Title: **Applying Geographic Information System /GIS/ and remote sensing in the South Gobi of Mongolia to support conservation interventions**

WCS Mongolia, 01/03/2023

Sponsoring institutions: Wildlife Conservation Society – Mongolia /WCS Mongolia/ – Conservation Leadership Programme

The overall aims: To train young conservation leader and researcher on the natural conservation for the future

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Disclaimer:

I officially started my internship from 1 September 2022 prior to the previous intern Anudari Bayarkhangai who went abroad to do her Master's in Sweden.

Executive Summary

This internship program included two main works such as GIS and remote sensing in the South Gobi of Mongolia. In order to carry out the main works, the following five objectives were set.

Objectives:

- Learn how to develop and manage a database for a multi-project GIS program
- Learn how to create movement animations using Global Positioning System /GPS/ livestock tracking data
- Update an existing anthropogenic disturbance layer in the South Gobi for khulan habitat suitability analysis
- Identify remote sensing products used in time-series analysis of vegetation productivity in the South Gobi region
- Learn how to tell a conservation story using story maps

Gazelle migration animation was done by an expert Nandintsetseg Dejid and I created an animation in traffic counter (volume).

Introduction

This internship program mainly emphasized on the works for the Mongolia's Southern Gobi Desert. That is among the world's largest and most intact arid rangelands, and thus is of global importance (Batsaikhan et al., 2014). This region supports a unique assemblage of native wildlife, including the largest populations of Asiatic wild ass (or khulan, Equus hemionus) and goitered (or black-tailed, Gazella subgutturosa) gazelle in the world (Buuveibaatar et al., 2017). For both species, poaching is the primary driver of past population declines throughout their range (Mallon and Zhigang, 2009; Stubbe et al., 2012), although habitat loss and fragmentation across the species' range may also be important (Clark et al., 2006; Ito et al., 2013; Batsaikhan et al., 2014).

The overall study area (*Figure 1*) covered by this study spans three provinces with an estimated area of 349,619 km2; Umnugobi contains the largest area (165,186 km2 or 47.2%), followed by Dornogobi (109,754 km2 or 31.4%) and Dundgobi (74,679 km2 or 21.4%). A strong fence alongside Mongolia's national border with China impedes the wildlife movements (Linnell et al. 2016). Three railway lines (with a total length of 909 km) connecting the Tavan Tolgoi coal mine border crossings to China were completed in the last two years. Paved roads between province centers and border crossings are also present. There are a total of 13 protected areas (PAs) across three provinces totaling 61,276 km2, the largest being Gobi Gurvan Saikhan National Park located on the western edge of the study area. The overall area of the PAs represents approximately 17.5% of the survey region within which any form of infrastructure development (e.g., mining, roads, and railways) is limited.

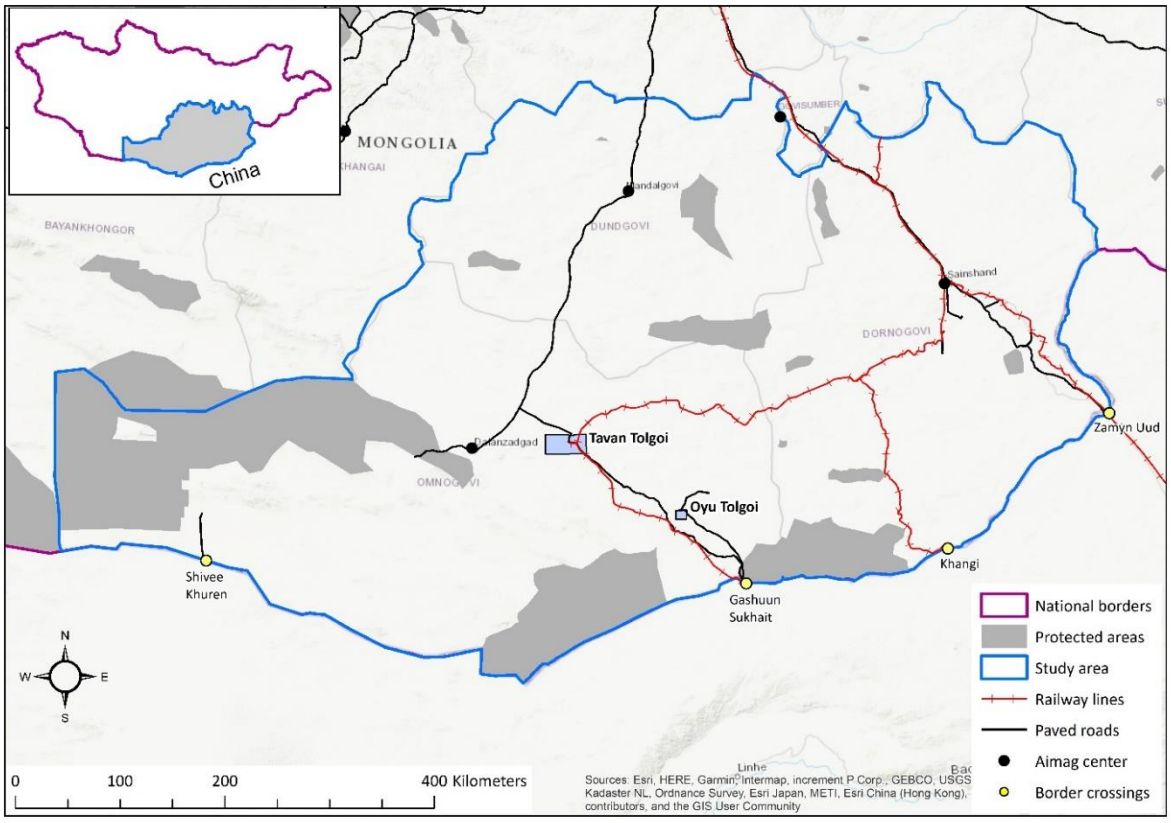

Figure 1. Study area covered by the survey effort in the Southern Gobi region of Mongolia

Given that mining and associated infrastructure development is projected to thrive in the region, developing monitoring frameworks for consistently assessing the habitat loss of ungulates resulting from this land-use change is a crucial need. To examine impacts of human influences on movements and habitat suitability of nomadic ungulates, the human disturbance data layer created by The Nature Conservancy (TNC) for the Southern Gobi is often used for analysis (Buuveibaatar et al. 2016; Nandintsetseg et al. 2019). This layer was created using a wide range of human-associated factors, including road and railroad density, population centers and associated areas of impact, and existing mines and infrastructure (for details see Heiner et al., 2013, 2016). However, this layer is outdated and there is a critical need to update the data for at least the Southern Gobi region.

Aim and Objectives

One of the main aims of this project will be applying existing skills in GIS and remote sensing, as well as new skills, to support and enhance conservation efforts for WCS Mongolia.

The other primary objective of this project is to become a young leader and researcher on conservation for the future.

Activities and Methodology

1. Developed and managed a GIS database (shapefile and map) for a multi-project GIS program at the WCS Mongolia program which was already done by Anudari Bayarkhangai.

My part: Replicated GIS database to a public server in WCS Mongolia program. (*Figure 2*)

2. The disturbance layer created by The Nature Conservancy used 5 sources of data associated human influence:
    - herder households,
    - mine and petroleum lease areas,
    - population centers,
    - transportation network, and
    - agricultural lands.

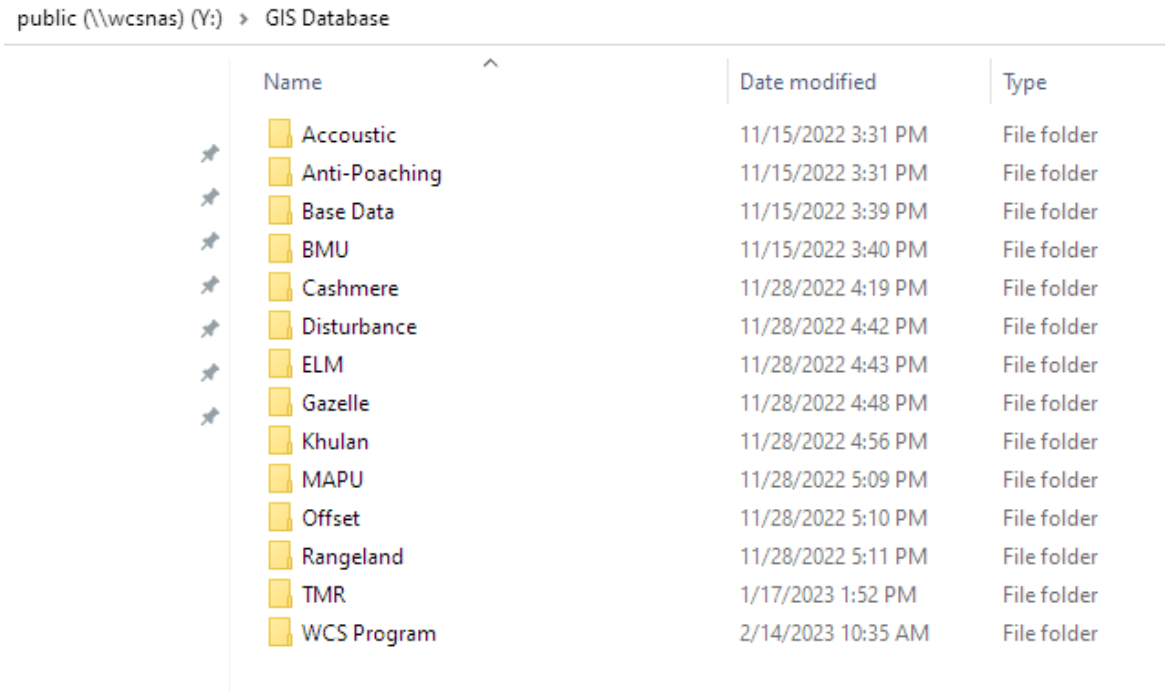

Figure 2. WCS Mongolia-All staff's GIS Database

Of these, I obtained a transportation network and herder households across the study area from the OpenStreetMap online GIS database. In addition, I digitized the dirt roads connecting settlements for Mongolia using Google Earth.

3. Created movement animations using GPS livestock tracking data which was done by an expert.

I created an animation based on traffic counter volume.

The animation was made according to the steps below.

1. Prepare your data in Excel.
2. Add Excel latitude, and longitude coordinates table to ArcMap
3. Display XY Data
4. Save as a feature class
5. Symbology

6. Preparing for your animation
7. Starting your animation

4. As part of the anti-poaching project:

As part of the anti-poaching project, the main location of the Khulan (Wild ass), which represents the main typology of the southeastern Gobi region of Mongolia and has relatively preserved its natural appearance, is an endangered species in the world. TRAFx Vehicle Counter (*Figure 3*) was installed on the side of the road in the 18,391 km2 Small Gobi Strictly protected area (SPA), consisting of 2 parts: "A" and "B", covering parts of the Borzon Zag region, Zeemeg, Galba, and Kharmagtain Govi.

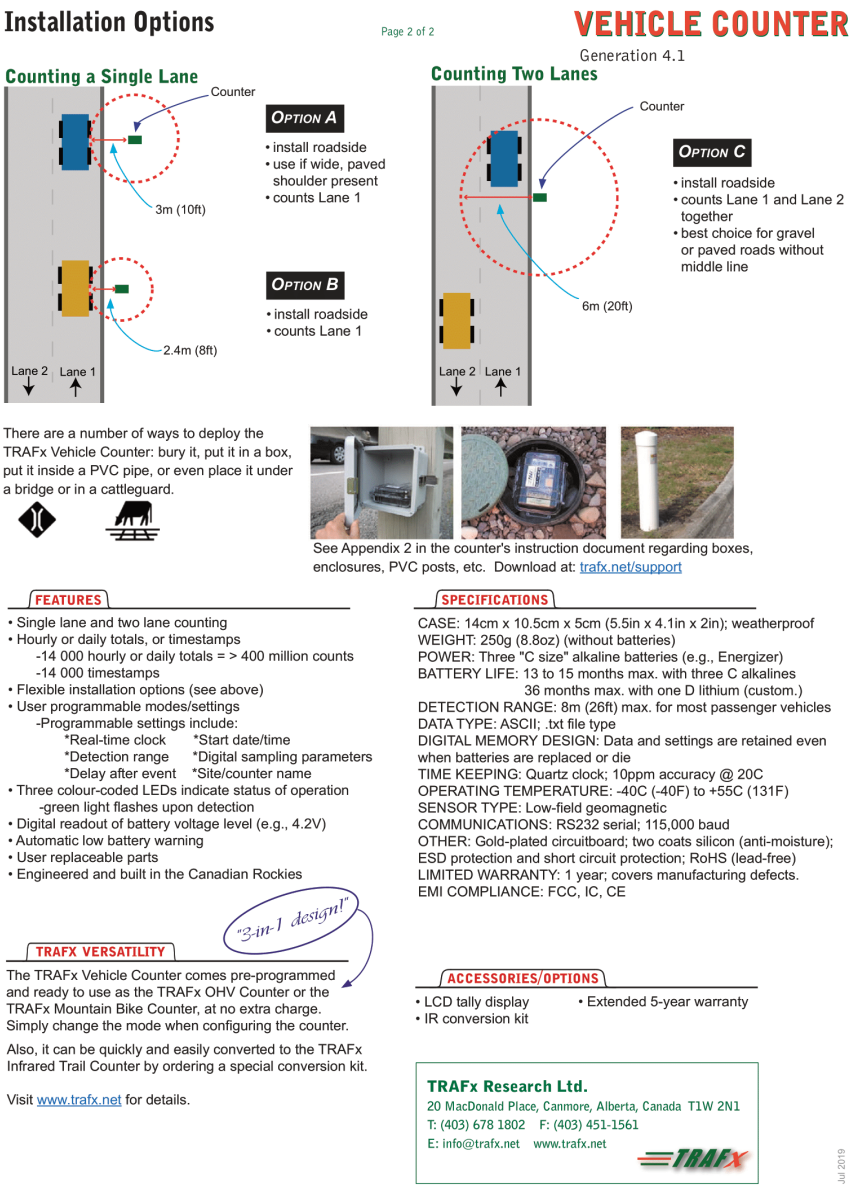

Figure 3. TRAFX Vehicle Counter's all information

That project is using automatic traffic monitoring devices along the roads of entering/leaving the Protected Area /PA/ boundary to quantify traffic volume and patterns. This data will allow the PA administration to target messaging around regulations for those living within the park, and to improve rangers' efficiency in patrolling by focusing efforts on high-traffic volume areas, and potentially deciding to close roads. Therefore, the traffic monitoring project officially started in September of 2019 the project installed traffic counters along 21 roads in Small Gobi Part A and in September 2020 along 26 roads in part B (*Figure 4*).

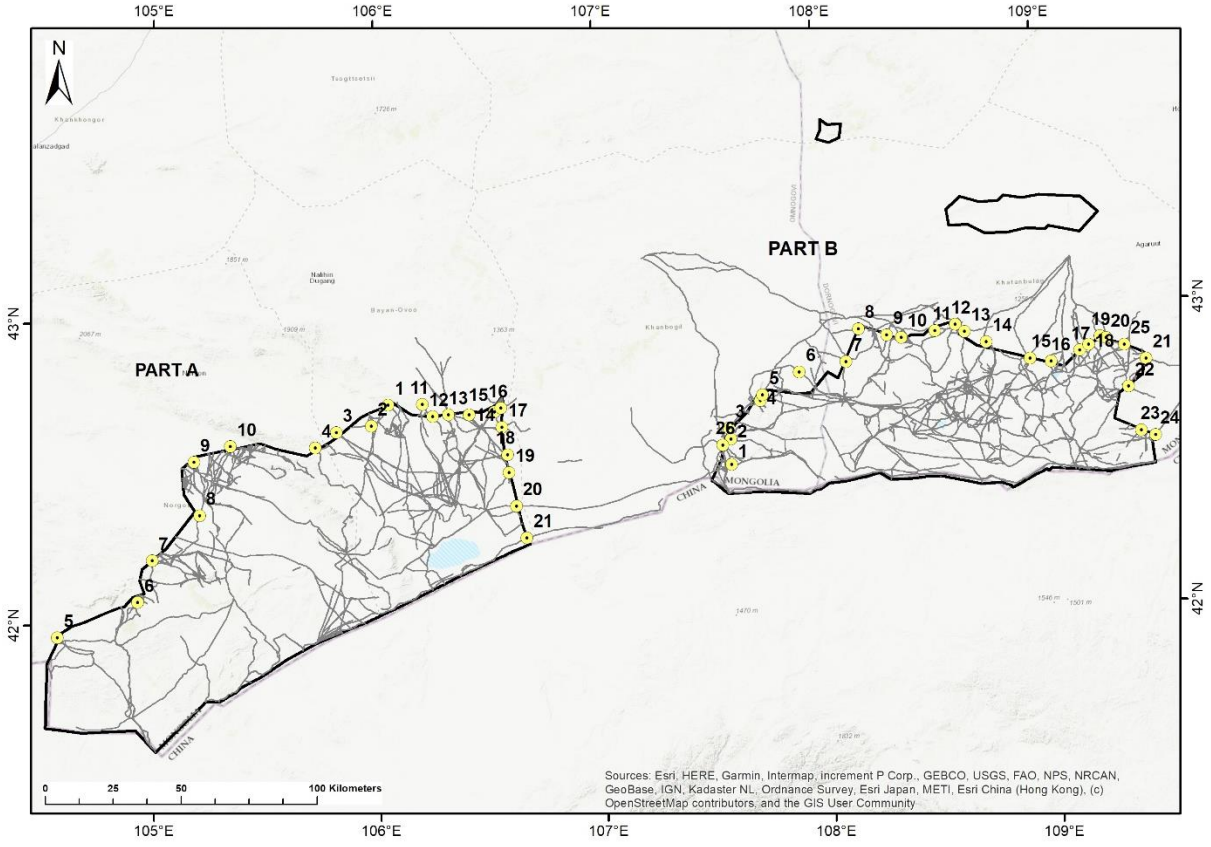

Figure 4. SGSPA Part A and Part B

Analyze according to the following 4 steps:

1. Install counter; collect data
2. In the field, download data using the dock
3. Return to office end sync data from dock to PC
4. Finally, the collected data were systematically analyzed by using the Microsoft excel \Analyze, manage, store and share data with TRAFxDataNet software\
5. Making map of traffic volume of Small Gobi SPA and make a traffic volume animation via time series.

Outputs and results

1. GIS Data base: WCS Mongolia staff and researchers now have access to all data from anywhere as long as they are connected to the Internet. It is updated regularly and currently has 12.4gb of data.
2. Disturbance Layer:

Total 56775.8 km of roads (Figure 5) and 4798 herder's houses (Figure 6) were identified on the ArcGIS Pro program, and the total research area needed more than 3 months. In this way, the data needed to determine the disturbance index for the Gobi region was created. As a result, The mean disturbance index value for the Gobi province in 2011 was 0.085 (SD = 0.195) For the updated layer in 2022, the mean disturbance index value is 0.132 (SD = 0.066), which is a significant increase from 2011 ($t = -50.496$, $p < 0.001$). An increase in the disturbance index across the region is likely due to the expansion of the road network, settlements, and mining activities. Moreover, the coefficient of variation in the disturbance index across the study region was 228% in 2011 and this has decreased down to 50% by 2022. In others, the spatial distribution of human disturbance across the Gobi has been becoming more homogeneous since 2011. When comparing the updated disturbance layer between provinces, the average value was greatest for Dundgobi (0.140 ± 0.57) while the disturbance index values were fairly similar between Dornogobi (0.128 ± 0.066) and Umnugobi (0.129 ± 0.069) provinces. There was a significant difference in the mean disturbance values among the three provinces (One-way ANOVA: $F = 122.3$, $p < 0.001$). In addition, human disturbance significantly increased for all provinces from 2011 to 2022.

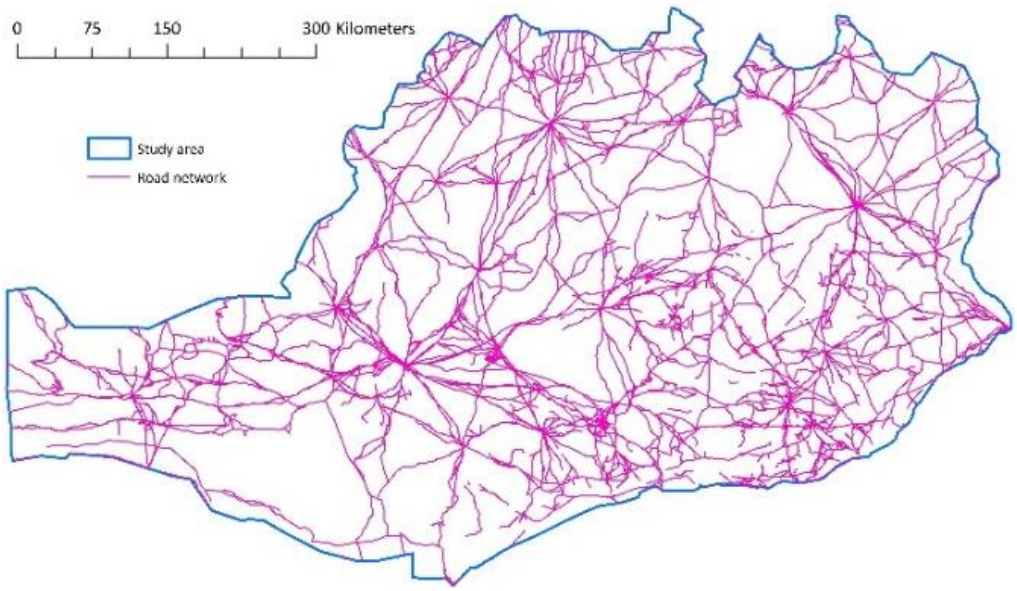

Figure 5. Study Area – Digitized transportation network

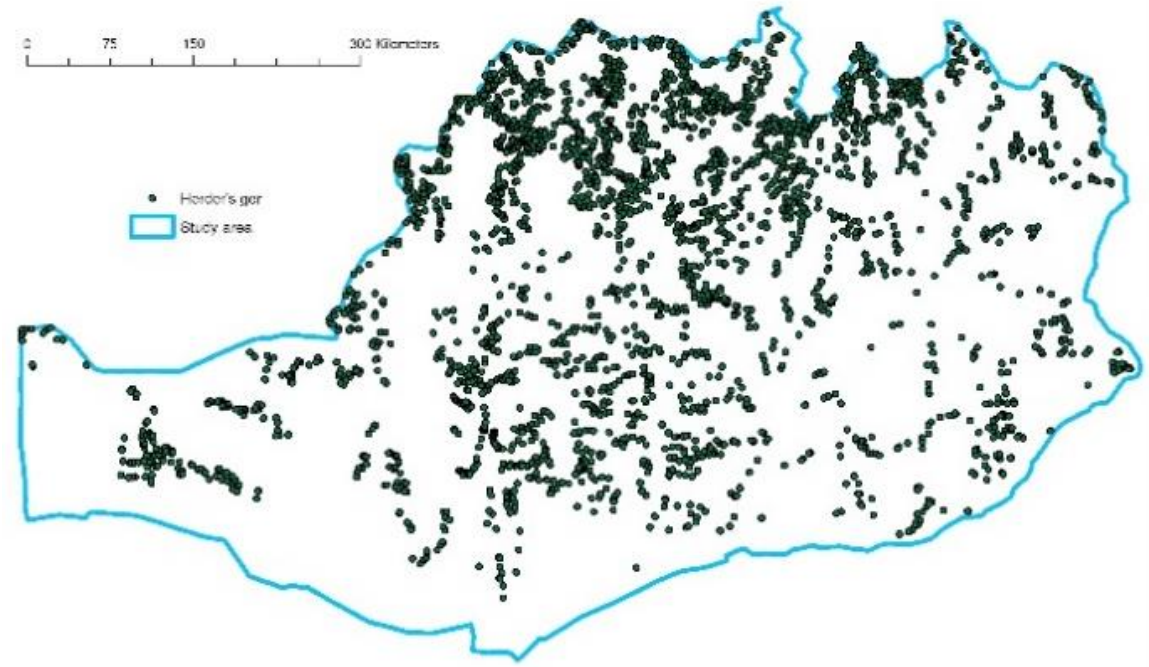

Figure 6. Study Area – Digitized all herder's ger

3. Animation result (Figure 7):

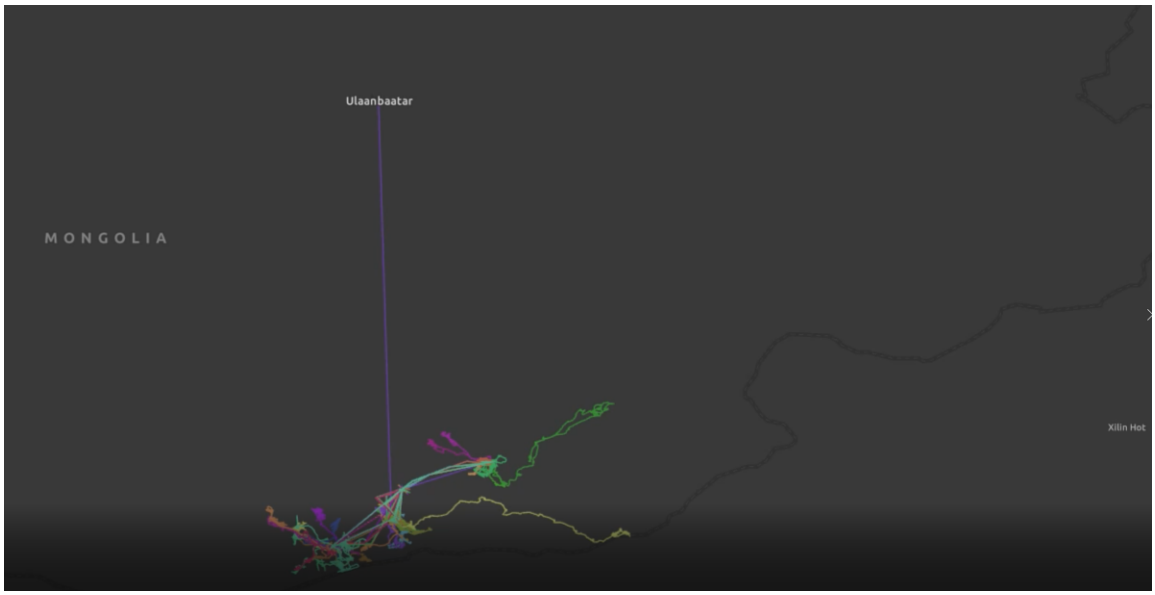

Figure 7. Gazelle migration animation

4. Traffic volume:

Part A: A3 and A4 roads are the highest traffic volume since 2019 (A3-1296.9; A4-1723.8 vehicles) (Figure 8).

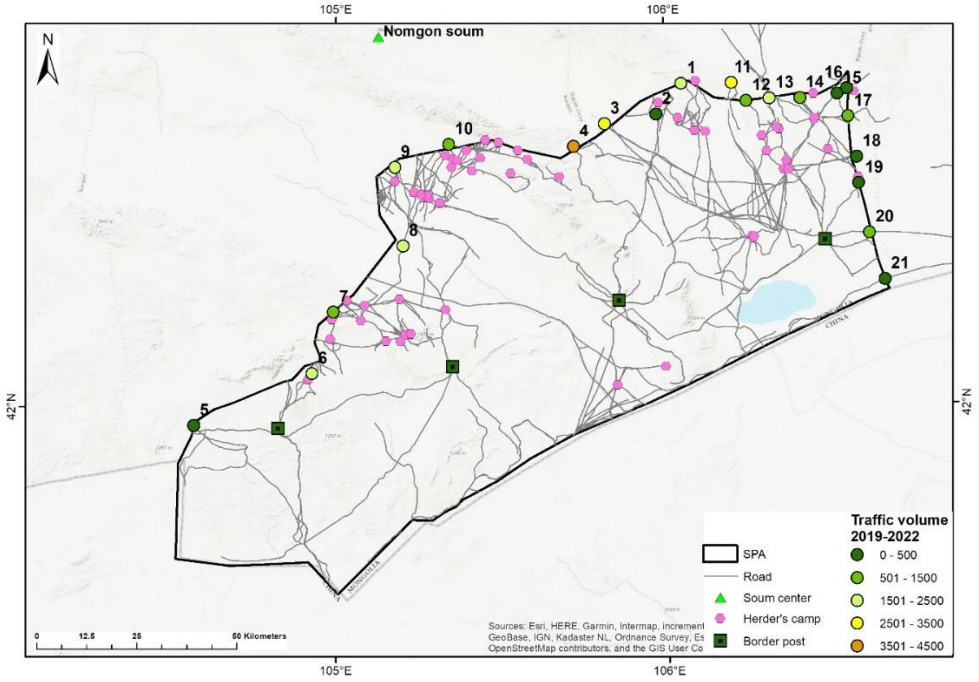

Figure 8. Part A – Traffic volume 2019-2022

The main purpose of these roads is a settlement and border post usage which is using their daily routine from home to soum center. A6 is used by Border post and tourism (the most southern point of Mongolia). The highest traffic volume occurred in December and May. Part B: B6 and B7 roads are a high volume of traffic since 2020 (B6-2611.3; B7-3002.9 vehicles) (Figure 9). B6 is used by Gashuun Sukhait border crossing point and B7 road is used by the border post to Khanbogd soum center. The highest traffic volume occurred between March to May.

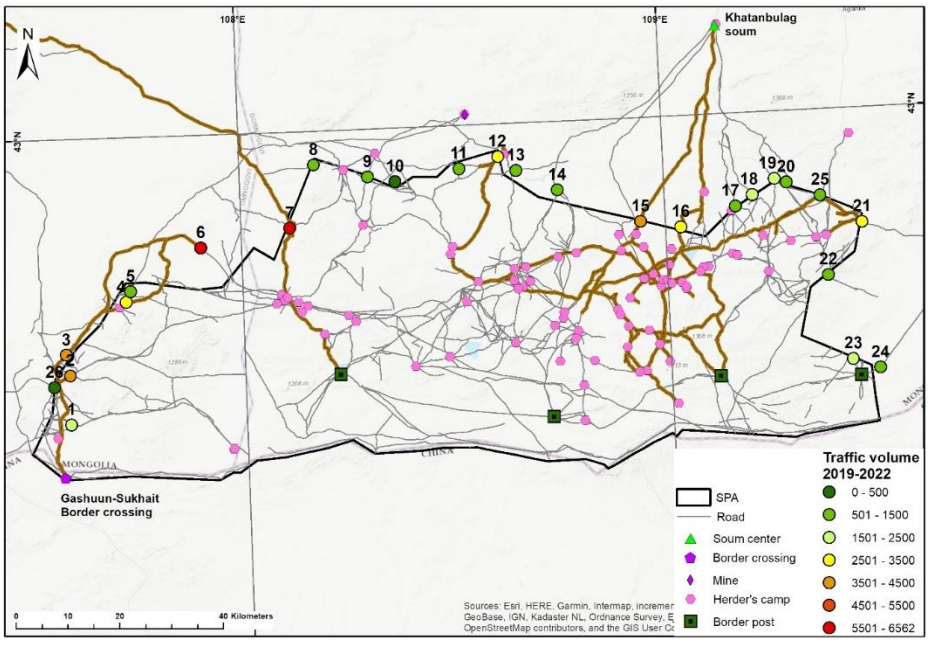

Figure 9. Part B – Traffic volume 2020-2022

Achievements and impacts

By making the GIS database online, the members of the conservation use the GIS database anywhere as long as they have access to the internet to improve the efficiency of cooperative work.

Developing a monitoring system for regular assessment of habitat loss of ungulates due to land use changes in the area of Umnugovi province is a very important need. Human disturbance data layers created by the Nature Conservancy for the entire Umnogovi province are often used in the analysis to study how human influence affects the movement and habitat of migratory ungulates. This layer was created using a wide range of human-related factors such as road and rail density, population density and associated impact areas, and existing mining infrastructure. However, since this layer is outdated, it has been updated and updated to 2022, providing the information needed to develop a monitoring system to regularly assess habitat loss for ungulates. This is essential for future wildlife conservation.

Traffic counters are now installed at nearly all roads crossing into both A & B sections of Small Gobi SPA. This data collection revealed where vehicles are more concentrated in certain areas than others, and after analyzing the data we were able to find out why these areas are concentrated and guide patrol planning in areas of concern. This data will be incorporated into the Small Gobi Administration's data collection efforts using the SMART approach which will be starting from September in every year's patrol plan. This is a multi-year effort to evaluate traffic patterns.

These results are helping the SGSPA administration better understand areas of high visitation across the protected area and make informed decisions and actions to take around visitor management.

The limits the capacity of the PA Administration to improve visitor management and to better inform rangers and their patrol planning around activities associated with households living within the PA boundaries. To address this, gap the project is using automatic traffic monitoring devices along roads entering/leaving the PA boundary to quantify traffic volume and patterns. This data allowed the PA administration to target messaging around regulations for those living within the park, and to improve rangers' efficiency in patrolling by focusing effort in high traffic volume areas, and potentially decide to close roads.

Conclusion

WCS saves wildlife and wild places worldwide through science, conservation action, education, and inspiring people to value nature.

WCS Mongolia's mission is the conservation of Mongolia's priority species and its intact landscapes, particularly the vast expanses of the Eastern Steppe and the Southern Gobi. The biggest threats to wildlife in these regions are development, poaching, and climate change. During the internship, research on the habitat of wild animals such as the gazelle and khulan in the vast area of Southern Gobi, how to protect them, and use GIS and remote sensing to fight poaching, contributed to the beginning of many ways that can be taken in the future. In the future, it was decided to digitize herder's gers, which are important data for determining the index of human disturbance in the monitoring study of ungulates throughout Mongolia. I fully believe that it will make a valuable contribution to future conservation efforts. I didn't have

enough time to do the story map, so it's not ready yet, but if you want it, I don't mind sending it again as an attachment when it's done.

Acknowledgments

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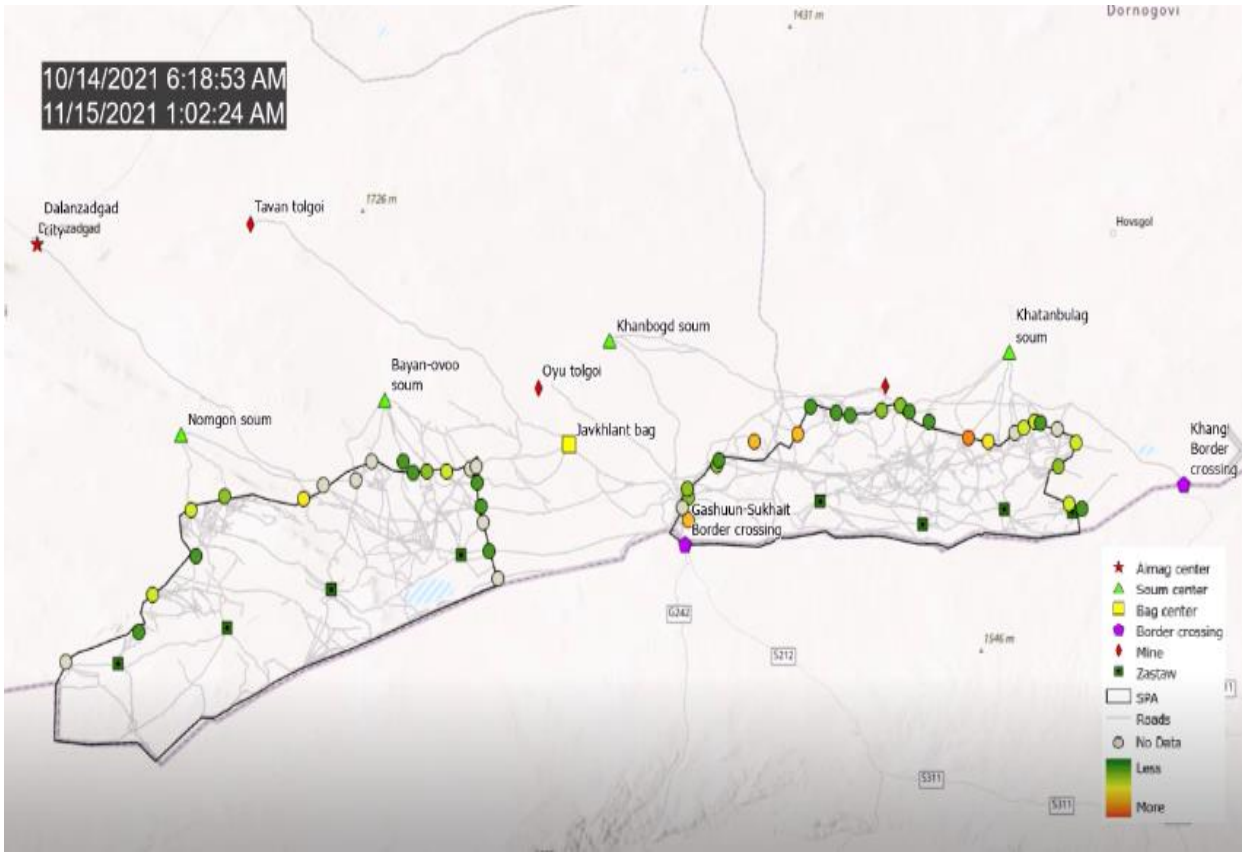
Appendices



An animation of the vehicle volume of a total of 47 traffic counters from September 2019 to December 2022 was released with a duration of 1 minute. /I attached a rar file/