

Empirical Analysis of Pastoralists' Sustainable Livelihood within Mineral Exploitation: A Case Study of Huogeqi Sum in Inner Mongolia

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Abstract—The aim of study is to evaluate the pastoralists' livelihood capital of Huogeqi sum in Inner Mongolia within mineral exploitation. We construct mineral exploitation sustainable livelihood framework to reveal the relationship between livelihood capital and livelihood strategy, basing on sociological and statistical method such as questionnaires, entropy and logistic regression analysis. The results indicated that: 1. the stock of pastoralists' human capital, material capital, cultural capital is higher, and the stock of natural capital, social capital and financial capital is lower. 2. Pastoralists' livelihood strategies can be divided into livestock type, mixed type and non-livestock type. 3. The pastoralists with higher stock of natural capital and cultural capital incline to choose livestock strategy and mixed strategy, pastoralists with higher stock of human capital and financial capital are apt to select the non-livestock strategy. 4. Mineral exploitation and the shortage of pastoralists' capital will limit the adjustment for better livelihood.

Keywords—*Mineral exploitation; Pastoralists; Sustainable livelihood framework; Livelihood capital; Livelihood strategies*

I. INTRODUCTION

The mineral exploitation on prairie referred to in this paper lays interest in the pastoral area of Inner Mongolia Autonomous Region (IMAR). The grassland of IMAR is not only the base of animal husbandry, but also rich in mineral resource (Da&Zheng,2006)[1]. In recent years, with the acceleration of industrialization and China's Western Development Program, the mineral exploitation has boomed in the pastoral area of Inner Mongolia. In terms of the role played by the mining in a country, some studies have indicated that the mineral exploitation has always been deemed as the significant factor to boost the economic development of both developed and developing countries (Stevens P,2007) [2]. The investment of mineral exploitation should not only boost the economic growth and drive the economy to prosperity, but also spread the benefit to the poorest (Judith Rees,2002) [3].

The mineral exploitation has increased the growth of the GDP in IMAR. From 2000, mining industry has become the major industry in IMAR. Its profit has increased from about 0.16 billion in 2000 to 70.423 billion in 2014 with its ratio for the total industry has increased from 9.94% to 54.20% (Zhang,2016) [4]. However, the livelihood of pastoralists has

been seriously affected by mining. Pastoralists are in a passive situation and cause the attention of political circle and academic circle in China. The externality of mineral exploitation has not only exerted the negative influence on the well-being and development of pastoralists (Wang, 2010) [5], but also increased the risks that pastoralists will have to endure in the future (G.S. Daia et al.,2014) [6]. The benefit distribution of mineral exploitation has resulted in the progressively fewer mineral resources, a growing number of rich people and the increasing poverty (DRCIM,2009)[7]. Even worse, the gap between the rich and the poor would be consequently out of control, and contradiction among different ethnic groups would be intensified progressively (Da and Yu, 2014) [8].

The foregoing research is deemed to be significantly critical for us to understand the current influence of mineral exploitation on the livelihood of pastoralists in IMAR, but these researches can be further deepened and optimized. First and foremost, more research simplified the livelihood as the economic topic centered by income and expenditure. Due to the unique culture and ecological characteristics of the grassland in IMAR, a multi-dimensional interpretative framework should be adopted to analyses the influence of multiple uncertainties caused by mineral exploitation on the livelihood of pastoralists. Second, the activities associated with mineral exploitation were proved to damage the livelihood of pastoralists. However, few studies concerned about different difficulties to be faced and the livelihood strategy to be adopted by the pastoralists within the mineral exploitation. In addition, the contrastive analysis of the type of pastoralists' livelihood plays the critical role in the selection of livelihood strategy. In this regard, this study seeks to illustrate the status of pastoralists' livelihood capital and the relation between capital and livelihood strategy through adopting the framework of sustainable livelihood. On that basis, this study aims to ascertain the factors confining the sustainable livelihood of pastoralists in different types.

II. MATERIALS AND METHODOLOGY

A. Study site

First, This survey was carried out in Huogeqi sum¹, which lies in the west part of IMAR in the North of China, ranging from east longitudes of 106°24'07" to 106°25'32", and north latitudes of 41°24'11" to 41°74'57". This area includes a total of 9323 Km². Huogeqi sum is an animal husbandry sum, which dominated by the Mongolian nationality. By the end of 2015, 2439 people of 896 families lived in this sum, the annual per capital income were 11060 Yuan. Among these residents, 834 people from 194 families engaged in grazing. Sum is with the average elevation over 1200m, takes on the climatic characteristic of high wind, heavy sand, low precipitation, short frost-free season, and the annual precipitation less than 80mm, and pertains to the typical desert grassland (URB local chronicles compilation committee, 2015) [9]. The desert is in the north of sum, hilly land lies in the south. The multi-metal mineral zone lies in the south of sum, and the copper mine which is the sixth largest resource reserve in China lies in sum. It has been upgraded as the large-scale combined enterprise, which taking on the mining and processing ability of 3 million ton per year. In 2016, the net asset of the copper mine was 3.00774 billion Yuan, the turnover reached 0.78781 billion Yuan, and the net profit was 77.26 million Yuan. As the local big tax-payer, the copper mine has totally turned over 1.48 billion Yuan since its establishment, with 0.2 billion Yuan annually turnover. It has successively been titled as "the Most Caring Enterprise", "A-level Credit Taxpayer" and others honor on the level of municipality.

B. Method

During the summer of 2016, the research team conducted field works in three gacha nearby the copper mine. Questionnaires were designed to collect data on the livelihood assets and the livelihood strategy of pastoralists' households. Due to the scattered pastoralists, the sampling investigation failed to be adopted, and the research had to conduct the investigation in the region surrounding the copper mine. After excluding erroneous responses, we obtained 91 appropriately completed questionnaires. In the quantitative method of data, we adopted the method of assignment and different standardization to standardize the data. The entropy method was used to measure the weight of the index system of livelihood capital. To measure the relationship between livelihood assets and livelihood strategy, logistic regression analysis was used in this study.

C. Study design

Livelihood can be simply defined as the approach or method to sustain the life, including assets (natural, material, human, financial and social assets), action and the rights to obtain these assets (Ellis F, 2000) [10]. Sustainable livelihoods refer to the ability that individuals or families have to make a living and obtain assets in order to improve their long-term

living conditions (Roberts & Yang, 2003) [11]. It also indicates the income surmounts the expenditure and the family has savings (Sati & Prasad, 2014) [12]. Given that the research institutions or individuals have different developmental ideas, multiple analytical frameworks have been created for livelihood. Since the 1990s, the SLA analytical framework of DFID in Britain has been employed by several primary international institutions in virtue of its rational characteristics of being experienced, logical and open (Morse & Mcnamara, 2009) [13]. Hence, SLA has become the popular method to implement the intervention for development. It consists of three variables which are livelihood capital, institution and policy background, and sensitive background. Firstly, SLA focuses on the interactive relations between livelihood factors under certain sensitive environment and policy background. Secondly, it concerns about how people maintain the sustainability of multiple assets (nature, human, society, material and financial) and make choice of livelihood strategy. The crux of SLA is to estimate different assets. In recent years, some scholars seek to apply the Metis² to SLA as the cultural capital (Tao et al., 2010) [14]. In Chinese academic field, SLA has been extensively adopted to analyze livelihood, such as the analysis of Tibetan pastoralists' livelihood capital and the population subjected to poverty (Li & Mao, 2012) [15], and the influence exerted by climate change on the pastoralists' livelihood (Chen et al., 2013) [16].

Guided by SLA, we analyze the influence of mineral exploitation on the sustainable livelihood of pastoralists and build the mineral exploitation-sustainable livelihood analytical framework (ME-SLA Framework, as shown in Fig. 1). This frame is different from the conventional SLA framework as follows. Firstly, arising from the indispensably important role of unique Mongolian culture and local livelihood knowledge of pasturing on maintaining the sustainable livelihood of pastoralists in IAMR, cultural capital is introduced in the multiple assets combination. So the ME-SLA Framework includes material capital, human capital, natural capital, social capital, financial capital and cultural capital; Secondly, According to the field work, mineral exploitation as the developmental program strongly advanced by the local government has broken the balance between the ecology of animal husbandry and economic compound system under the grassland contract policy and grassland Feed-animal Balance policy. Mineral exploitation had permanent effects on the pastoralists' livelihood and livelihood strategy. As a result, it can be manifested as the background of institution and policy. Thirdly, given the local ecological context and the pasturing livelihood characteristics, the vulnerability background and the allocation of pastoralists' livelihood capital strongly interact

² James C. Scott invokes the metis concept in his book "Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed". The practical or cunning intelligence called metis in early Greek poetry and discussed under other names by later Greek philosophers, particularly Aristotle. Scott understands metis as "a wide array of practical skills and acquired intelligence in responding to a constantly changing natural and human environment." In literature, the central example is Odysseus, who demonstrated metis through his ability to improvise to the complexities of ever-changing situations. The essence of metis—the characteristic that all these failed state projects disregard—is knowledge about when and how to apply rules of thumb to concrete situations.

¹ In the administrative organization of the Inner Mongolia Autonomous Region, banner, sum, gacha correspond to county, township and village in the provinces. Further annotation of these terms will not be provided in the paper.

with each other. These two factors and the mineral exploitation jointly determine the selection of pastoralists' livelihood

strategy. Additionally, the livelihood output of pastoralists should further influence the setting of livelihood capital.

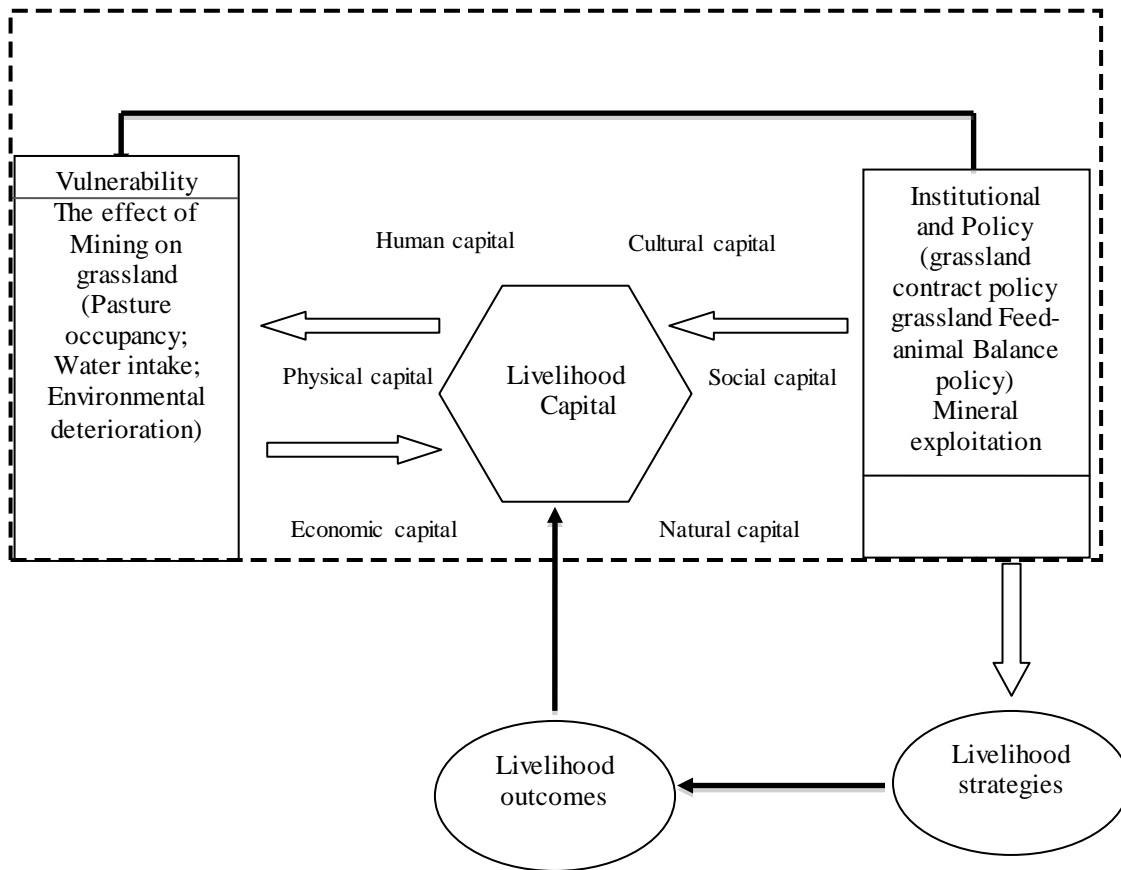


Fig. 1. The mineral exploitation sustainable livelihood framework

III. RESULTS

A. Quantification of pastoralists' livelihood capital

Combined with the ecological environment, resources endowment, cultural practices within mineral exploitation, a suitable measurement index system is designed to measure the local pastoralists' livelihood capital in this paper. Moreover, we borrowed ideas from some studies (Xie et al.,2010)[17] to design the livelihood index. Firstly, grassland and water are the most important resources for the livelihood of pastoralists. As a result, the grassland area (N1), grassland quality (N2) and water source quality (W1) were represented the index of natural capital. Secondly, we selected livestock quantity (P1), housing assets (P2), productive and domestic assets (P3) as the material capital. Thirdly, the labour force of both men and women is equally important in the pastoral areas. In addition, the levels of education are crucial to the transformation of animal husbandry, so we adopted the household laborers (H1) and the education level of family members (H2) to measure the human capital. Fourth, we selected the household income (E1), whether there are informal channels for obtaining credit (E2), and whether there are formal channels for credit availability

(E3) as the measure of financial capital. Fifth, we selected whether there are the cadres in family (S1), participated in community organization (S2), and the neighbourhood relationship (S3) as the measures of social capital. Sixth, cultural capital refers to the human society which have means of dealing with the natural environment and adaptability, such as world outlook, the world view, philosophy and ethics, religion, traditional ecological environment knowledge, cultural diversity, etc. (A Skjerven&J Reitan,2016) [18]. We selected skilfully use of the Mongolian (C1), skilfully grazing(C2), and familiar with traditional culture (C3) as the measures of cultural capital. The specific assignment and calculation procedure of the index are shown in TABLE I.

TABLE I. EVALUATION INDEX SYSTEM AND QUANTIFICATION OF PASTORALISTS' LIVELIHOOD ASSETS

Capital types	Index	Explanation	Symbol	Evaluation
Human capital	household laborers	Age	H1	H1=H11*0.25+H12*1.0+H13*0.75+H14*0.5
	education level	Educational background	H2	H2=H21*0.00+H22*0.25+H23*0.50+H24*0.75+H25*1.00
Natural capital	grassland area	Contracted grassland area	N1	N1= Actual grassland area /the households' maximum grassland area in investigate
	grassland quality	Subjective evaluation	N2	Good=1.00,Average=0.67,Poor=0.33
	water source quality	Subjective evaluation	N3	Good=1.00,Average =0.67,Poor=0.33
Material capital	livestock quantity	The number of livestock	P1	Conversion of cattle and horses by 5 sheep units, camel to 8 sheep units; P1=The actual number of livestock/ the households' maximum number of livestock
	housing assets	Brick house	P2	Have=1,have not=0;
	productive and domestic assets	Production and means of livelihood	P3	Have=1,have not=0; P3= The amount of productive capital owned / All the amount of capital
Economic capital	household income	Husbandry income; Prohibited grazing subsidies; grassland Feed-animal balance subsidies; mineral compensation; part-time job salary; other income	E1	E1= Family annual income/the households' maximum Family annual income
	loaning ability	Get the bank loan	E2	Have=1,have not=0;
	Borrowing ability	Get borrowing from others	E3	Have=1,have not=0;
Social capital	cadres in family	Family members are leader	S1	Have=1,have not=0;
	participated in community organization	Degree of participation	S2	Often=1.00;sometimes=0.67;very few=0.33
	neighborhood relationship	The frequency of interaction	S3	Often=1.00;sometimes=0.67;very few=0.33
Cultural capital	skillfully use of the Mongolian	Speaking and writing	C1	Good=1.00,Average =0.67,Poor=0.33
	skillfully grazing	The ability to graze	C2	Good=1.00,Average =0.67,Poor=0.33
	familiar with traditional culture	Cognition of Mongolian Cultural Products	C3	Good=1.00,Average =0.67,Poor=0.33

Based on other research (Xu et al.,2005) [19], we adopted the entropy method to calculate the weight of each index in six livelihood capitals. The calculation process of the entropy method in this paper is as follows:

First, there are m pastoralists and n indexes to calculate the original matrix of index.

$$A = \begin{pmatrix} X_{11} & \cdots & X_{1m} \\ \vdots & \vdots & \vdots \\ X_{n1} & \cdots & X_{nm} \end{pmatrix}_{n \times m}$$

First, there are m pastoralists and n indexes to calculate the original matrix of index.

Second, to avoid the logarithm from being meaningless when acquiring the entropy, the data should be shifted. X_{ij} refers to the j-th index value of the i-th pastoralists household.

$$Z_{ij} = X_{ij} + 5$$

Third, we calculate the proportion of the i-th pastoralists' household to the j-th index, where m denotes the sample number.

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^m X_{ij}} \quad (j = 1, 2, \dots, m)$$

Fourth, we calculate the entropy of the j-th index, where constant k is related to sample number m.

$$e_j = -k * \sum_{i=1}^n P_{ij} \log(P_{ij}), k = 1 / \ln m$$

Fifth, we calculate the diversity factor of the j-th index. For the j-th index, the larger diversity of X_{ij} is attained, the larger influence on evaluating the project should be, the smaller the entropy should be. The index should be more significant with the increase of g_j .

$$g_j = 1 - e_j$$

Sixth, we acquire the weight.

$$W_j = \frac{g_j}{\sum_{j=1}^m g_j}, j = 1, 2, \dots, m$$

The computational formula of livelihood capital is presented as follow.

$$S_i = \sum_{j=1}^m W_j * P_{ij} \quad (i = 1, 2, \dots, n)$$

From TABLE II, it can be seen that the grassland area, livestock quantity and pastoralists' income are the most important index of livelihood capital, which bespeaks that the animal husbandry is the major livelihood. However, Mongolian ability, Mongolian cultural cognition, and other livelihood capitals are comparatively less important, which is consistent with the actual situation of the field work.

TABLE II. EVALUATION OF PASTORALIST'S LIVELIHOOD ASSETS

Capital types	Index	symbol	weight	Mean value	Mean capital
Human Capital	household labor	H1	0.0643	1.1361	0.0886
	education level	H2	0.0503	0.3092	
Natural Capital	grassland area	N1	0.1312	0.1272	0.0392
	grassland quality	N2	0.0826	0.1313	
	water source quality	N3	0.0585	0.1986	
Material Capital	livestock quantity	P1	0.1406	0.2257	0.0726
	housing assets	P2	0.0184	0.9273	
	productive and domestic assets	P3	0.0334	0.7114	
Economic Capital	household income	E1	0.1246	0.1035	0.0324
	loaning ability	E2	0.0457	0.2508	
	Borrowing ability	E3	0.0295	0.2726	
Social Capital	cadres in family	S1	0.0921	0.1458	0.0335
	participated in organization	S2	0.0362	0.1437	
	neighborhood relationship	S3	0.0207	0.7201	
Cultural Capital	skillfully use of the Mongolian	C1	0.0082	0.7841	0.0558
	skillfully grazing	C2	0.0472	0.8224	
	familiar with traditional culture	C3	0.0165	0.6406	

B. Analysis of pastoralists' livelihood capital

As shown in Fig. 2, human capital (0.0886) and material capital (0.0726) are the most important livelihood capital. Although the educational level of the pastoralists is concentrated in junior high school level, the high human capital indicates that there is a relatively abundant labor force, which is also related to the characteristics of animal husbandry. The higher material capital is related to the program of "Ten Full Coverage" in the agricultural and pastoral areas of IMAR and the local infrastructure construction. Thanks to the construction of "ten full coverage", the problems of dilapidated buildings, safe drinking water and power supply have been improved greatly.

Under the development path of mining, the local government's revenue has increased dramatically, the infrastructure level of the pastoral area and the ability to provide public services for the pastoralists improved also. The copper enterprise has built 30 well-built brick buildings and provided free electricity for them. The cultural capital (0.0558) indicates that the pastoralists have a high degree of

preservation and inheritance of Mongolian language and traditional livelihood knowledge. Natural capital (0.0392) does not score well, which is linked to the reduction of grassland and the pollution from copper mine. Take a gacha in the core region of copper mine as an example, the expansion of the scale of copper mine and its administrative housing, supporting facilities, and waste slag has occupied 17,000 mu of grassland, which accounting for 13.5% of the gacha. The dust and tailings dams produced by the copper mine have polluted the grassland and water resources, and the quality of the grassland and water have been deteriorated. The social capital (0.0335) is scored low. Although the relationship between the pastoralists is generally harmonious. However, the "fence effect" in the background of grassland contracting and copper deposits has resulted in the deterioration of the neighborhood relations. In addition, the development of local social organizations is immature, and there are no other economic cooperatives or social organizations except for a horse association. Financial capital (0.0324) scored lowest. On the one hand, it was obvious that the pastoralists' income had not increased within mineral exploitation. On the other hand, it was also illustrated the

pastoralists had low ability in getting loans or borrowing money.

Status of pastoralists' assets values

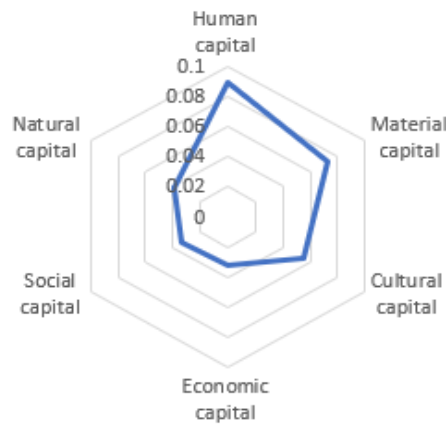


Fig. 2. Status of pastoralists' livelihood assets values

C. Pastoralists' livelihood strategy

The mineral exploitation in grassland can directly affect the pastoralists' livelihood means and the livelihood capitals. How to use the reasonable livelihood strategy and how to change

existing livelihood capital for a better livelihood are deemed as the key in the sustainable livelihood. Based on field work, we divided the pastoralists' livelihood strategy into livestock type, mixed type, and non-livestock type.

TABLE III. PASTORALIST'S LIVELIHOOD STRATEGIES

livelihood strategies	Standard of division		
	Grassland area(mu)	Source of livelihood	Household Percentage
livestock type	3435	animal husbandry; government and enterprise compensation	17 18.28%
mixed type	2184	animal husbandry; government and enterprise compensation, be in business; work locally; work in logistics; wage income	56 62.37%
non-livestock type	0	government and enterprise compensation; be in business; work locally; work in logistics; work away from hometown; work in copper mine	18 19.35%

There are 17 households in livestock type strategy, mainly grazing goats, sheep, cattle, horses, camels, with 3435 mu of grassland per household. Their incomes include animal husbandry income and compensation income. Compensation income includes the subsidy of Feed-animal Balance policy as 1.18 Yuan/mu/year issued by government and fuel subsidies as 500 Yuan/ man/year. In addition, in order to meet the water demand for mining each year, the copper mine can get the water source by building dams, and the native pastoralists will be compensated 3,600 yuan per person per year. There are 58 households in the mixed type livelihood strategy, with 2184 mu of grassland per household. Due to the smaller area of grassland, the livestock income and compensation income of the mixed type is less than that of the livestock type. Some of the pastoralists can receive a temporary subsidy of 1.75 Yuan/m² from the copper mine, but the subsidy is not issued on time. In addition to the animal husbandry, some mixed type pastoralists also work near copper mines, do business in the welfare area of copper mine, transport ore, work at the sum and undertake other means of livelihood. There are 18 households undertaking the non-livestock livelihood strategy. Because grasslands are completely taken over by the copper mine, their

livelihood depends mainly on compensatory money and non-livestock livelihoods. The compensation includes two parts. The first part is the government's allowance of 4.74 Yuan/mu/year of grazing prohibition fee, 7200 Yuan/person/year for grazing land and grass subsidy. The second part is the 2.53 Yuan/m² of grassland occupation subsidy and water subsidy issued by the copper mine. It is noteworthy that, the copper mine provide jobs such as security guards, warehouse management, etc. Therefore, the family members of this type can get the job from the company. In addition, some of the pastoralists do a part-time job in the nearby town.

D. Relationship between Pastoralists' livelihood capital and livelihood strategy

We selected six livelihood capitals as the independent variables, selected pastoralists' livelihood strategy as the dependent variables, which include livestock type, mixed type, and non-livestock type. Thus, we adopted the multi-nominal logistic regression to reveal the relation between livelihood capital and livelihood strategy. The livelihood strategy Y is

selected as the classified variable, and there is no order among all classifications, with the class number as 3. a=non-livestock type, c=Pastoralists' livestock type, a is adopted as the control group, and $P_a + P_b + P_c = 1$. Hence, the following model is attained.

$$\text{logit}P_a = \ln \left[\frac{P_a}{P_a} \right] = \ln 1 = 0$$

$$\text{logit}P_b = \ln \left[\frac{P(Y=b)}{P(Y=a)} \right] = \alpha_b + \beta_{11} X_1 + \dots + \beta_{1p} X_p$$

$$\text{logit}P_c = \ln \left[\frac{P(Y=c)}{P(Y=a)} \right] = \alpha_c + \beta_{21} X_1 + \dots + \beta_{2p} X_p$$

We applied SPSS19.0 software to calculate the coefficients. The results show that the fitting degree of data and regression equation are better, and the independent variable can affect the dependent variable to a large extent, through the simulated fitting and likelihood ratio test.

TABLE IV. POLYNOMIAL LOGISTIC REGRESSION ANALYSIS OF LIVELIHOOD ASSETS AND LIVELIHOOD STRATEGIES

Livelihood Strategies	B	Standard error	Wald	df	ρ	
Mixed type	Intercept	-3.491	14.202	2.313	1	.038
	Cultural capital	7.042	0.888	1.855	1	.045
	Material capital	4.781	16.105	2.759	1	.097
	Social capital	-5.050	2.995	1.168	1	.280
	Human capital	-3.314	4.838	2.173	1	.015
	Natural capital	1.108	3.005	2.929	1	.017
	Economic capital	-1.569	17.622	.053	1	.018
	Intercept	-2.118	4.571	4.786	1	.003
Livestock type	Cultural capital	1.456	10.055	1.008	1	.030
	Material capital	2.828	1.009	3.700	1	.044
	Social capital	-1.664	7.998	3.462	1	.063
	Human capital	4.305	3.880	1.265	1	.607
	Natural capital	6.585	4.673	2.184	1	.004
	Economic capital	2.459	1.315	1.069	1	.793

As can be seen from TABLE IV, compared to non-livestock type livelihood, the higher rates of natural capital for livestock type (B = 6.585) or mixed type (B = 1.108) are also higher, bespeaking that the grassland is closely related to the two livelihood strategies. There is also a high probability for pastoralists with the high cultural capital to select the livestock type (B = 7.042) or mixed type (B = 1.456). Cultural capital, such as traditional national culture, still plays an important role in the livelihood strategy of pastoralists. Pastoralists with high material capital tend to undertake the livestock type (B=2.828). Compared with the mixed type, the increase of human capital can significantly increase the selection of non-livestock type (B = -3.314). The higher the financial capital, the higher the probability that the pastoralists will be engaged in non-livestock strategy (B = -1.569). This indicates that cultural capital and financial capital play an important position in the transformation of pastoralists' livelihood. And social capital has no influence on the three livelihood strategies.

E. Pastoralists' livelihood willingness and restraining factors

According to the sustainable livelihood framework, people will adjust their livelihood when the vulnerability increases or the livelihood is threatened. The development of copper mines has undoubtedly caused disturbance and erosion of the pastoralists' livelihood and increased the vulnerability.72 Pastoralists' household; totally 79.12% are willing to adjust the present livelihood means. The specific information is listed at TABLE V.

TABLE V. WILLINGNESS TO ADJUST LIVELIHOOD

Current Livelihood Strategy	Willingness to adjust			
	Household	Percentage of this type	Reason	Intension
Livestock type	4	23.53	lower income (2) worsening environment (2)	increase livestock (3) be in business (1)
Mixed type	51	91.07	lower income (26) worsening environment (20) livestock reduction (5)	increase livestock (19) work in the copper mine (14) work locally (10) be in business (1) work away from hometown (2)
Non-livestock type	17	94.12	lower income (12) stay at home (1) idleness (4)	grazing (9) work in the copper mine (3) work locally (3) be in business (2)

Note: the number of Pastoralists' household is in ()

TABLE VI. UNWILLINGNESS TO ADJUST LIVELIHOOD

Current Livelihood Strategy	Unwillingness to adjust		
	Household	Percentage of this type	Reason
Livestock type	13	76.47	satisfied with the present (7) only good at grazing (3) lack of money (3)
Mixed type	5	8.93	only good at grazing (3) lack of money (2)
Non-livestock Type	1	5.88	satisfied with the present (1)

Note: the number of pastoralists' household is in ()

The household undertaking non-livestock type and mixed type has a high willingness to adjust the livelihood, reaching 94.12% and 91.07% respectively. Household undertaking livestock type has low willingness to adjust the livelihood, merely reaching 23.53%. Household undertaking mixed type have classified the specific reasons for the adjustment as lower income (26), worsening environment (20) and livestock reduction (5). The main reasons for the adjustment of non-livestock type are lower income (12) and idleness (4). The adjustment of the livestock type is attributed to lower income (2) and worsening environment (2). Therefore, all types of pastoralists' livelihood have been impacted by mining. As far as household undertaking livestock type and mixed type concerned, grassland pollution, water resource in taking and decrease of grassland caused by mining are the direct causes of the decrease of animal husbandry income. For most non-livestock type, the compensation offered by mineral exploitation is higher than the original income. But the rise in cost of living and the unexpected spending have resulted in a decline in income because of their separation from the livestock system. In addition, the mineral exploitation has left them out of the grassland, and the ideas can be seen in TABLE IV, among household without a willingness to adjust, the livestock type has the highest proportion, which accounts for 76.47%. The specific reasons are being satisfied with the present situation (7), only good at grazing (3) and lack of money (3). Although most of the household are satisfied with their present living conditions, some of them are unable to adjust their livelihood due to their educational level and economic conditions.

It can be seen from TABLE V, there were 31 households with the intension of "increasing livestock" or "grazing", taking up 43.06% of the total number of household who has the willingness to adjust livelihood. It can be argued that herding is the main adjustment intention of three livelihood types. It is noteworthy that attracted by the high income and stable job in copper mine; household prefers to work at copper mine. 17 households have this willingness, taking up 23.61%. Other household wishes livelihood such as work locally (11), be in business (5) and work away hometown (2), it also reflects the diverse willingness of pastoralists' livelihood.

However, due to the problems caused by the development of copper mine and the restriction of the pastoralists' livelihood capital, it is difficult to realize the adjustment favored by the pastoralists, and the income is difficult to increase. First, natural capital, such as grassland, restricts the willingness to "increase livestock" or "grazing". In the production structure of grassland, the supply of grass becomes the most sensitive issue in the management of the pasture. The subtle changes in the grasslands will have a big impact on the livelihood of the pastoralists, especially in the market and settlement conditions, and the income of the pastoralists is directly proportional to the number of grasslands [4]. The development of copper mines has continuously reduced the living space of pastoralists in the adjacent area of copper mine. Coupled with the policy of "livestock balance", either "grazing" or "increasing livestock" will put a lot of pressure on the grassland. Consequently, the vulnerability of pastoralists' livelihood shall be increasing.

Secondly, "work in the copper mine", "work locally" and "work away from hometown" are mainly limited by the lower educational level of the pastoralists. According to the provisions of article 23 of the law of the People's Republic of China on regional autonomy: "in accordance with the provisions of the state regulations, enterprises and public institutions in autonomous region should recruit members of the minorities". However, due to the problems of language communication and educational level, the copper mine is reluctant to recruit native pastoralists, and the pastoralists are not suited to the strict management system of copper mine. Few pastoralists have access to take the stable income. There are only 34 native Pastoralists working in copper mine, accounting for just 1.4% of the total population. And the vast majority of pastoralists work in logistics, with an average monthly salary of around 2,000 Yuan. Some pastoralists get their incomes by working in or around copper mines, but with little skill, they earn less.

IV. CONCLUSION AND IMPLICATIONS

From the above analysis, mining as an important representation of modernization development has exerted a far-reaching influence on the pastoralists' livelihood. The copper mine has improved infrastructure and, to a certain extent, increased the material capital of the pastoralists, whereas it has reduced the stock of natural capital and increased the vulnerability of animal husbandry. More importantly, the development of copper mine has not effectively improved the financial capital of pastoralists. In addition, it is difficult for the pastoralists to adjust the reasonable livelihood strategy. From the perspective of sustainable development, animal husbandry is the basic productivity of the pastoral area. Mining in the grassland ecosystem are governed by the laws of nature and the law of social economy, and the natural laws such as ecological laws play a fundamental and decisive role. Therefore, under the precondition of respecting the natural law and ensuring the effective implementation of ecosystem function of prairie, how to effectively integrate the development of the mining industry and promote the rational growth and optimization of pastoralists' livelihood capital is the top priority to realize the sustainable livelihood of the pastoralists and the harmonious relationship between mining industry and animal husbandry. Based on the results of this study, we propose following policy recommendations.

First, we must reform the compensation mechanism of mineral exploitation in the pastoral areas and make the livelihood of animal husbandry a priority. The current compensation of mineral exploitation in the pastoral area is relatively simple and lacks scientific evidence. Especially, the principle of proximity compensation ignores the integrity of the ecological-ecology and the vulnerability of animal husbandry and has no long-term consideration for the sustainable livelihood of pastoralists. It is necessary to establish a three-dimensional compensation mechanism for the mineral exploitation in the pastoral area, which mainly consists of livelihood compensation, intergenerational compensation and ecological environment compensation. It would help to increase the stock of natural capital and financial capital of the pastoralists, and reduce the vulnerability of animal husbandry,

and realize the harmonious coexistence of mineral exploitation with animal husbandry.

Second, governments should develop relevant policies to improve the income of pastoralists within mineral exploitation. The state need to regulate the existing irrational distribution pattern by the tax and other means. The benefit proportion of local government in the distribution of interests should be improved. Local governments should vigorously promote people's livelihood construction and increase social welfare, encourage pastoralists to actively integrate into the transport, trade and highway maintenance industries derived from the development of mineral exploitation. Enterprises should strictly fulfill the relevant regulations law of the People's Republic of China on National Autonomous Region, strengthen corporate social responsibility, and provide the pastoralists with knowledge and skills training in mineral development and provide corresponding jobs.

Third, we should take some measures to boost the pastoralists' livelihood capital and improve the pastoralists' self-development ability. Local government need to push forward the development of pastoral special economic cooperative organization and encourage pastoralists to participate in. Hence, the shortage of social capital can be made up. It will help the pastoralists improve their ability to negotiate with the market and resist market risks. In addition, local governments should improve the human capital of the pastoralists, launch vocational skills training programs on a big scale, and create more jobs by encouraging business startups. These measures will help pastoralists adapt to mineral exploitation, enhance the ability of self-development, and realize the sustainable livelihood.

ACKNOWLEDGMENT

This work is supported by the National Social Science Foundation of China under Grant No.15XSH010, the Humanities and Social Sciences Fund of Chinese Ministry of Education (No. YJC850027)

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