Analysis on the Comprehensive Utilization Degree of Typical Villages in the Agricultural-Pastoral Intersection of Horqin Sandy Land from 1990 to 2015
Taking Mother and Son Mountain Village of Chifeng City as an example

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Abstracts: The eco-environment in the agro-pastoral ecotone of Horqin sandy land is fragile and the land use is unreasonable. Based on the typical mother-son mountain villages in ecological environment, population and economy, and according to the interpretation data of remote sensing images and field survey data, the present situation and dynamic changes of land use in the village area were quantitatively analyzed from the micro perspective. The results show that the cultivated land area of Mother and Son Mountain Village village has fluctuated in the past 25 years, increasing from 836.53 hm² in 1990 to 1011.01 hm² in 2000 and decreasing to 651.23 hm² in 2015; the pasture area has decreased from 1437.15 hm² in 1990 to 675.8259 hm² in 2015; the grassland coverage has decreased, and the grassland with high coverage has decreased in 1990. The annual proportion of grassland area was 13.58%, which decreased to 0 in 2015; the forest coverage increased rapidly from 17.6% in 1990 to 53.1% in 2015; and the desertification land area decreased sharply from 13% in 1988 to 3%. In the past 25 years, the land use change index of Mt. Mozi is 9.35. The degree of human land change is increasing, and the relationship between human and land is becoming closer and closer. The degree of land use has changed from low level to high level. The main reasons are population factors, changes in livestock and the results of the adjustment of national policies.

The farming-pastoral ecotone in Horqin Sandy Land includes Horqin Right Wing Middle Banner of Xingan League, Tongliao City and Chifeng City, each of which has a total land area of about 142,500 km² and a population of 6.167 million, of which the rural population is 493,480,000 [1]. Historically, the area was dominated by animal husbandry, with abundant aquatic plants and cattle and sheep everywhere. Due to the rapid growth of population and unreasonable land use over a long period of time, the ecological system of the area was degraded and the economic development was backward. Fourteen of the 16 banner counties belonged to poverty-stricken counties. Reasonable land use is the key to ensure the ecological security and economic development of the region. Relevant experts and scholars have carried out extensive research on this issue, but most of them are based on macro-level research, which can better show the large-scale pattern changes, but the quantitative research on micro-level is...
rarely reported. The research based on micro-perspective is more convenient to grasp the
essence of the development of things and reveal the inherent law of the development of things
[2]. In the ecotone of agriculture and animal husbandry, there are significant regional differences
in both natural and human aspects. Therefore, in order to fundamentally solve the ecological
and economic problems in the region, the micro-quantitative research in different regions must
be focused on. Based on the typical mother-son mountain villages in ecological environment,
population and economy, the author conducted a field survey in August-September 2016.
Combined with the statistical data of township government and village committee and remote
sensing image data provided by relevant departments, the author analyzed the dynamic changes
of land use in the past 25 years and made use of soil. The dynamic degree model of land use is
used to measure the degree of comprehensive land use in order to provide scientific basis for
the rationalization of land use and the sustainable development of agriculture and animal
husbandry in this area.

1. Introduction
The mother-son village in the study area is located at the southernmost end of Saliba Township in the
middle of Aohan Banner, 15 km away from the township government. In the East and north, Lao
Niugou Village and Zhang Jingyingzi Village in Saliba Township are adjacent to each other, while in
the South and west, Xinhui, Hongnianggou Village and Jiahaigou Village in Sidetang Township are
adjacent to each other. Its geographic location is 119°48′42″, N. The climate belongs to the
continental monsoon climate area. It is dry and windy in spring, with an average wind speed of about
48 m/s. Temperature warmed up quickly; summer was short and hot, rainy and hot in the same season,
and autumn temperature dropped sharply. The average annual temperature ranges from 7 to 9 and
the accumulated temperature of 10 is 2600 to 3200. The frost-free period lasts about 135 days. Spring frost
usually ends from May 5 to 8. Autumn frost appears from September 28 to 30. The annual sunshine
hours are 1500 to 1630 hours and the annual precipitation is about 350 mm. The landform is loess hilly
platform. Mother and Son Hill Village has 12 villager groups and 9 natural villages, namely Budengao,
Yangshuwanzi, Mother and Son Hill, Zhalandi, Chenjiawopu, Chai Cao Gou, Running Water Well,
Najina and Lao Yizigou. By the end of 2015, the total population of the village was 1313, including 31
ethnic minority population, 318 households, 318 agricultural households, 1313 agricultural population
and 613 total labor force. Among them, 576 people of working age lived in relatively scattered areas
with a population density of 39.22 people/km². Agriculture is the main industrial structure in the
village, while forestry and animal husbandry account for a small proportion. Maize, millet, sorghum
and beans are the main crops, and sunflower and sesame are the cash crops. In 2015, the per capita
income of farmers and herdsmen was 1920 yuan. There was no organic farmland area in the village,
and farmland depended on animal farming. Traffic is inconvenient. All the people in the whole village
walk in and out of the ditch. There is only one sand and stone road outside which connects with the
ditch.

2. Research methods
The remote sensing data covering Muzishan Village in 1990, 2000 and 2015 (LandsatTM/ETM/OLI,
resolution 30 m) were used to obtain the remote sensing data of the study area through geometric
correction, image clipping and mosaic. The multi-scale segmentation in object-oriented classification
method [3-5] is used to interpret remote sensing data and obtain three-year land cover data. Based on the
data of field social survey (archives data, statistics of village committees and township governments,
survey data of village conditions), land use data of Mother and Son Mountain Village in 1990, 2000
and 2015 were obtained. The dynamic degree model of land use, the comprehensive index model of
land use degree and the comprehensive change model of land use degree were used to make a
comprehensive analysis of land use in the study area. Among them, the proportion of cultivated land
interpreted by remote sensing is larger than that of government statistics, mainly because: in the
agro-pastoral ecotone, the phenomenon of farming and grazing is widespread, and it is sometimes
difficult to distinguish between cultivated land and abandoned wasteland by remote sensing images; because of the relatively large pixels, it is difficult to grasp small areas of cultivated land, forest grassland, ridge; in addition, it is difficult to grasp agricultural taxes and ridges. For the reasons of returning farmland to forestry and pasture, local farmers and herdsmen report less cultivated land and less statistical cultivated land. For example, in the survey, it was found that the per capita cultivated land reported in Liushuijingzi Village was 0.31 hm², while the actual per capita cultivated land was more than 0.67 hm², more than twice the reported amount. Farmers planted crops between forested land and grassland. To increase grain production.

3. Land use status and dynamic change

3.1 Current Situation and Dynamic Change of Cultivated Land Resources
Since 1990, the cultivated land area of Mother and Son Mountain Village has fluctuated, mainly due to population pressure, national policies and the impact of ecological environment. The dominant factors are different in different periods. From 1990 to 2000, the arable land area of Mother and Son Mountain Village increased from 836.53 hm² in 1990 to 1011.01 hm² in 2000. The proportion of arable land in total land area increased from 25% in 1990 to 30% in 2000. From 2000 to 2015, the arable land area of Mozishan Village decreased rapidly. In 2015, the arable land area was 651.23 hm², and in 15 years, it decreased by 360 hm², with an average annual reduction rate of 7.12%. From the late 1980s to the 1990s, driven by the national development policy and the increase of population, farmers and herdsmen reclaimed a large number of wasteland and grassland, which increased the area of cultivated land. Due to the fragility of the agro-pastoral ecotone, unreasonable reclamation caused the deterioration of the local ecological environment. In recent years, especially after 2000, the state has intensified efforts to adjust the eco-environment fragile areas such as the agro-pastoral ecotone. Many measures have been taken to restore the ecosystem, such as the ecological protection measures of returning farmland to forestry and grassland, which has reduced the cultivated land area.

3.2 Current Situation and Dynamic Change of Grassland Resources
The grassland area of Mother and Son Mountain Village has been decreasing for more than ten years. From 1990 to 2015, the grassland area decreased 761.33 hm². Especially during 1990 to 2000, the rate of reduction was very fast. In 2000, the grassland area was 752.82 hm², which was only 52% of 1990. Meanwhile, the grassland degradation was serious and the grassland area with high coverage was very high. The proportion of grassland in 1990 was 13.58%, and that in 2000 was 0.73%. In 2015, there was no grassland with high coverage in Mother and Son Mountain Village. The main reason is that a large number of grasslands have been converted to arable land and woodland, while cultivated land is constantly in the vicious circle of reclamation-planting-abandoning-reclamation, resulting in the reduction and degradation of grassland. Since 2000, the grassland area has been effectively controlled by the national policy.

3.3 Current Situation and Dynamic Change of Forest Land Resources
The total area of forest land in Mother and Son Mountain Village in 2015 is 1776.62 hm². The forest coverage rate has increased from 17.6% in 1990 to 53.1% in 2015. It has been growing rapidly in recent ten years. Among them, shrubs account for 44% of the total area of forest land and woodlands account for 43%, of which more than 90% belong to shelter forest. In addition, there are wildlife, microorganisms and other biological resources attached to forests. These artificial forests, natural secondary forests and natural forests have laid a solid foundation for the ecological environment restoration and economic development of the village.

3.4 Status and Dynamic Change of Sandy Land
Since 1990, the area of desertified land in Mother and Son Mountain Village has decreased sharply, to 102.08 hm² by 2015, and the proportion of total land area has decreased from 13% in 1990 to 3%.
From the above data, we can see that the effect of controlling desertification in Mother and Son Mountain village in recent ten years is remarkable.

4. Analysis of Land Use Dynamics and Comprehensive Utilization Degree

The dynamic change of land use can be measured by the dynamic degree model of land use. The quantitative change of a land use type in a certain period of time in the study area of land use dynamic degree is expressed as follows:

$$LC = \left( \frac{U_b - U_a}{U_a} \times \frac{1}{T} \times 100\% \right)$$ (1)

In the first formula (1), LC is the dynamic degree of a land use type in the study period; $U_a$ and $U_b$ are the number of a land use type at the beginning and the end of the study period respectively; T is the long study period. When the T period is set to a year, the LC value is the annual change rate of a land use type in the study area. According to the above formulas, the dynamic degree of land use in Mother and Son Mountain village is calculated. From 1990 to 2015, the absolute dynamic value of grassland, woodland, sandy land and residential land exceeded 0.030, and the absolute dynamic value of cultivated land exceeded 0.020 in 2000-2015. The change of woodland was the most obvious, and the dynamic degree was as high as 0.1188. Among them, woodland and residential land showed an upward trend, while cultivated land and grassland decreased in general. Mainly due to local policies, large-scale afforestation in Mother and Son Mountain Village in the past two decades has resulted in a rapid increase in forest area, and some grasslands and arable land have also been converted into woodland.

The degree of comprehensive land use can reflect the degree of human change to the natural system. This can be analyzed quantitatively. Firstly, according to the research results of relevant scholars on the degree of land use, combined with the attributes of land use in Mother and Son Mountain village, the degree of local land use is divided into four levels, each level is given corresponding grading index.

$$L_a = 100 \sum_{i=1}^{n} A_i \times C_i$$ (2)

(2) In the formula, $L_a \in [100,400]$, which represents the comprehensive index of land use degree; $A_i$ is the grading index of land use degree of grade I; $C_i$ is the percentage of grading area of land use degree of grade I.

The size of comprehensive index reflects the level of land use. The calculation model of comprehensive land use change is as follows:

$$VL_a=L_b-L_a=100 \sum_{i=1}^{n} A_i \times C_i - \sum_{i=1}^{n} A_i \times C_i$$ (3)

(3) In the formula, $L_a$ and $L_b$ are the comprehensive index of land use degree in a-time and B-time regions; $A_i$ is the grading index of land use degree in grade I; $C_i$ and $C_i$ are the percentage of grading area in grade I of land use degree in a-time and B-time regions. In the analysis of land use change from time a to time b, if $VL_a$ is positive, the land use in the region is in the development stage, that is, the degree of utilization is constantly improving; otherwise, the land use is in the adjustment or recession period, and the degree of land use is declining. Based on the above two models, the land use change index of Mother and Son Mountain Village in 1990-2015 can be calculated.

$$VL_{1990-1990}=224.89-215.54=9.35$$ (4)

$$VL_{2000-1990}=229.06-215.54=13.52$$ (5)

$$VL_{2015-2000}=224.89-229.06=-4.1$$ (6)

From the above results, we can see that in the 25 years from 1990 to 1990, the change index of land use degree is 9.35, the comprehensive utilization degree of land is generally improving, the degree of human land change is increasing, the relationship between human and land is getting closer and closer, and the degree of land use is changing from low level to high level. If we look at the period from 2000 to 1990 in stages, the degree of land use is greater, the change index is 13.52, which is in the rapid development stage; the land use change index is - 4.17 from 2015 to 2000, which indicates that the land use is in the adjustment period after 2000.
5. Influencing factors analysis

5.1 The Impact of Population Factors
The change of population causes the change of land use. Over the past 25 years, the total population of Mother and son Mountain Village has been decreasing, from 1388 in 1990 to 1308 in 2015, a total of 80 people have been reduced. Meanwhile, the annual birth population (birth rate) has also been decreasing, from 22 in 1990 to 16 in 2015. This change has lessened the pressure on resources and environment. However, according to the international population carrying capacity standards, the population density in semi-arid areas should not exceed 20-25 people/km², otherwise a large number of immigrants should be required. In 2015, the population density of the village was 39 people/km², although it was reduced compared with 1990, but because of the large population base, it still far exceeded this standard. Population pressure makes cultivated land expand continuously, large areas of grassland are reclaimed, and unreasonable land use leads to land degradation.

5.2 Impact of Livestock Change
In the past 25 years, the area of pasture has been decreasing, but the total number of livestock has been increasing. This phenomenon has increased the burden of pasture. In 2015, the average amount of pasture per sheep unit is 0.21 hm². In semi-arid areas, the national standard is 1.04 hm² for each sheep unit, and only the mother-son mountain village and the national standard. Although the village adopted the policy of "seasonal forbidden grazing", the phenomenon of overgrazing was serious, which resulted in the decrease of grassland coverage and the degradation of grassland.

5.3 Impact of Policy Adjustment
In the late 1990s, the farming-pastoral ecotone in Horqin Sandy Land was damaged by unreasonable land use methods such as reclamation and grazing, resulting in the destruction of vegetation, the decline of soil fertility, the decline of land productivity and land carrying capacity, forming a vicious circle, which had a serious impact on the sustainable development of the local and even the whole country. Therefore, the project of returning farmland to forestry, grassland and forbidding grazing, which began in 2000, has played a significant role in improving the ecological environment and effectively controlled the increasing trend of cultivated land area in this area. After more than 10 years of harnessing, the mobile semi-mobile sandy land has all disappeared, and only 102.08 hm² of the fixed sandy land is left at present.

6. Conclusion and discussion
Based on the survey data of 302 households' social and economic conditions and archives data, the statistical data of village committee and township government, combined with remote sensing image data, the land use data of Mother and son Mountain Village village in 1990, 2000 and 2015 were obtained. The land use dynamic degree model, land use degree comprehensive index model and synthesis were used. The land use in the study area was comprehensively analyzed with the land use degree change model. This paper attempts to make quantitative analysis from the micro perspective, which complements the previous macro-perspective research.

Because of the lack of data, the author only collects Landsat remote sensing images with a resolution of 30 m, and corrects them precisely with topographic maps. According to field surveys and statistical data, landmark interpretation signs are determined. There are still some deviations in the interpretation data for the micro-village system research. There are many factors affecting land use. How to quantify the micro-village remains to be studied in depth.

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