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Livestock Sampling Survey Dataset Development of Prairie Chenbarhu Banner in Hulunbuir City Based on UAV Images

Wang, D. L.[1*] Chen, W. B.[1,2] Zhang, A. C.[1]

1. Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (IGSNRR/CAS), Beijing 100101, China;
2. College of Surveying and Spatial Information Engineering, East China University of Technology, Nanchang 330013, China

Abstract: Livestock population surveys are essential for grassland management jobs, such as health and epidemic prevention, grazing prohibition, rest grazing, and forage-livestock balance assessment, which is closely related to the modern transformation and upgrading of animal husbandry, and the sustainable development of grasslands. In July 2023, a UAV-based survey was conducted in Chenbarhu banner, Hulunbuir city. A total of 48 flights captured 45,254 images. The UAV image tiles were then mosaicked to obtain flight strips that were visually interpreted to label livestock. Finally, the population sizes of sheep, cattle, and horse in the entire Chenbarhu banner were estimated according to their population densities in flight strips. The dataset includes: (1) boundary data of the study area; (2) boundaries of the sample strips surveyed by UAV in 2023; (3) location of livestock surveyed in 2023; (4) estimated livestock population size. The dataset is archived in .shp and .tif formats, and consists of 49 data files with data size of 12.5 MB (Compressed into one file with 4.19 MB).

Keywords: sampling survey; UAV imagery; livestock; visual interpretation

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Dataset Availability Statement:

The dataset supporting this paper was published and is accessible through the *Digital Journal of Global Change Data Repository* at: https://doi.org/10.3974/geodb.2023.12.02.V1 or https://cstr.escience.org.cn/CSTR:20146.11.2023.12.02.V1.

1 Introduction

China is a major nation in grassland animal husbandry, grassland animal husbandry

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***Corresponding Author:** Wang, D. L. 0000-0002-1377-8394, IGSNRR/CAS, wangdongliang@igsnrr.ac.cn

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[2] Wang, D. L., Chen, W. B., Zhang, A. C. Livestock sampling survey dataset in Prairie Chenbarhu banner, Hulunbuir based on UAV images (July 2023) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2023. https://doi.org/10.3974/geodb.2023.12.02.V1. https://cstr.escience.org.cn/CSTR:20146.11.2023.12.02.V1.

constitutes an important component of agricultural production[1]. Accurate and timely livestock data is the basic data for grassland management such as health and epidemic prevention, grazing prohibition, rest grazing, and forage-livestock balance assessment. These data play a crucial role in the rational utilization of grassland resources, ensuring a stable supply of meat products, and mitigating the adverse ecological impacts of overgrazing[2].

Traditional animal population surveys typically employ ground surveys, allowing for close observation of animal behavior and quantity, as well as the collection of animal traces and forage samples. However, ground surveys are inefficient, costly, prone to repetitive results, and may be restricted by terrain[3]. Due to the low resolution of satellite imagery, satellite surveys are mainly used for monitoring and assessing suitable habitats, grass production, and ecological capacity for wildlife[4], and could not be used to directly observe small-sized livestock and juvenile individuals. UAVs equipped with high-resolution cameras have been used to quickly and accurately capture small-sized livestock and juvenile individuals, and then count the numbers of livestock[5]. Chenbarhu banner is a traditional animal husbandry area with animal husbandry as the basic industry, covering an area of 17,458 km^2. The available livestock data in Chenbarhu banner are mainly ground-based statistical data, which is laborious and costly. The timeliness of the statistical data is poor. In this study, a fixed-wing UAV was used to capture imagery for livestock surveys in Prairie Chenbarhu banner from July 13 to 26, 2023. Livestock were then labeled in the flight strips that were mosaicked from UAV image tiles. Finally, the livestock population sizes of sheep, cattle, and horses were estimated according to their population densities in flight strips. This study provides a scientific basis for local animal husbandry production and grassland management.

2 Metadata of the Dataset

The metadata of livestock sampling survey dataset of Prairie Chenbarhu banner in Hulunbuir city based on UAV images (July 2023)[6] is summarized in Table 1. It includes the dataset full name, short name, authors, year of the dataset, spatial resolution, data format, data size, data files, data publisher, and data sharing policy, etc.

3 Study Area

Chenbarhu banner (Figure 1) is located in the juncture of Great Khingan and Hulunbeier upland plain in the northwest of Hulunbeier city, Inner Mongolia autonomous region. It is the main part of Hulunbeier grassland, located at 48°48′N–50°12′N and 118°22′E–121°02′E, and belongs to the semi-arid continental climate in the middle temperate zone, with an annual average temperature of –2.5 ℃ and an annual average precipitation ranging from 300 to 550 mm[8]. The terrain is relatively flat, with an average elevation ranging from 600 to 800 m. and it is an animal husbandry banner with Mongolian as the main body. The population of the banner is 58,000. The banner's land covers include temperate steppe, temperate meadow-steppe, sandy meadow, mountain meadow, and lowland meadow for haymaking, occupying a total area of 18,600 km^2. The banner is dominated by grasslands, covering 85% of the total area (15,800 km^2). The banner is also the hometown and main breeding base of Sanhe horse and Sanhe cattle, and it is one of the most important animal husbandry production bases in Hulunbeier city. The main livestock types include cattle, sheep and horses.

Table 1 Metadata summary of Livestock sampling survey dataset in Prairie Chenbarhu banner, Hulunbuir city

Items	Description
Dataset full name	Livestock sampling survey dataset in Prairie Chenbarhu banner, Hulunbuir based on UAV images (July 2023)
Dataset short name	Chenbuerhuqi_UAVlivestock
Authors	Wang, D. L. 0000-0002-1377-8394, IGSNRR/CAS, wangdongliang@igsnrr.ac.cn Chen, W.B. 0009-0009-9608-1717, IGSNRR/CAS, 976101217@qq.com Zhang,A.C. 0009-0009-5617-657, IGSNRR/CAS, zhangaochong0013@igsnrr.ac.cn
Geographical region	Prairie Chenbarhu banner, Hulunbuir city: 48°48′N–50°12′N, 118°22′E–121°02′E
Year	July 13–26, 2023
Spatial resolution	3–5 cm
Data format	.shp, .tif Data size 12.5 MB
Data files	boundary data of the study area, boundaries of the sample strips surveyed by UAV in 2023, location of livestock surveyed in 2023,estimated livestock population size
Foundations	Chinese Academy of Sciences (XDA23100200); Ministry of Science and Technology of P. R. China (2021YFD1300501)
Data publisher	Global Change Research Data Publishing & Repository, http://www.geodoi.ac.cn
Address	No. 11A, Datun Road, Chaoyang District, Beijing 100101, China
Data sharing policy	(1) ***Data*** are openly available and can be free downloaded via the Internet; (2) End users are encouraged to use ***Data*** subject to citation; (3) Users, who are by definition also value-added service providers, are welcome to redistribute ***Data*** subject to written permission from the GCdataPR Editorial Office and the issuance of a ***Data*** redistribution license; and (4) If ***Data*** are used to compile new datasets, the 'ten per cent principal' should be followed such that ***Data*** records utilized should not surpass 10% of the new dataset contents, while sources should be clearly noted in suitable places in the new dataset[7]
Communication and searchable system	DOI, CSTR, Crossref, DCI, CSCD, CNKI, SciEngine, WDS/ISC, GEOSS

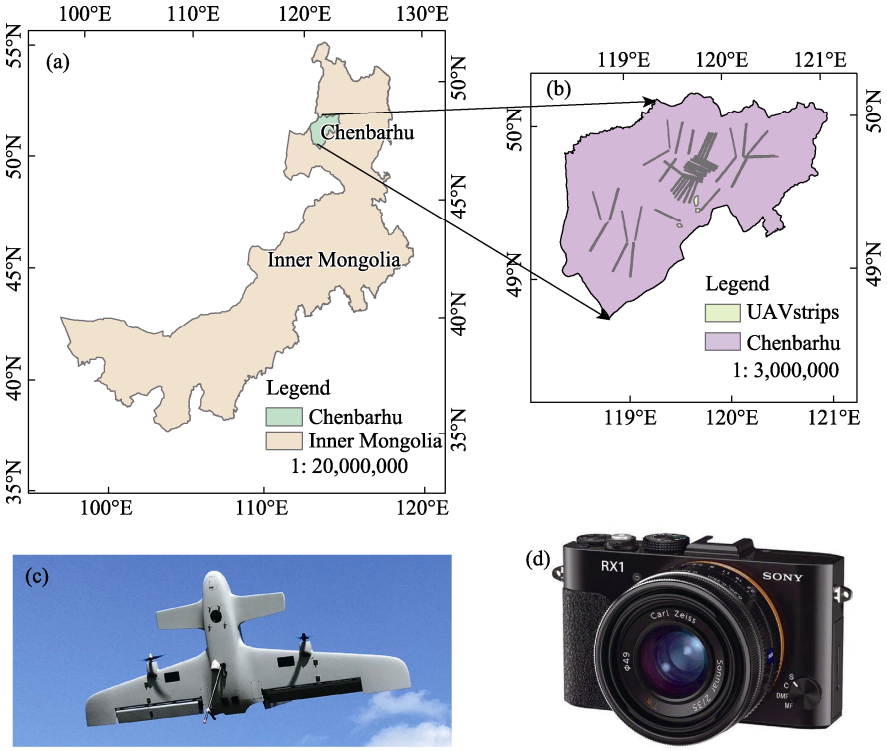


Figure 1 Geo-location of the study area (a), flight path (b), UAV (c) and sensor photo (d)

4 Data Sources and Acquisition Methods

4.1 UAV Data Acquisition

From July 13 to July 26, 2023, 45 UAS flights under vertical over-looking attitude was conducted over Prairie Chenbarhu banner, as shown in Figure 1b. The campaign captured 45,254 images covering an effective aerial surveying area of approximately 526.24 km^2. The flight altitude was 300 m above the take-off location. The image resolution of each image ranged from 3 to 5 cm. The total data size is 727 GB. These images were acquired by a fixed-wing UASs, as shown in Figure 1c. The endurance of the fixed-wing UAS employed in this study is 120 min flying at an altitude of 500 m with a cruising speed of 76 km/h. The UAV was mounted with a Sony RX1R II camera that has effective pixels of 42.4 million (7952×5304) and a sensor size of 35.9 × 24.0 mm, as shown in Figure 1d. The survey employs a systematic sampling method with a sampling intensity of 2.15%.

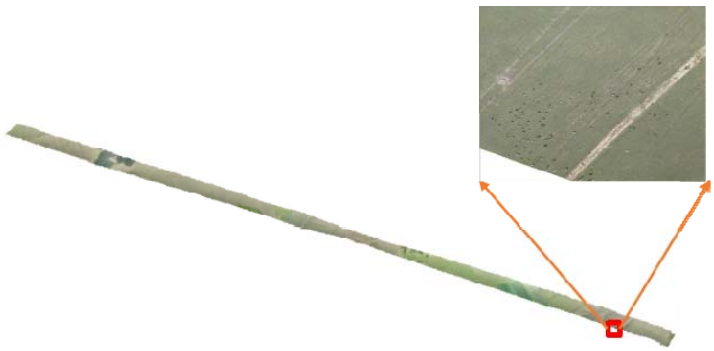


Figure 2 Example of a flight strip mosaicked with UAV image tiles

4.2 UAV Image Mosaicking

Photoscan was used to mosaick the UAV image. A total of 83 flight strips were generated, and covered approximately 526.24 km^2. One of the flight strips is shown in Figure 2.

4.3 UAV Image Interpretation

The visual interpretation method is one of the classic and widely used interpretation methods in the field of remote sensing[9]. Visual interpretation was utilized to determine the position and type of livestock in ArcGIS.

4.4 Population Estimation Method

The population sizes of sheep, cattle, and horses were estimated for Chenbarhu banner according to their population densities in flight strips, as expressed by:

$$N_i = N_i' \times \frac{A}{A'} \tag{1}$$

where,

N_i ——the population of the ith kind of livestock in the surveyed area.

N_i' ——the population of the ith kind of livestock in the sampled strip.

A′ ——the total area of all surveyed strips.

A ——the total area of the surveyed region.

5 Data Results and Validation

5.1 Data Composition

The dataset includes: (1) boundary data of the study area; (2) boundaries of the sample strips surveyed by UAV in 2023; (3) location of livestock surveyed in 2023; (4) estimated livestock population size. The boundaries of flight strips and locations of livestock within the flight strips are shown in Figure 3.

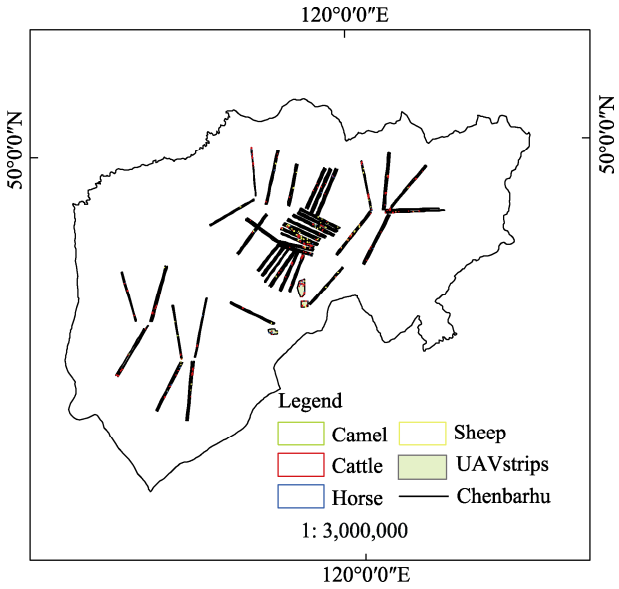


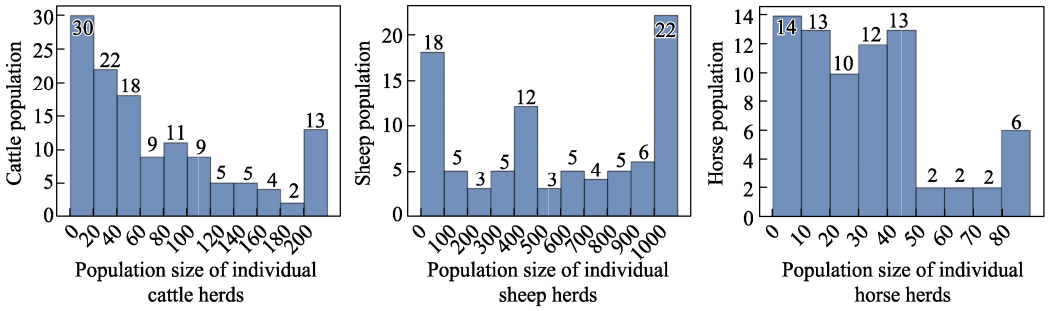
Figure 3 The distribution map of livestock in Prairie Chenbarhu banner

5.2 Data Products

5.2.1 Analysis of Livestock Strip Results in Prairie Chenbarhu banner, Hulunbuir City

(1) Livestock numbers and densities within flight strips. In the 2023 UAV flight strips, 52,171 livestock, including 38,956 sheep, 10,655 cattle, 2,560 horses and 25 camels, were found. The animal densities across the flight strips averaged 74.02 sheep/km^2, 18.33 cattle/km^2, 4.40 horses/km^2, and 0.047 camels/km^2, respectively.

(2) Group sizes within flight strips. In the 2023 UAV flight strips, 128 cattle herds, 88 sheep herds, 74 horse herds, 2 camel herds were found. The group size of cattle, sheep, horse, and camel herd across the flight strips averaged 83, 641, 34, and 12.5 individuals, respectively. Among 128 cattle herds, there are 30 herds with less than 20 individuals, accounting for 23.45% of the total herds; 85 herds had 20–200 individuals, representing 66.40% of the total herds; and 13 herds had over 200 individuals, constituting 10.15% of the total herds. Among 88 sheep herds, 18 herds had fewer than 100 individuals, representing 20.45% of the total herds; 48 herds had 100–1,000 individuals, accounting for 54.55% of the total herds; and 22 herds had over 1,000 individuals, making up 25% of the total herds. Among 74 horse herds, 14 herds had fewer than 10 individuals, accounting for 18.92% of the total herds; 54 herds had 10–80 individuals, representing 72.97% of the total herds; and 6 herds had over 80 individuals, constituting 8.10% of the total herds. 13 and 12 individuals were found in 2 camel herds, respectively. The group size frequency histograms for cattle, sheep, and horses are shown in Figure 4.



(a) Cattle Population Distribution Chart (b) Sheep Population Distribution Chart (c) Horse Population Distribution Chart

Figure 4 Population size frequency histogram: (a) cattle, (b) sheep, and (c) horses

5.2.2 The Estimation and Validation of Livestock Population in Chenbarhu Banner

(1) The population size of each kind of livestock across the entire Chenbarhu banner was estimated using Equation (1). Chenbarhu banner has an area of 17,938.1 km^2. We estimated approximately 1,924,501 sheep, 363,200 cattle, and 87,263 horses in Chenbarhu banner. The corresponding sheep unit was 4,176,816 (assuming that one cattle and horse equals a 5 sheep unit equivalence).

(2) The livestock population sizes estimated using UAV imagery were then compared with counts from statistical yearbook 2022[10]. The statistical yearbook 2022 showed 1,234,406 sheep and 222,855 large livestock (cattle and horses) in Chenbarhu banner in June, 2021(Table 2). The corresponding sheep unit was 2,348,681. Compared to the ground-based statistical count, the UAV image counts deviated in sheep and large livestock (cattle and horses) quantity by 55.9% and 102.1%, respectively.

Table 2 Livestock population sizes estimated using UAV imagery and statistical data for Chenbarhu banner

Livestock	Population sizes estimated using UAV imagery (July 2023)	Population sizes from statistical data (June, 2021)	Deviations between UAV image estimates and statistical data	Relative deviations between UAV image estimates and statistical data (%)
Sheep	1,924,501	1,234,406	690,095	55.91%
Large livestock (cattle and horse）	450,463	222,855	227,608	102.13%
Sheep unit total	4,176,816	2,348,681	1,828,135	77.84%

6 Discussion and Conclusion

A UAV-based livestock survey was conducted in Chenbarhu banner, Hulunbuir city in July, 2023 and 45,254 UAV aerial images were mosaicked into 82 flight strips. In the 82 UAV flight strips, 52,171 livestock, including 38,956 sheep, 10,655 cattle, 2,560 horses and 25 camels, were found. We estimated approximately 1,924,501 sheep, 363,200 cattle, and 87,263 horses in Chenbarhu banner according to the livestock densities. Compared to the ground-based statistical count, the UAV image estimates deviated in sheep and large livestock (cattle and horses) quantity by 55.9% and 102.1%, respectively. The discrepancies between estimated sheep inventory and statistical data were 55.9% and 35.8%. The discrepancies between estimated large livestock (cattle and horses) and statistical data were 102.1% and 76.2%, respectively. Such significant deviations may attribute to inter- and intra-annual variations because of natural disasters and human factors, and uneven distribution of UAV flight paths and the simple estimation method may also result in inaccurate estimation. Additionally, the statistical data may also have significant biases. Thus, comparisons of population sizes between UAV image estimates and statistical data in

different years have great uncertainty. These UAV-based estimates provided better understanding livestock resources in Chenbarhu banner.

Compared to traditional ground-based statistical methods, UAV can be used for large-scale livestock surveys in the shorter time and at the lower labor cost. However, UAV survey may be affected by adverse weather conditions. On the other hand, the use of visual interpretation methods is susceptible to subjective judgments. Different observers may interpret the same image or scene with different results. Therefore, automatic recognition algorithms should be introduced in the future which will allow the higher frequency of counts for large areas both within and between years and provide more consistent and objective results. Furthermore, significant deviations were observed between UAV image estimates and statistical data. We will collaborate with relevant statistical departments to investigate the reasons behind these deviations, aiming to improve the accuracy and reliability of UAV-based estimates.

Author Contributions

Zhang, A. C. was responsible for unmanned aerial vehicle (UAV) image acquisition and processing. Wang, D. L. undertook the overall design of the dataset development, and Chen,W. B. along with Zhang, A.C. marked the sample dataset and wrote the paper.

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Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Thornton, P. K. Livestock production: recent trends, future prospects [J]. *Philosophical Transactions of the Royal Society B*: *Biological Sciences*, 2010, 365(1554): 2853–2867.

[2] Harris, P., Brunsdon, C., Charlton, M. Geographically weighted principal components analysis [J]. *International Journal of Geographical Information Science*, 2011, 25: 1717–1736.

[3] Shao, Q. Q., Guo, X. J., Li, Y. Z., *et al*. Using UAV remote sensing to analyze the population and distribution of large wild herbivores [J]. *Journal of Remote Sensing*, 2018, 22(3): 497–507. DOI: 10.11834/jrs.20187267.

[4] Liu, S. L., Zhao, H. D., Dong, S. K., *et al*. Dynamic of vegetation in the Altun mountain nature reserve based on SPOT NDVI [J]. *Arid Zone Research*, 2014, 31(5): 832–837.

[5] Cao, N., Xi, R. N., He, L. N., *et al*. The Application Prospects and Challenges of UAV in Livestock Farming [J]. *Today Animal Husbandry and Veterinary Medicine*, 2023, 39(7): 53–55.

[6] Wang, D. L., Chen, W. B., Zhang, A. C. Livestock sampling survey dataset in Prairie Chenbarhu banner, hulunbuir based on UAV images (July 2023) [J/DB/OL]. *Digital Journal of Global Change Data Repository*, 2023. https://doi.org/10.3974/geodb.2023.12.02.V1. https://cstr.escience.org.cn/CSTR:20146.11.2023.12.02.V1.

[7] GCdataPR Editorial Office. GCdataPR data sharing policy [OL]. https://doi.org/10.3974/dp.policy.2014.05 (Updated 2017).

[8] Nie, H., Yue, L., Yang, W., *et al*. Present situation, evolution trend and causes of sandy desertification in Hulunbuir steppe [J]. *Journal of Desert Research*, 2005, 25(5): 635–639.

[9] Zhou, Z. W. Monitoring of marine macro-plastic litter in the coastal zone based on UAV remote sensing and computer interpretation [D]. Shanghai: East China Normal University, 2022. DOI: 10.27149/d.cnki.ghdsu.2022.001948.

[10] Hulunbuir Bureau of Statistics. Hulunbuir statistical yearbook 2022 [OL]. http://tjj.hlbe.gov.cn/News/show/1037849.html.