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Research Paper

Determining the Method of Reclamation of Surface Mines Based on Renewable Energies Using A New Hybrid Approach

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Abstract: Mines as non-renewable resources have a significant role in the economic and social development of countries. However, at the end of the mine's life, to achieve sustainable development, the mine's pits reclamation is vital. Due to the situation of most mines that are located in remote areas, mine's reclamation based on renewable energies can be an appropriate strategy. In this study, a new hybrid method using the Fuzzy Cognitive Mapping (FCM) method, grey Complex Proportional Assessment (COPRAS-G), and Z-theory reliability is introduced for prioritization and selecting of the mine's reclamation strategies. The proposed method, for reclamation of an open-pit lead-zinc mine by considering several criteria and strategies is applied. The results of the FCM show that the average wind speed criterion has the highest weight. Also, the prioritization of the strategies showed that "closing the mine and building wind turbines" is the best strategy for reclamation of the investigated mine. Therefore, considering the windy situations in the study area, building a wind farm to supply electricity is a suitable strategy to achieve sustainable development in the region.

Keywords: Mine reclamation, Renewable energy, Fuzzy Cognitive Map, Z-number theory, COPRAS-G.

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INTRODUCTION

Humanity's most valuable asset is the earth and its resources. The value of these resources can be seen not only for the current generation but also for future generations. The mining industry is one of the activities that search and obtain resources. Nevertheless, this industry sometimes and unintentionally disturbs the landscape and destroys the environment [1]. Therefore, scientists and managers attempt to present the solutions that solve these critical problems. Mine lands extracted can be beautified and used usefully [2,3]. Renewable energy is an appropriate solution for mine reclamation and power supply. The world community is leading the world towards clean energy such as solar, wind, biomass, etc. [4]. Therefore, this study aims to use a new hybrid method for investigating the possibility of renewable energies as a mine's reclamation solution.

METHODS

In this research, for the mine land reclamation, new techniques for eliminating the uncertainties, and to present more reliable results are used. To this aim, mine land reclamation alternatives are firstly considered, and the most effective criteria are identified. Then, the Z-number concept is used to evaluate the uncertainty of expert views. FCM theory is organized to determine the criteria weights based on causal-effect relationships between concepts. Finally, the best mine land reclamation strategy is determined using the grey COPRAS techniques.

FINDINGS AND ARGUMENT

In the present study, to obtain more reliable results by the FCM, a hybrid learning algorithm by integrating the nonlinear Hebbian algorithm and differential evolution is used. FCM simulates the weight of concepts in various iteration, which the results illustrated in Figure 1. In this process, the reliability of opinions listed in the initial matrix importable to the FCM framework is provided and computation uncertainty is eliminated. The simulated weights are used in COPRAS-G, and the calculation processes are performed to prioritize the mine land reclamation strategies. The prioritizing of strategies and rank of each of them are tabulated in Table 1. Based on results, Alternative 7, namely the use of wind turbines, is the best solution to mine closure, and reclamation of the mine environment. Notably, the proposed strategies follow green mining and sustainable development.
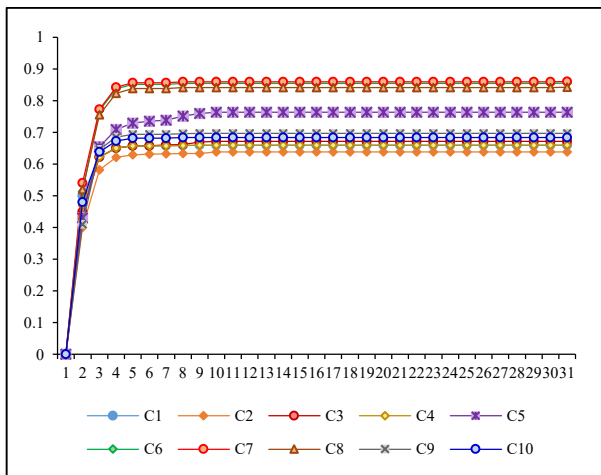

Figure 1. Criterion weights in different iterations

Table 1. Ranking of alternatives

	P_j	R_j	Q_i	N_i	RANK
A1	0.442	0.102	0.697	60.24	8
A2	0.644	0.196	0.776	67.08	6
A3	0.726	0.077	1.062	91.83	3
A4	0.724	0.104	0.972	84.04	4
A5	0.602	0.258	0.702	60.68	7
A6	0.987	0.179	1.131	97.83	2
A7	1.041	0.223	1.156	100	1
A8	0.741	0.283	0.832	71.99	5

CONCLUSION

Mining activities have an essential role in the country's economy. Mine reclamation is one of the strategies to consider about the environment. In recent decades, renewable energies have been considered one of the valuable solutions in mine reclamation. In this study, a novel hybrid method, namely the Z-number theory based on the FCM framework and the gray COPRAS (G-COPRAS), is presented to evaluate and prioritize

the reclamation strategies of a lead-zinc mine. In this way, ten main criteria and eight reclamation strategies based on renewable energies are considered. Based on the results, the criterion of "average wind speed" with the value of 0.86, and the criterion of "number of sunny days" with the value of 0.638 obtained the highest and lowest value of weights, respectively. As well, based on the prioritization results, the strategy of "mine closure and reclamation of wind turbines" is selected as the most appropriate reclamation strategy. Notably, the wind analysis results indicated that calm winds account for a negligible percentage of regional winds.

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