to assess ecological conditions and estimate livestock carrying capacity have existed for decades, their use in the real world needs to be adjusted to the local environment and culture. A study[1] of the Akmola region in Kazakhstan aimed to understand the baseline information of its rangeland status and livestock carrying capacity through field sampling and remote sensing.

Field-based measurements, household surveys, ecological and hydrological models, and remote sensing techniques were integrated to address these objectives. A decision support system was also developed to visualize and disseminate livestock carrying capacity information.

Analyses of data and information revealed the baseline information of livestock carrying capacity, challenges, potential, and opportunities to expand, enhance and invest in Akmola’s livestock production, including management practices, governance policies, animal health, and climate change.

The project was conducted by a group of experts from the Michigan State University, Agricultural Research Service at the United States Department of Agriculture, and Kazakh National Agrarian Research University under the joint Asian Development Bank and Government of Kazakhstan Knowledge and Experience Exchange Program.

Establishing Baselines

Global demand for meat and the need for economic prosperity motivated the Kazakhstan government to expand the use of its vast rangeland resources to increase livestock production. However, there is a lack of systematic and uniform baseline information of livestock carrying capacity.

This study surveyed 51 ranch sites across the Akmola region to obtain baseline information of the rangeland ecological conditions and livestock carrying capacity. It adopted a framework with six phases to assess rangeland conditions and estimate stocking rates.

**Figure 1: Project Design to Assess Akmola Region Rangeland Conditions and Stocking Rates**

Source: Author’s elaboration.
The findings showed that about 40% of the region’s rangelands (236,965.5 square kilometers) are degraded. The livestock carrying capacity, measured in the number of animals per unit land area, ranged from \( \sim 0.01 \) to 0.17—a significant variation among the 51 sites, most likely due to the differences in climate and management.

A total of 80,292.5 km\(^2\) of land is required to sustainably graze the current 860,940 animal unit equivalent (AUE) reported in 2019 in Akmola region (cattle, horses, sheep, and goats). There is potential to increase livestock production by threefold if beef cattle are grazed on all the current rangelands in the region, thereby contributing to food security. However, this assumes that the region has all of the resources, equipment, personnel, and expertise necessary to manage livestock, grow hay for winter feed, and barley for winter supplemental feed.

The survey results further indicated that water availability must be addressed to meet livestock requirements if livestock are to utilize all grazing lands. The project focused on rangelands of beef producing farms and its sustainability because Kazakhstan was developing an environmentally sustainable, inclusive, and competitive beef production.

### Step-by-step Guide

In this study, the high variability in livestock carrying capacity suggests that policies and programs must be optimized for ranch operations, vegetation status, and annual variation in weather. These findings provided important insights into the current rangeland state, potentials, and challenges that the government needs to consider as the country expands its livestock production at the national level.

The first step is to conduct workshops to train local scientists on rangeland assessment and methods to estimate stocking rates at the ranch and regional level. Next is to gain practical experience and collect field data for rangeland health assessment and stocking rate estimates and data collections on plant, soil, environmental, and management information. The third step is to use hydrological and ecological models to assess erosion potential, species composition, plant nutrition, and carrying capacity.

The modeling work allows for identifying hotspots where alternative management or conservation scenarios would be beneficial and enhance sustainability and production capabilities. Once the ecological conditions and environmental information, such as access to water, topographic slopes, feeding information, and forage availability data, are collected, stocking rate is calculated as a function of forage quantity, water distance, slope, grazing period, and management options.

The fourth step is to analyze field data and modeling results, including plant information, such as forage and biomass from the remotely sensed net primary productivity \([2]\) using Moderate Resolution Imaging Spectroradiometer (MODIS) and Landsat data. The analysis enabled the building of a geospatial model to scale the onsite stocking rate model to the entire Akmola region (Figures 1 and 2).

**Figure 1: Coefficient of Variation of Annual Stocking Rate, 2001–2019**
A suite of land-use and land-cover products (e.g., MCD12Q1.006 MODIS Land Cover Type Yearly Global 500m, Copernicus Global Land Cover Layers: CGLS-LC100 Collection 3) were used in this step to identify rangelands in the Akmola region, compute the slopes at 90 meters spatial resolution, calculate water distances and net primary productivity, and retrieve climate information. These geospatial data were then integrated with the in-situ stocking rate model to build a scaling up model.

The fifth step is to develop a simple decision support system on the Google earth engine platform (Photo 1). This will include all remote sensing data sources used for the project, geospatial models for stocking rate calculations, interactive tools to extract statistics information, and visual analysis tools to give users access to the data and visual analysis of rangeland information at individual or regional level for sustainable livestock management purposes. The Google earth engine codes, stocking rate maps, and other data have been transferred to the Kazakh National Agrarian Research University and other platforms as needed.
The final step is to synthesize the results to better understand Kazakhstan’s rangeland ecosystem. This effort included (i) analyzing results with local experts to obtain an indirect validation and consensus, (ii) comparing results with the existing literature to identify discrepancies and agreements, and (iii) discussions with external international experts to interpret the results.

**Recommendations**

**Expand beef cattle grazing to all current rangelands.** Ranchers, however, should have secure access to land, equipment, labor, and skills to manage livestock, and to grow and have the capital to purchase hay, grain (barley, oats, wheat) or concentrated commercial feed for winter supplemental feeding.

**Use modern technologies.** It is recommended to operationalize the rangeland decision support system to scale up livestock grazing expansions. Decision support systems can be further enhanced with national remote sensing capabilities to provide monthly status, trends, and early warning of droughts to minimize disruptions in livestock production and avoid rangeland degradation.

**Improve herd management.** This is needed in areas where current operations involve grazing in areas around ranch headquarters. The most challenging aspect of increasing livestock production will be allocating grazing rights to ranches so they have appropriate land base and forage resources for the desired herd size and mixture of animals.

**Develop methods and policies** to address severely degraded lands and to set up appropriate grazing systems.

**Improve livestock water infrastructure and facilities,** and evaluate them in more detail. Systematic water distribution will minimize the travel distance that impedes weight gain of livestock and increases...
the degradation of rangelands.

**Increase hay and grain production** to meet the winter feed supplementation requirements to keep animals healthy.

**Address labor issues**, specifically migration from rural communities to the city and finding individuals who want to ranch in remote areas. More workers will be needed for haying, growing winter supplemental feed, and managing an expanded livestock population.

**Increase access to capital** for purchasing livestock to increase herd sizes and farming equipment to develop non-grazing season forages.

**Develop cost-effective drought, crop, and herd insurance** to reduce risks to small and medium livestock producers from climate extremes or disease outbreaks.

**Increase veterinary services and animal tracking** to facilitate the documentation of when and what vaccinations were received and which cows produced a calf.

**Develop infrastructure**, such as roads, to efficiently move livestock, feed, and other resources across the region to facilitate increases in production.

**Develop and enhance ecological site descriptions** that describe vegetation plant communities, range in annual production, and early warning signs or thresholds of degradation.

**Enhance international rangeland management training programs.** Capacity building may include developing an exchange program for undergraduate and graduate students with foreign universities to provide standardized training on rangeland management. Extension services should be improved to offer ranchers with training in the best rangeland management practices.

[[1]] The full report is available upon request.

[[2]] Net primary productivity (NPP) is the difference between carbon dioxide fixed by plants and carbon dioxide lost to autotrophic respiration. It is a good indicator of the productivity of rangeland ecosystems, and their contribution to the cycling of carbon in the earth system.

**Resources**


Dr. Jiaguo Qi uses geospatial technologies, environmental monitoring and modeling tools to address sustainability challenges of agroecosystems. He is interested in global change issues and wants to better understand the complex interactions between land, water, energy, food, climate, and society systems. He is also co-director of the program that promotes and facilitates Michigan State University’s engagement with the People’s Republic of China.

Follow Jiaguo Qi on

Dr. Mark Weltz is a rangeland researcher with primary interests in approaches, methodologies, models, and databases to produce scientifically credible estimates of the environmental impacts of rangeland management practices on water quality and quantity, water erosion, and salinity mobilization and transport at both hillslope (plant community) and watershed scales.

Follow Mark Weltz on

Gulnaz Iskakova focuses on the application of digital technologies in agriculture. She has consulted and coordinated projects for the Asian Development Bank, Michigan State University, American Soy Association, Kazakh National Agrarian Research University, Ministry of Agriculture of Kazakhstan, and Food and Agriculture Organization of the United Nations. She is currently a PhD student at Kazakh National Agrarian Research University where her thesis focuses on the development of the agro-industrial market in the context of food and water security in the Akmola region as example.

Follow Gulnaz Iskakova on