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The false promises of coal exploitation: How mining affects herdsmen well-being in the grassland ecosystems of Inner Mongolia



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HIGHLIGHTS

- Evaluation of the human well-being of the Xilinguole grassland, Inner Mongolia, China.
- Impact of mining affects herdsmen well-being in grassland ecosystem.
- Quantity of questionnaires survey.
- Addressing the relationship between coal exploitation in grasslands and human well-being.

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ABSTRACT

The grasslands of Inner Mongolia are not only the source of the necessary resources for the survival and development of herdsmen, but also represent a significant green ecological barrier in North China. Coal-mining production is important in maintaining GDP growth in Inner Mongolia. However, over-exploitation has created serious problems, such as pollution of the environment and significant decreases in grassland ecosystem services, in addition to impacting the well-being of herdsmen and other humans. Based on questionnaires survey performed among 864 herdsmen addressing the relationship between coal exploitation in grasslands and human well-being in Xilinguole League in Inner Mongolia, we found that (1) coal resource exploitation in these grasslands does not benefit the herdsmen by increasing their income; (2) the rapid development of this resource has not obviously materially improved the life of the herdsmen; and (3) these activities have increased the risks that herdsmen will have to endure in the future. Overall, coal resource exploitation in grasslands has more negative than positive effects on the well-being of herdsmen. We propose the conservation of coal resources and improvement of ecological compensation should be carried out without blindly pursuing economic growth, instead of focusing on economic development and structural adjustments.

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1. Introduction

China is the world's largest coal producer and consumer. At present, coal still serves as the major energy resource in China. The demand for coal in China is projected to increase in the near future. According to statistics, coal consumption accounts for approximately 70% of China's primary energy consumption, and it is predicted to remain China's main energy source far into the future (Yang and Xue, 2012). In recent years, with the acceleration of industrialization and urbanization, China's energy needs have

grown rapidly. Coal consumption in China in 2011 exceeded 3.2 billion tons (Liu, 2012a). China's oil and gas production cannot meet the rapidly increasing energy demand, resulting in the need for continuous imports, with the dependency on oil imports now exceeding 50% (Geng et al., 2010). In this context, to meet the energy needs associated with economic growth and achieve economic security, the development of coal resources in China has increased significantly in recent years.

The grasslands of Inner Mongolia are not only the source of the necessary resources for the survival and development of herdsmen, but also represent a significant green ecological barrier in North China (Zhao et al., 2008a). Grassland ecosystems perform fundamental life-support services upon which the herdsmen society depends. The grasslands of Inner Mongolia are rich in coal

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resources. As mining resources in other coal-rich provinces have been exhausted, Xilinguole League has drawn attention as an investment hot spot, and the national energy base is developing toward a new economic growth point in Inner Mongolia and even in western areas (Lu, 2012). An increasing number of coal factories are being built in grasslands to generate revenues through large-scale coal exploitation. Coal exploitation has increased the growth rate of the GDP in this region. However, the natural environment and even the well-being of herdsmen has been heavily affected by the activities associated with coal exploitation in grasslands. Several environmental problems are generated caused by coal mining, transportation, storage and utilization (Meij and Te Winkel, 2009). Mining coal resources was proved to damage and alter the natural environment (Finkelman et al., 2002; Meij and Te Winkel, 2009) and to cause subsequent environmental problems that seriously affect human daily life in both production activities and health, among other impacts (Finkelman et al., 2002; Dai et al., 2005).

Coal exploitation activities are characterized by persistence in time, space scalability, long development cycles, numerous forms of perturbations of environmental systems, a wide range influence and complex mechanisms; the influence of coal exploitation on human well-being is profound and long-lasting (Wang et al., 2010). Coal exploitation seriously pollutes surface and groundwaters while also impacting the growth of surface vegetation (Lu et al., 2007). The expansion of mining goaf areas has taken up increasing areas of grasslands and caused the levels of toxic material pollution in grass roots to rise. Through the application of three research programs, Finkelman et al. (2002) demonstrated that the coal mining process causes a range of human health problems. Lu et al. (2007), through three time phase TM (thematic mapping) of remote sensing data, analyzed the growth of vegetation near the Bulianta coal mining region in arid and semi-arid areas subjected to coal exploitation stress and showed that coal exploitation had permanent effects on the environment in spite of environmental protection measures. Toxic elements released during coal combustion were proved to influence the normal growth of animals and vegetation as well as human health in various countries and certain areas (Finkelman et al., 2002; Dai et al., 2005). These kinds of damage can induce serious ecological and environment problems and increase the conflict between the demand for resources, environmental protection and preservation as well as impact the self-modulation functions of the natural system (Lu et al., 2007) in so altering the ecosystem services that support human well-being.

Since the 1950s, concerns were raised in Europe, North America, Australia and other areas about the environmental problems related to mining activities. A number of engineering and biological measures have been implemented to restore and restrict mining, water pollution and soil erosion (Christensen et al., 1996; Pilar and Eduardo, 2006). At present, the focus of studies in countries other than China has shifted from land restoration towards the prevention of negative effects in ecosystems, ecological restoration and reconstruction (Vangronsveld et al., 1995). China is a fast developing country, where a great deal of energy is invested to support growth. China is also the larger producer of CO₂ emissions in the world, although per capita emissions are still much lower than USA and Europe (Olivier et al., 2012). Policies aimed at energy conservation and emission reduction play an important role in maintaining the sustainable development of society and satisfying the demand of people to live in a favorable environment. However, the activity of coal exploitation in grasslands is still a critical issue. More research should be conducted to systematically investigate the day-by-day influence of coal exploitation on human well-being. In this context, the question arises, once again, of whether increasing GDP is more important to

well-being than the environmental protection of grasslands and how to make such comparison. Furthermore, what is the attitude of local herdsmen towards coal exploitation, and is it possible to increase GDP and human well-being simultaneously?

In this study, human well-being includes five large components: the basic material needs associated with sustainable high-quality living, safety, health, societal relationships, the freedom of choice and activity rights, similar to Maslow's (1954) pyramid of self-actualization. We analyze the influence of coal exploitation on the net income herdsmen, describe the effects of coal mining on the basic needs of herdsmen, and finally, discuss the health and safety problems caused by coal exploitation in grasslands. These are not, of course, all the impacts caused by coal mining, but they are used here to illustrate the influence of coal exploitation on human well-being and to address the importance of the protection of grassland ecosystems.

2. Materials and methodology

2.1. Study site

This survey was carried out in Xilinguole League, which lies in the middle part of the Inner Mongolia Autonomous region in the North of China, ranging from east longitudes of 115°25' to 119°58' and north latitudes of 41°35' to 46°46' (Fig. 1) (Shi et al., 2010). This area includes a total of 19,988,400 ha, 89.85% of which is available high-quality natural grassland (XLSY, 2011). Xilinguole belongs to the dry continental monsoon climate region and displays an annual average temperature of 0 °C. The average annual rainfall generally ranges between 400 mm in the eastern part to 150 mm in the western part of this region. Most of rainfall occurs in July, August and September.

As one of the four major grasslands of the world, the Xilinguole grassland is rich in natural resources and famous for its abundant species diversity. The national Grassland Nature Reserve of the China has been brought under the international monitoring system by UNESCO. It is not only an important source of livestock products of China but it is also at the forefront of China's Western Development Program and represents an important ecological barrier in North China.

Furthermore, this area displays abundant mineral resources, including more than 80 kinds of known minerals. The available reserve of coal resources in this region is extremely rich. According to coal exploration data, Xilinguole League has a total of 188.28 billion tons of coal reserves and contains the second largest reserve in Inner Mongolia (Yu and Wang, 2007).

The total population of Xilinguole League increased from 987,400 in 2008 to 1,002,600 in 2010 (XLSY, 2011). The economy of this area mainly depends on animal husbandry, primary commodities and tourism. Based on statistical data, the number of people working in the coal sector in the years 2000, 2005, and 2010 were respectively 4027, 4978, and 12,919 units, while instead the number of people working in the livestock sector in the same years were 108,091, 124,777, 130,944, respectively. Coal mining, refining and eventually burning for electricity has much lower labor intensity, and generally involves small fractions of local, unskilled population in addition to high-tech labor from outside. The huge jobs difference between livestock and coal sectors suggests that changes generated by mining activities must be carefully monitored in order to prevent wellbeing decrease in other sectors.

Understanding the potential impacts of future growth on both human well-being and natural systems is a topic of considerable interest to local governments and herdsmen.

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