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Coal Subsided Area Land Harmonious Governance and Suitability Evaluation Methods

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Abstract

The soil is the foundation of human survival, to realize the sustainable development and utilize of the soil resources in coal subsided area, to speed up constructing a conservation-minded society, the land reclamation as a practical and effective measures to protect the soil has been paid more and more recognition and attention by the government and society. This paper combined the Coal subsided area land reclamation planning, adapted coal subsided area land suitability evaluation, land structure optimization method, the evaluation method of combining cost and benefit impact factors quantitatively and qualitatively to research the design of land reclamation plan. Discussed some related content about the land reclamation technology and ecological reconstruction suit for the local environment.

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1. Introduction

The development of coal provides a guarantee to the rapid and sustained economic development, while, it is increasingly prominent that the large-scale exploitation of coal mining caused severe damage to mines and their surroundings, and the subsidence areas formed by the coal mining also have a serious impact on our ecological environment, resulting in the deterioration of the ecological environment more rapidly, which seriously restrict the construction of a harmonious mine [1]. Especially in recent years, because of the overexploitation, the area of coal subsided area increases, river silts, caved area and stagnant water field appears in farmland, made great changes in the natural ecological environment of mine, and varieties of natural environment elements are undergoing different degrees of damage, made a negative influence on the balance of mine ecosystem, which making great impact on sustainable development of the coal area.

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To meet harmonious governance of the subsidence area in coal mine, it can be considered for the following measures: First, adapted coal gangue backfill the subsidence area, and covering soil marshes. For a long time, it have been done a lot of experiments and researches by many scholars at home and abroad, putting forward many land reclamation technologies, and achieved certain results, such as the Reclamation Planning and Use Status of Subsided Lands in Renlou Mining Area by Zhou Fudan [2].Through land reclamation, made subsidence area re-using, ensure the fluency of river, and avoided stagnant water, which would improving the land use efficiency. Second, It can be further improve the environmental conditions in mining through carrying out planting trees and taking effective measures to eliminate spontaneous combustion of coal gangue [3]; Third, built a coal gangue power plant to multipurpose using the gangue, flyash and other solid waste. Fourth, re-establishment the ecological systems through land improvement, and establish a virtuous circle of ecological, obtaining higher economic and environmental benefits [4].

2. Land reclamation technology and evaluation methods

2.1. Land reclamation technology in coal subsided area

Coal land reclamation is based on mining ecology, land economics, environmental science, surveying and mapping science, soil science and regional planning theory, and so on ,combined with the mining project characteristics, took measures to control the soil which was damaged by excavating, collapse and occupy in the mining process, and restore the available state. Land reclamation is a comprehensive engineering technology, included engineering reclamation and biological reclamation two process, and finally restored land productivity and realized the new balance of ecologic system [5]. The Coal subsided area land reclamation technology mainly includes: land levelling technology, thin line method reclamation, filling method reclamation, and so on.

2.2. The classification of mining reclamation objects and reclaimed land suitability evaluation methods

When formulated the Land reclamation planning, according to the classification of reclaimed land reclamation object to conformed reclamation direction, reclamation emphasis, and some influence factors of restricting the land reclamation project implementation, usually adapted fuzzy clustering method to the classification of land reclamation object. Coal reclaimed land evaluation method commonly included extreme conditions method, the index method and methods of fuzzy mathematics[6], this paper adapted a fuzzy set of comprehensive evaluation method which based on the principles of fuzzy mathematics. Fuzzy set of comprehensive evaluation method included single suitability assessment model and multi-objective production distribution decision model two parts.

a) Single suitability assessment model

Assumed adapted a reclamation direction to analyze, the number of Influence factors is "m", each factor corresponds to a state sets V_i :

$$V_i = (v_{i1}, v_{i2}, \dots, v_{ij}, \dots, v_{in}) \quad (i = 1 - m, j = 1 - n) \tag{1}$$

Formula:

- I —Impact factor serial number;
- J —suitable level of a reclamation direction

For example, for the additional gradient of impact factor, if divided land reclamation direction into two grades, the corresponding state V_i : $V = (\leq 0.5^\circ, > 0.5^\circ)$. Obviously, every factor's state set is a all ordered set with preferential treatment to bad episodes for a designated reclamation direction. The superiority of all the affecting factors attribute values could be showed by matrix R.

$$R = \begin{bmatrix} a_1 p_{11} \cdots a_i p_{1i} \cdots a_m p_{1m} \\ \vdots \\ a_1 p_{j1} \cdots a_i p_{ji} \cdots a_m p_{jm} \\ \vdots \\ a_1 p_{n1} \cdots a_i p_{ni} \cdots a_m p_{nm} \end{bmatrix} \quad (2)$$

Formula:

a_i —the effect weight value of factor "i" to the designated reclamation direction;

p_{ji} —the contribution function value of factor "i" to the designated reclamation direction "j".

a_i can be confirmed by analytic hierarchy process (ahp), Delphi method, ultiple regression analysis method or experience. The Determination method of p_{ji} is set a appropriate range, then confirmed other appropriate levels range by Contribution function equation or Score distribution formula.

Obviously, the ideal score of level "j" p_j :
$$p_j = \sum_{i=1}^m p_{ji} \quad (3)$$

Assumed the attribute values of each assessment unit or plots are ID:

$$ID = \frac{1}{\sum_{i=1}^m a_i p_{1i}} \sum_{i=1}^m a_i p_{ji} \quad (4)$$

Then assumed "D" is the Consistency degree:
$$D = 1 - \left| ID - P_j / p_1 \right| \quad (5)$$

If P_j can make "D" increase, the level of assessment unit is "j".

b) Multi-objective production distribution decision model

Assumed the number of optional reclamation direction is k, so need to establish multi-objective production distribution decision model to comprehensive suitability evaluation.

Assumed the number of factors related with reclamation direction is "r", the actual attribute values is (t_1, t_2, \dots, t_r) , the best requirements attribute values is (T_1, T_2, \dots, T_r) , So the distance between the actual attributes and best required attribute is d_k :

$$d_k = \sqrt{\sum_{i=1}^r (t_i - T_i)^2} \quad (6)$$

When d_k is Minimum, the direction is the best reclamation direction

3. Coal subsided area land Planning

3.1 Land management technology solutions in coal subsided area

Taking a mine in Shandong as case, the mine used coal gangue to backfill and cover 2000 acres of serious collapse mine land, included 1500 acres of land reclamation management, restoring its farming function, meanwhile perfected the reclamation area's drainage and road system. Adjust measures to local conditions; took the reclamation area to be an Agricultural science area for planting and farming.

According to the current mining technology of the coal mine and the control method of subsidence land, the subsidence land's comprehensive treatment in mining area is mainly solved by using coal gangue to backfill (as shown in figure 1). This land management method not only make full use of the mine's by-products—coal gangue, but also resume the functions of the subsidence land. There are two methods to use coal gangue to backfill, the one is using coal gangue to cover in filling area directly and

compact, then as other used (non-agricultural land); the other is digging up the primary surface soil, using the using coal gangue to Cover and compact, then covering soil, the thickness of backing land is 0.5 to 1.5 meter according to the soil properties, and restore to agricultural land.

Land subsidence destroyed the original landform, gully valley in subsidence area appeared low-lying, and some place appeared the phenomenon of seeper in the rainy season. At the same time, the production of mine brought waste, such as coal gangue, and it brought bad effects to the ecological environment of mining area. Therefore, the comprehensive management of subsidence area should observe the principle that adjust measures to local conditions to give judicious guidance according to circumstances, the best overall profit, take measures that technically feasible, economically rational, socially easy to accept. In line with principle that restoring the functions of land and make the full use of the resources of coal gangue, adapted coal gangue to fill and compact the bottom land, and cover soil to manufacture fields on the surface.

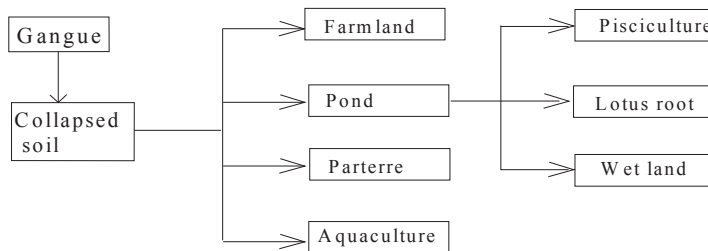


Fig.1 Overall thinking figure

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a) Subsided land management

Reclaimed by coal gangue, governance process should first strip the 0.5m surface plans of soil, regularly, and depositing around the reclamation land. Used cars to gangue backfill and compaction, and then using the stripping soil to evenly cover the surface. To form the slope and elevation of land without drastic changes, the drainage slope can construct as 2 %, and drainage direction is from the edge of collapse pit to the river way, this can not only meets the requirements of reclamation, but also meet the water out organically, restoring the original topography and natural environment. This project required backfill 2,000 acres of subsidence areas, it consist of 1,500 acres of reclaimed land, which needing gangue 999000 m³, stripping soil and backfill 499500m³.

b) Establish agriculture ecological garden

The area of perennial subsided water in a coal subsided area is approximately 20 hectares, and the largest sink value has reached 3m.Planned to continue digging deep perennial water area, in deep-water area artificially kept grass carp species, carp, etc, and in shallow water grow aquatic economic plants, such as lotus root or reed, kept waterfowl in the nearshore area. Recover the flower-growing area, food-processing zones in the subsided area near the road. The west of subsided area developed into a edible fungus area and a awning vegetables planting area; plant poplars on the east slope of the coal subsided

area; In southeastern built a meat processing plant, in order to facilitate transport, planed to build an asphalt highway to reclamation work.

Another subsided area in this mine, mining maximum lowering value is 2.0m in recent years. This area adopt digging deep to fill shallow, plan is to build lotus planting base of 16.67 ha, plant economic plants such as planting reeds, and feed water species such as silver carp, grass carp in shallow water, considering Chicken more developed in the village. They build a large of farms in the east of collapse reclaimed area.

Through the implementation of first-stage project, some preliminary results has achieved in the subsiding area, the function of ecological garden has been basically implemented. It forms a kind of ecological economy which is the joint operation of many kinds of industry, included agriculture, forestry, animal husbandry and sideline, fishery and so on. They process and promote each other, and make a development in an all-around way. The controlling effect in the first-stage project of the subsided area was shown in figure 2.



Fig.2 The first-stage project

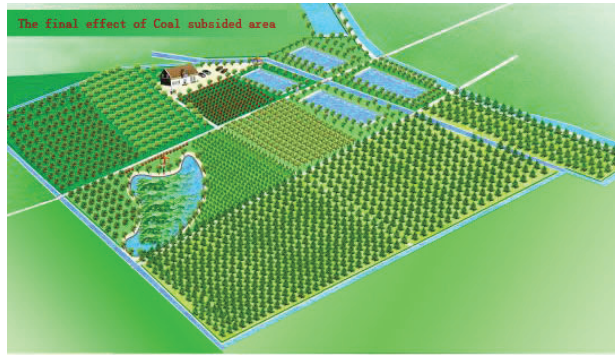


Fig.3 The final effect

Can believe that through the implementation of first-stage project, the function of ecological garden will be more perfect, The rehabilitation of ecological environment and exploiting will get maximum play. Figure 3 is the final effect of Coal subsided area.

3.2. Benefit evaluation

a) Social benefit evaluation

Move off hillock, the vacated site can be used for developing other non coal industry project, to make it become new economic growth point in the mining area. Planting trees and farming in backfilling reclamation land may change the ecological environment in the mining area. Meanwhile it will greatly increase the region's economic development level, stabilize the status foundation status of agriculture. It will greatly stimulate structure optimization of mining industry and adjustment of rural industrial structure.

b) Ecological benefit evaluation

Through ecological agriculture reclamation in the Coal subsided area, land get reasonable layout, from traditional agricultural development for farming only to the modern agriculture. Forestry, animal husbandry and sideline, fish integration, planting and breeding of supporting included. This has obvious ecological benefits and it speed up the agricultural structure adjustment .By building the forest tries through field, it effectively adjust the regional micro-climate, and improves its ecological environment.

c) Economic effect evaluation

After the project implementation, all the hillock had been moved away in coal mine, which will restore occupy land 6.53 hectares, filling 2,000 acres in the subsided area, and 1,500 mu reclaimed land. By the

calculation of 1.5 million yuan/mu, the land value is 2,250 million yuan after land reclamation; in addition it will reduce annual outlining 4.5 million yuan in the subsided area.

4. Conclusions

Through systematic analysis the affects of mining to the local environment, compared various kinds of land reclamation technology in the coal subsided area, Proposed different management technologies to suit the coal subsided area, further promoting the construction of ecological garden, establish ecological system and ecological benign circulation, to achieve higher economic benefits and environmental benefits.

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