Study on the Xinjiang Herder County Planning from the Perspective of Production-living-ecological Space

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Abstract. Herdsmen settlements project is one of the most important measures to improve production, living standards and economic revitalization of pastoral herders. Due to technical and economic constraints, the herdsman settlements currently have and imperfect construction. This article taking Wenquan County as an example explores the arrangement strategy for herdsman-friendly rural planning, defined the living, production, and ecological spaces from the perspective of herders. During the implementation of the settlement project, there has been a development dilemma in which the production space invades the ecological space and separate from the living space. Through the evaluation of suitability, the suitable settlements construction areas are defined from the perspective of production-living-ecological space. The agricultural and pastoral space should be properly separated to relieve the pressure on land-use and promote the high-quality development of agricultural and animal husbandry.

1. Introduction
For a long time, nomadic use of water and grass resources has been a very common form of animal husbandry in China's arid grassland areas. Herders have no permanent residence, no medical care, and children's education cannot be guaranteed. Along with rapid economic development and urbanization, the need to improve the lives of nomads in economically underdeveloped areas has become apparent. Since the late 1980s, the Nomads Settlement Project was planned by the national level, and Xinjiang, Tibet, and other places have begun to settle the herdsmen in orderly guidance.

Nomads settlements project is an important measure to fundamentally transform the nomadic traditional nomadic production, and change lifestyle and promote the economic development of the pastoral area [1]. Xinjiang prepared the "Xinjiang Herdsmen Settlement Project Implementation Plan (2011-2020)" in 2010, which plan will benefit more than 169,300 nomads with highly standardized settlements so that herdsmen can enjoy education, health care, and other public facilities services. However, during the construction process, external and internal factors have resulted in the herdsmen’s low willingness to settle [2]. Even in some areas, the phenomenon of “returning to nomadism” after settled has emerged, at present "semi-nomadic and semi-settled" has become the new normal of the herdsmen's production and lifestyle.

China's research on rural planning since 2008 has gradually deepened and shifted to comprehensive public policy guidance; research methods are gradually changed to a qualitative and quantitative comprehensive study. Research objects and research areas are mainly aimed at economically developed areas [3-4]. The research on rural planning in Northwest China economically backward areas relies on
local universities to have a certain research foundation, but the research is relatively less in nomads’ settlements as a specific group. In this background, this article takes Wenquan County in Xinjiang as an example, from urban and rural planning subject knowledge, based on the suitability of land space development and construction from the perspective of production-living-ecological space, it researches the rational arrangement of herdsmen’s village planning. Intending to raise herdsmen’s settle willingness, improve the life and production quality, it also provides a theoretical basis for the settlement projects in other pastoral areas.

2. Research process

2.1. Area of research

Wenquan County belongs to the Bortala Mongolian Autonomous Prefecture (hereinafter referred to as Bortala) of Xinjiang. "Bortala" is Mongolian meaning “Sparkling grassland”. The Bortala River originates here as the largest river in Bortala, As early as the Yuan and Ming Dynasties, Bortala was a Mongolian nomadic area. Now Mongolian herdsmen in Bortala are also one of the four major nomadic peoples in Xinjiang.

![Location map of Wenquan County in Xinjiang.](image)

Wenquan County is located in the west of Bortala, administers multiple townships, it is a border county with abundant agricultural resources, the agricultural population accounts for 65.3% of the total population, is one of 22 animal husbandry counties and 41 food production counties in the autonomous region. This county has a total population of about 75,000 people, including more than 9,000 people in the Corps. It is a highly multi-ethnic region and the minority population ratio is as high as 42.8%, including 17 ethnic groups like Mongolian, Kazakh, and Uygur. Wenquan County covers an area of 5585.85 square kilometers and belongs to a continental arid climate. It has many types of landforms such as snow mountains, alpine meadows, and mountain forests. The terrain in the arid regions has created very good seasonal pastures for animal husbandry, herdsmen can use grassland efficiently according to climate and terrain conditions.

2.2. Page Numbers Research methods and data sources

This paper is based on the suitability evaluation system of the "production-living-ecological" space. Use spatial analysis methods such as the analytic hierarchy process, accessibility analysis, and nearest neighbor analysis. Through quantitative data and results to assist explanation of qualitative analysis results. Evaluation of the rural planning suitability from the perspective of "production-living-ecological..."
space". First, according to the current land use status, identify the spatial function, and construct the space suitability evaluation system. Using ArcGIS spatial analysis, from the "background constraints -- single space suitability "to carry out the spatial suitability evaluation of herders' settlements. Finally, the single space suitability evaluation will be weighted and overlaid to obtain the "production-living-ecological space composite suitability evaluation", guiding the rational development of the planned space.

Terrain conditions are important factors that restrict development and construction. Quantitative evaluation using 30m × 30m as the basic unit, with a red line of arable land protection, basic farmland protection, and ecological protection as the bottom line [5]. Image recognition based on the current land use status in Wenquan County; according to the main functional properties of the land dividing three types of space [6-7]. The weight of weighted overlay analysis determined by consulting experts, by overlay and finally obtained a suitability construction evaluation chart of herder settlements.

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PLS = \sum_{i=1}^{n} w_i \times U_i
\]  

Where PLS is the suitability index of site selection for herders settlements, i is the i-th index, wi is weighted of the i-th index, Ui is the value of the i-th evaluation index.

This paper uses 2018 Landsat 8 OLI_TIRS 30m resolution satellite digital products (Path/Row147/29 and Path/Row 148/29), select summer cloudless images as the basic data, Using ArcGIS multiband blending and image explanation, refer to the 2011 land use map of Wenquan County and previous master planning, optimize road feature line style and residential feature borders, Draw a map of the 2018 land use situation in Wenquan County. Image fusion and overlay according to the spatial classification system to obtain vector data. The DEM data in this paper uses DEM 30m data (SRTM30m) from the Institute of Geographic Sciences and Natural Resources Research.

2.3. Research process

2.3.1. Geographical feature. By processing and analyzing the DEM data of Wenquan County, The county area is a typical mountain basin and characterized by a large altitude span. Overlay land-use status data, road elements, and settlement factors, the analysis shows that the residential areas are mainly distributed in flat basins in the middle of Wenquan County with an altitude of 700-1200m. In the process of screening herder settlements and farmers' settlements, through investigation, it is known except for the area of the herdsmen settlements is relatively large, there is no obvious difference between the siting and separated from local farmers, therefore this research object selects all construction land.

Figure 2. Map of land-use in Wenquan County (2018).
Table 1. Land use structure at different altitude sections.

| Elevation (m) | Land classification | Construction land | Arable land | Wood land | Grass land | Meadow | Rivers and lakes | Sparse grass land | Bare land |
|---------------|---------------------|-------------------|-------------|-----------|------------|--------|-----------------|------------------|----------|
| 700-1200      |                     | 70.65             | 405.05      | 77.41     | 143.10     | 0.12   | 41.01           | 135.57           | 0.00     |
| 1200-1500     |                     | 14.22             | 88.42       | 6.02      | 464.29     | 0.68   | 13.50           | 90.04            | 0.02     |
| 1500-1800     |                     | 1.17              | 14.34       | 0.47      | 594.03     | 7.84   | 20.72           | 73.60            | 0.01     |
| 1800-2200     |                     | 0.30              | 17.51       | 1.97      | 666.84     | 67.40  | 8.64            | 29.62            | 0.19     |
| 2200-2600     |                     | 0.08              | 7.93        | 0.06      | 413.34     | 312.35 | 2.32            | 0.12             | 1.21     |
| 2600-3000     |                     | 0.08              | 2.01        | 0.05      | 182.89     | 499.20 | 1.43            | 0.00             | 19.71    |
| 3000-3300     |                     | 0.08              | 0.05        | 0.00      | 91.43      | 277.78 | 1.48            | 0.00             | 136.47   |
| 3300-3700     |                     | 0.01              | 0.00        | 0.00      | 23.08      | 92.41  | 1.79            | 0.00             | 435.73   |
| 3700-4460     |                     | 0.00              | 0.00        | 0.00      | 0.03       | 1.27   | 0.01            | 0.00             | 107.21   |

Total area(km²) | 86.59 | 535.30 | 85.98 | 2579.01 | 1259.06 | 90.90 | 328.95 | 700.54 |

Table 2. Classification of land use functions.

| Type of space | Division                  | Subdivision                        |
|---------------|---------------------------|-------------------------------------|
| living Space  | Living land               | Residential land, transportation land, recreation land |
|               | Living-ecological land    | Landscape area                      |
|               | Ecological Space          | Water area, bare area, glacier, permanent snow, nature reserve |
|               | Eco- production Space     | wood land, grassland                |

According to the analysis, the land use types in Wenquan County have obvious vertical distribution rules, the altitude from low to high is as follows: rivers and lakes → woodland → construction land, arable land → sparse grassland → grassland → alpine meadow → bare land → glacier, permanent snow. According to the statistics of the current types of land use, grasslands, meadows, and arable land account for a large proportion, it meets the resource needs for the development of agriculture and animal husbandry as the mainstay industry. Under the land properties of various lands, divided it into the following types of land and space, as shown in the following table.

2.3.2. The production-living-ecological space definition from the Perspective of Herders. In April 2019, the author team conducted interviews and surveys on some nomads in Wenquan County, regarding the nomads’ production situation throughout the year, daily life status and production activity tracking, and their willingness to settle completely, to understand herders’ dissatisfaction and expectations. Based on the principles of ecological priority and sustainable development, from the perspective of herders define the production-living-ecological space [8].

(a) Living space

With the advancement of the settlement project, the traditional production and lifestyle of nomads have changed drastically. At present, most herdsmen have achieved semi-settled or settled status, who adapting to modern life, have got all-round improvement. However, up to three or four seasons nomadic that depend on natural pastures still the main mode of production for this group [9]. During the nomadic period, herdsmen have a simple diet and graze from 8 am to 10 pm every, except the time to transfer pastures, the living space of the herders is basically inside the fence. In contrast, the settlers have greater living space, a diverse lifestyle, ensuring forage supply and only need feeding livestock every day. It was learned during the survey that if a stable provides of livestock forage can be guaranteed, herdsmen's willingness to settle down is as high as 90%.
Figure 3. Map of herder settlements arrangement analysis.

Selects the current residential land as the research subject of living space, establish transportation network with roads, central towns and other facilities, analysis of the service scope of various facilities, use nearest neighbor analysis by ArcGIS. It can be seen that the residential areas in Wenquan County show a strong agglomeration in the county space. The settlements take traffic, terrain, and topography as the main sensitive factors, showing the distribution characteristics of hydrophilicity; the average distance between settlements is 2407m.

(b) Production space

The outstanding characteristic of nomads is that it is both a mode of production and a lifestyle, and animals are both production materials and living supplies [1]. When animal husbandry and agricultural are combined, herders’ lifestyles also change. During the ancient nomadic period, with insurmountable vulnerability and inefficiency due to natural factors, herdsmen have inadequate production capacity and impoverished living environment [10-11]. Settlement not only enriched the production methods of herdsmen but also beneficial to improving herdsman's anti-risk capabilities and promoting industrial transformation. But many years of experience makes it difficult to changes in production methods quickly, after the settlement, animal husbandry production is still the main production method and source of living for most herders [12].

The arable land, grassland, and meadow in Wenquan County are distributed from low to high at an altitude of 700-3000m. Herdsmen produce on the grassland and meadow depending on the season. The altitude of husbandry space decreases after herdsmen settle cause many contradictions, the amount of forage planting around the settlements cannot meet the needs of herdsmen's feeding, the food of animal is still dominated by natural pastures from spring to autumn, and herdsmen buy forages in winter.

Figure 4. Distribution of living-production space.
Analyze the production space outside the tourist attractions and nature reserves, compare it with residential areas and road facilities. That more than 90% of the construction land in the county area is concentrated between 700m and 1200m above sea level, and there is almost no construction land above 1500m; The production space is evenly and widely distributed from 700m to 3000m, most of the land below 1200m is arable land, and gradually changes to grasslands and meadows as the altitude increases. The settlement is used as living space, and the grassland is used as an important production space, above two have a serious imbalance in a spatial arrangement, so are separated from the perspective of herders.

(c) Ecological space
The Bortala River in Wenquan County flows from west to east into Ebi Lake, which as a national ecological protection area, has an important status in the ecological system of Bortala. Water and grass are the most important production materials for herders, it is also a significant ecological space in Wenquan County. The ecological goal of herder settlement is to replace the natural grassland by establishing artificial grassland and increasing capacity, reduced grazing, make full use of grasslands and prevent grassland degradation. Make the ecological function sustainable, and finally achieve the balanced development of grassland and animal, improve the defense capacity of the entire grassland ecological environment. However, in reality, some herders try to change their production methods, while squeezing natural pastures by reclamations, exacerbated the conflict between grass and livestock.

![Distribution of ecological-production space.](image)

Select tourist attractions, nature reserves, forest land, water, and other ecological space surfaces as the main research space. Overlay analysis of production and ecological space, as shown in Fig.5, the green range is the overlap, are mainly grassland and meadow. Due to the special nature of grazing, grassland is both a production space and an important ecological space, Wenquan County as an animal husbandry county with a high proportion of grassland, resulting in the serious conflict between ecology and production space.

3. Discussion of results and optimization measures

3.1. Implementation dilemma of the herdsmen settlement project
Since the project was implemented, standardized construction of settlement projects has effectively alleviated the contradiction between the production-living-ecological spaces, but progress has slowed in recent years constrained by the humanities and economic [11, 13]. Some herders maintain the original nomadic production and living habits, live in settlements only during winter. There are many difficulties in the settlement planning process, given the low satisfaction of herd's settlements. Comprehensive consideration of the separation between living and production space, and the overlap between ecological and production space, the following main reasons are summarized.
3.1.1. The settlements project is hard to fulfill production needs. By processing and analyzing the DEM data of Wenquan County, overlay land-use status data, road elements, and settlement factors, in the process of screening herder settlements and farmers' settlements, through investigation, it is known except for the area of the herdsmen settlements is relatively large, there is no obvious difference between the siting and separated from local farmers, therefore this research object select all construction land.

Around the settlements, the development planning of related industries around the settlements is insufficient, short in the construction of artificial grassland and limited forage reserves, seriously restricted the improvement of animal husbandry level and the amount expansion of livestock, and hampering herder’s income increase. We can learn that the present settlements project is hard to fulfill the needs of herder’s production.

3.1.2. Herdsmen's uncomfortable life leads to a low willingness to settle. Nomadic groups are greatly influenced by traditional family values, grazing with parents since childhood and insufficient education, so there may be some trouble in social interaction and they get used to traditional nomadic life [15]. As the settlements are guided by the government, due to insufficient funds, factors such as site selection, supporting facilities, and construction standards are imperfect, herdsmen do not fully feel the superiority of settlement life, Lack of belonging further leads to reduce motivation. In some multi-ethnic settlements have also difficult to adapt to live due to language and ethnic lifestyles.

Through communication with local herders that most semi-settled herdsmen have adapted to the current condition, and also recognized that settlement has improved their lives. When asked if it would be difficult to abandon nomadism after the construction of standardized husbandry settlements in the future, most say they will give up. It can be considered that the herdsmen generally agree with the settlements, but are not satisfied with the current supporting facilities of the settlements.

3.1.3. The settlement location did not guide environmental protection. Modern animal husbandry requires the coordinated development of crop farming and animal husbandry; after the herdsmen settle, a certain area of farmland will be allocated to assist in animal husbandry production. In recent years, large areas of natural grassland have been reclaimed, increased irrigation water caused rivers to shrink. Groundwater levels drop, causing meadow vegetation to decay, the amount of natural pastures feeding has decreased, contradictions become more acute as the number of livestock continues to increase.

The settlement project should have been an important measure to guide herdsmen to settle and thereby protect the ecological environment, standardized husbandry model is conducive to the sustainable development of grassland animal husbandry. However, the current planning and siting of settlements do not take into account the conflict that the herdsmen may invade the ecological space while changing the production methods, thus causing disturbance to the ecological system.

3.2. Optimization measures for herder settlement projects
The above three aspects are the main dilemmas in the current plan for the settlement of the herdsmen, the issue of site selection is one of the important problems in rural planning from the perspective of production-living-ecological Space. It has an important impact on meeting the production needs, improving the quality of life, and protecting the ecological space. The following attempts to propose corresponding improvement measures for the above problems.

3.2.1. Settlement structure from the perspective of living space. Selecting living space and analyzing the current arrangement, based on the settlements’ average distance set up the buffer. Construct a traffic analysis network based on the roads planning in Master Plan; build buffers with central towns; the slope is divided into four levels of 0-8 °, 8-15 °, 15-25 °, and 25 °. Determine the value of various indicators through expert evaluation method. Get the result of Fig.6 by calculating the score, suitable areas are mainly distributed in the flat terrain of the mid-east parts of Wenquan County, which are more appropriate for development and construction; relying on high-density and high-grade road networks, herdsmen obtain a good experience by using various service facilities efficiently.
3.2.2. Grazing-living balance from the perspective of production space. Selecting production space, and reduce the value within 100m of the scenic area and nature reserves buffer zone. Considering the goal of settlements' standardized husbandry in the future, proper slope and elevation are more conducive to large-scale forage planting. As shown in fig.7, the suitable areas of animal husbandry production are mainly near water and close to grassland. To ensure the forage resources required by herdsmen to continue animal husbandry after settlement, there should be a certain scale of forage plantation land around the settlements, the land required for the long-term should also be considered. Animal husbandry production must not only consider the injection of external resources but also pay attention to the settlements' internal functions layout. Separation of humans and animals, and standardized husbandry are very necessary, the scale of facilities such as animal pens must also have shown great foresight.

3.2.3. Sustainable resources from the perspective of ecological space. Regions with lagging economies have limited inputs for sustainable ecological development, so strive to maximize social and ecological benefits, and the rational planning of settlements deserves attention. The ecological space is mainly glaciers and permanent snow-covered areas. Due to the high altitude, the restrictions on development and construction are not obvious. The most important task for herdsmen to settle is to protect the ecological space, guide herdsmen to change the animal husbandry production method, changing year-round grazing to warm-season grazing, and carry out systematic and planned use of grassland grazing. To restore grassland ecological functions, severely degraded pastures will be gradually closed.
3.2.4. Rural planning under the consideration of production-living-ecological Space. Based on the study of the spatial suitability of single space, use ArcGIS overlay the above three types of evaluation of production, living, and ecological space. According to the coordination between the three types of functions, the land in Wenquan County is divided into four areas as shown in fig.9, the suitable construction areas are the best location for herders settlements; under the principle of giving priority to the ecological space protection, and taking into account the distribution of forage land, it will be more convenient for herder’s lives and production in the future.

It is found that the current residential are basically in suitable locations, but the suitable area is higher than the current residential area and closer to the water, showing the strong dependence on natural resources of the animal husbandry economy. A little rise in herder settlements elevation can effectively distinguish animal husbandry from the farming economy. On the one hand, it makes the herders closer to the production space, which benefits the sustainable development of agriculture; On the other hand, it also avoids the ecological and land-use pressure caused by the high overlap between the production and ecological space. To enable herders to spontaneously change their production methods, complete supporting facilities, high-standard construction, and standardized husbandry facilities and space are also essential.

4. Conclusion
In the early stages of the herder settlements construction, production-living-ecological Space was an important consideration. Traditional rural planning focused on the construction of living space and ignored the coordination of spaces. In the implementation phase, the effective use of government
investment funds and the implementation of high construction standards to the end, are strong support for high-quality settlements. The optimization of settlement location and the improvement of facilities are important guarantees for the sustainable production and life of herders. The settlements integrated living and production are the development direction of the future, so in this kind of rural planning, more attention should be paid to the construction of a production-living complex space.

In the progress of the settlement project, the government needs to focus on the coordinated development of settlement work and urbanization, take comprehensive measures, increase the herders’ income and quality of life, and promote the implementation of projects. So that herdsmen can bring themselves into the socialist modern life. And finally, achieve a win-win for the government and herdsmen.

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