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Research on Mineral Resources and Environment of Salt Lakes in Qinghai Province based on System Dynamics Theory

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ABSTRACT

The purpose of this study is to understand the relationship between the exploitation of saline lake mineral resources and ecological system, providing decision-making references in terms of socioeconomic development and environment protection. Using system dynamics (SD), the study comes with a systematic analysis of the interdependence among saline lake mineral resources, the ecological environment and socioeconomic development as well as the trend of development in the future. Take the relationship between the saline lake mineral resources and the development of economic and the ecological system of Qinghai province for example. According to the model of study, as of 2020, proved reserves of saline lake mines in the region will only increase by 0.6 times more than that in 2013, which would impose a huge pressure on mining industries' sustainable development. Although the number of employees in mining industries have continued going up since 2013, the level of corporate profits will go down. At the same time, market changes of salt products will have higher and higher influences on the economic impact of salt industries. In addition, the value created by each employee in the industry will grow steadily, which shows that saline lake mineral resources will continue playing an important role in local economy. At the same time, the mining exploration process will witness a rapid increase in water use, emissions of waste water, gas and solid as well as environment pressure. Therefore, the exploitation of saline lake mineral resources needs to be managed in a systematic and scientific way, based on market mechanism and guided by good governance, in order to strike a balance between the economic growth and environmental protection. A pragmatic green circular economy of Qinghai province needs to be realized in the salt lake areas through encouraging technological innovation, boosting added value of salt-related products, spreading the knowledge of waste water recycling and accelerating the use of clean energy.

1. Introduction

The purpose of this research is to analysis the salt lake mineral resources development, the most important is to expand resources utilization and environmental protection from the effects of through establishing the system dynamics model of the salt lake mineral resources exploitation and economic development and environment protection. It is to provide the basis for the government and related enterprises.

The exploitation and utilization of mineral resources is a double-edged sword, and the research scholars of various countries have already begun to study this kind of problem. There are also a lot of scholars to study the relevant issues. Many researchers gave various ideas in the study of mining resources and related environmental problems. A general evaluation system featuring 7 first grade indicators and 18 secondary indicators has been set up to assess mining resources and environment capacity (Yan and Xu, 2005). Another assessment system has come up with 3 first grade indicators, 12 secondary indicators and 54 tertiary indicators to check correlations of mineral resources exploitation, environmental influence and socioeconomic influence (Zhao and Hu, 2005). There has been a system with 6 first grade indicators, 13 secondary indicators to analyze and select evaluation factors of environmental capacity and the vector projection method has been used to analyze the changing trend of the carrying capacity of mineral resources and environment (Sun and Zhou, 2007). 4 First grade indicators including groundwater, sound, ecology, atmosphere, and 7 secondary indicators including vegetation status, soil environment, animal resources, air pollution, air quality and so on,

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were used for environment evaluation at Xiaoyuanshan Mine in West Wulanbulang Township of WuChuan County in Hohhot (Hongliang Wang etal, 2011). One study evaluated mineral resources of Chenzhou using pressure indicators and it also evaluated the environmental carrying capacity of Yulin city using capacity indicators. Some variables are atmosphere, water, forest, mineral reserves, annual mining capacity, per capita water resources, per capita arable land, per capita forest, green coverage rate, per capita tourism income, annual tourists flow and emissions of waste water, gas and solid, etc. (Guo etal, 2011). In the evaluation of the economic and environmental effects of mineral resources industry, the indicators mainly reflected emissions of industrial wastes, water, gas and solid (Li and Yan, 2012). For the analysis of ecological carrying capacity in Zhungeer mining area, four primary indicators, including resources bearing capacity, social influence, environment carrying capacity, ecological resilience were used together with 15 secondary indicators, including the supply of coal and water, per capita land area, the total industrial output, the population and its derivatives, per capita arable land, per capita water resources, waste water and gas emissions, annual precipitations, forest coverage, land erosion and forestation (Hao etal, 2012). The ecological pressure and the footprint index were also used to assess the carrying capacity of water resources while evaluating using the method of ecological footprint (Tang and Liu, 2013).

Currently the modern minerals industry is more environmentally responsible and socially aware than at any time in the past, and yet faces increasing challenges to improve its performance in these areas still further (Poulton etal, 2013; Richards, 2008). Some educator use an augmented solow growth model with cross section and panel data to find evidence of conditional convergence of per capita production in China, how to deposit the natural resource to realize the sustainable development of the area economic (Chen and Fleisher, 1996). In the study of mineral resources in Qinghai Province, many researchers conducted detailed researches on the metallogenic regularity (Xu et al., 2012). Researchers also analyzed the composition of mineral resources, the storage, the production and consumption of mineral resources and the influences on the environment, such as the reserves of mineral resources, the exploration of mineral resources and some related environmental problems. As for environmental problems, researchers focused on the vegetation damage, soil erosion, geological disasters, water pollution, and the soil and air pollution, etc (Gan et al., 2006; Cui, 2005; Hu, 2011).

According to the characteristics and main use, mineral resources can be divided into metal mineral resources, non-metallic mineral resources, energy mineral resources and the moisture of mineral resources. The mineral resources can exist in different medium such as water, this creates a salt lake mineral resources. These mineral resources can exist in different media, such as water, rocks and other media. The mineral resources of Saline Lake are in the water medium. Also there were scholars who focused their studies on salt lake resources. Zhang Pengxi, an academician, detected a large amount of potassium in the salt lake, paving the ground of building a production base of the potash fertilizer in Qinghai. Previous Chinese studies mainly studied physical conditions of the salt lake, which helped the future scholars a lot on their studies on the industrial chain of salt lakes (Liu etal, 1996; Gao and Xia, 1999). Many more scholars analyzed the lake's resource reserves, influential factors, the detection, the exploration and management as well as how to sustain the industry[1] (Han and Song, 2002; Wang and Chen, 2003; Yan etal, 2014). Scholars also studied the future trend of saline lake mineral industries from the perspective of saline related products positioning and the resource tax reform (Wu, 2002; Yu and Yin, 2011). The study of social and economic development can be divided into two parts. One is the study of the economic structure and development trend of the region; and the other is to study the relationship among the economic development, the resource development and environmental protection, and so on.

Researchers, using spatial auto-correlation analysis, made an empirical analysis of spatial differences of economies at county level in Qinghai Province(Haifeng Zhang etal, 2009). Urban-rural income gap and its cause were also studied by comparing per capita disposable income of urban residents and per capita net income of rural residents which also takes Qinghai Province for example. (Yang and Xu, 2010). In addition, the coordinated development among economy and resources and environment protection was also studied in the perspectives of the economic growth, energy structure, energy efficiency, environmental quality level, export commodity structure and so on (Sun, 2006; Yufang Lu, 2006; Yan etal, 2007; Zhao etal, 2010; Guo et al., 2013; Kong and Xue, 2015). Since we have to know where these raw materials come from and how they are mined. Sustainable development requires the maintenance, rational use and enhancement of natural resources, as well as a balanced consideration of ecology, economy and social justice (Wellmer and Becker-Platen, 2002). The data also shows that economic development, technology progress and industry structure are the most important factors affecting China's CO_2 emissions (Limin etal, 2012). Therefore, especially in the study on the relationship between economic development and environment, the datum was mainly collected from desertification, deforestation, pasture degradation, water pollution, pollutant emissions and other aspects. And during studies on energy efficiency, researchers applied carbon footprint method, decoupling index model and energy theories to study the energy structure and environmental problems in a in-depth analysis (Kong and Xue, 2015). And scholars system dynamics model was used to study the environmental impact of social and economic activities, such as the problems of water environment in the coastal city of system (Mavrommati et al., 2013), the use of platinum's impact on the environment (Elshkaki, 2013), the global uranium market supply and demand in the future (Rooney etal, 2015).

In summary, many scholars have studied systematically the relationship between socioeconomic development and environment in different degree and perspectives. Some scholars established a lot of mathematical models to study socioeconomic development and the trend of mining development. But many researches focused more on the relationship between the technology development and local economic development, but less on the relationship between the industry and the environment of salt lakes. Therefore, it is necessary to study the influence brought by the pillar industry development and social changes on local ecosystem.

In addition, the collected information shows that the analyses of these studies and researches are mostly static or limited in two aspects such as industrial development and environment. Therefore, it is needed to introduce a better research model for the dynamic corelations between local mining industries, the social-economic development and the ecosystem in Qinghai Province.

From the data we get, we can find many important research methods were used in the study of Qinghai Province, such as the fuzzy comprehensive evaluation method, the Sorozen model, the spatial auto-correlation analysis, Grainger causality test, Kuznets curve (EKC) theory, the two-wheel driven method and so on. It lacks of systematic engineering theory to study the influence of the development of mineral resources on the local economy and environment in Saline Lake.

2. Methods and models

2.1. Methods

Many methods are available to study relationships among variables, such as the correlation analysis, the column analysis, the fuzzy analysis

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