APPLICATION OF GENETIC ALGORITHM IN OPTIMIZATION SIMULATION OF INDUSTRIAL WASTE LAND REUSE

PENG BAI,* YUNAN ZHAO,† AND JUNJIA CHANG‡

Abstract. In order to better understand the application of optimization simulation for industrial waste land reuse, the author proposes an application study based on nonlinear genetic algorithm in the optimization simulation of industrial waste land reuse. The author takes the landscape renovation and reuse of industrial waste sites as the research object, and through research on the current situation of landscape renovation and reuse of industrial waste sites both domestically and internationally, as well as on-site inspections, attempts to use landscape design techniques to deal with this once glorious but destructive industrial landscape that has already declined. Secondly, a genetic algorithm for enhancing the timeliness of industrial waste land reuse is proposed, which is based on random walks, combine users' long-term and short-term preferences to calculate the most suitable Top-N industrial waste land reuse optimization model for the current period. Finally, the two algorithms proposed by the author were experimentally validated on the dataset. In the CiteU Like dataset, the best performance was achieved at a=0.4, while in the JD dataset, the best performance was achieved at a=0.6. When k=6, the hit rate significantly decreases by about 50%. The URT-R genetic algorithm exhibits a high recommendation hit rate in recommendations targeting timeliness. The author analyzed the different characteristics of industrial waste reuse in scenic areas and optimized their essence and transformation methods, further improving the transformation and renewal methods of industrial waste land in the process of urban development in China. I hope to provide useful references for future research on related topics and practices.

Key words: Genetic algorithm, reuse of industrial waste land, optimization

1. Introduction. Waste industry refers to the land used for industrial production and transportation, transportation, storage, and then abandonment, such as landfills, quarries, factories, railway stations, loading stations, industrial wastes, etc. The wasteland industry has increased with the decline of the traditional industry, which is caused by the impact of the industrial disaster on the environment, as well as the development of modern technology, the transformation of industry, and the transfer of resources.Therefore, people are increasingly aware that although industrial civilization has brought certain material wealth to humanity, it has also brought a series of environmental problems: Environmental pollution, land desolation, species loss, Balance of nature imbalance, and a series of social problems: waste of land resources, serious impact on the living standards of residents around industrial wasteland, and so on. The emergence of these problems has sparked social attention to industrial waste land. How to achieve ecological restoration and seek scientific solutions in heavily polluted waste land caused by human overuse has become a practical topic in the research of industrial waste land regeneration, and has attracted attention from all sides. The reuse of industrial waste land has become a global topic of common concern.

In the 1960s, more and more landscape designers and ecologists began to pay attention to the reuse of industrial waste land, due to the reasons of the times, this focus is no longer satisfied with the simple focus on land reuse in the past, but his analysis has already shifted to conforming to historical and cultural values as well as the spiritual nature of this abandoned land. American city historian Lewis Mumford once said, "If you want to make a better living in a new city, we must first understand the historical characteristics of this city. People gradually realize that the successful reuse of industrial waste land from the historical value of buildings and derived cultural emotions is also a way to maintain people's experience of the historical characteristics of cities. Therefore, in the process of continuous transformation and utilization of industrial waste land, there has been a bold attempt to use landscape methods and approaches to solve the problem of reuse. After the

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*Shenyang Normal University, College of Fine Arts and Design, Shenyang, Liaoning 110034, China (PengBai939@163.com)

†Shenyang Normal University, College of Fine Arts and Design, Shenyang, Liaoning 110034, China (Corresponding author, YunanZhao7@163.com)

‡Dalian University of Foreign Languages, School of Software, Dalian, Liaoning 116044, China (JunjiaChang@126.com)
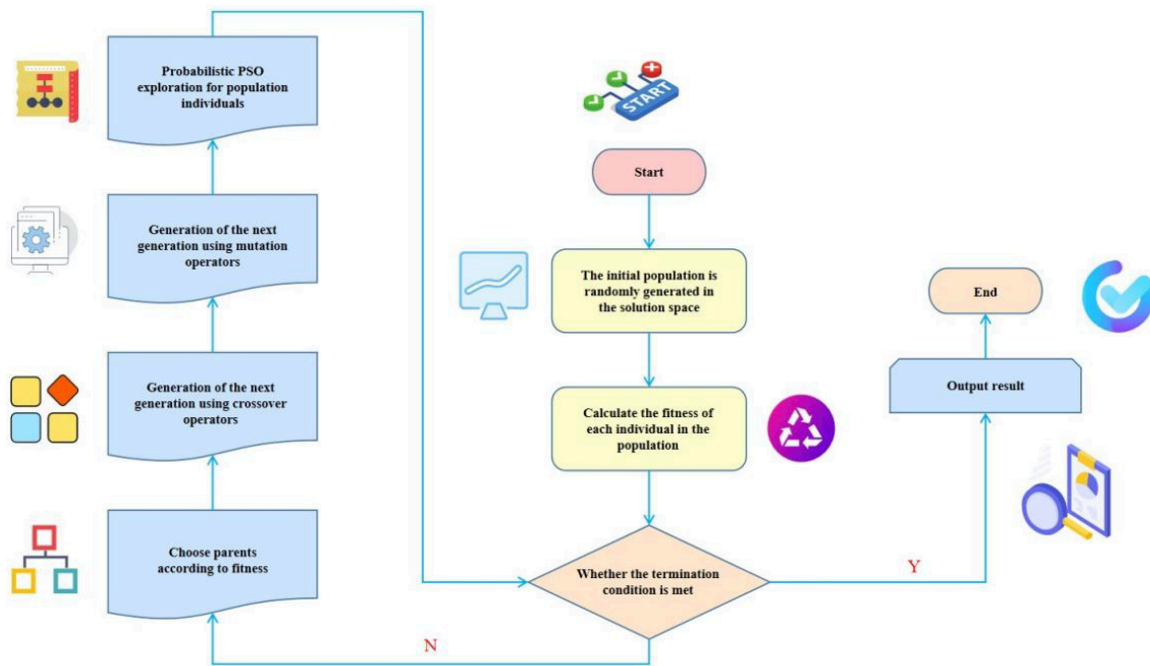
Fig. 1.1: Optimization simulation of industrial waste land reuse

1970s, with the decline of the traditional economy, the strengthening of environmental awareness, and the increase of environmental mobility, the number of industrial upgrades gradually increased. the number of industrial upgrades gradually increased. The continuous development of science and technology, as well as the achievements of ecology and biotechnology, have also provided technical support for the transformation of industrial wastes. In 1972, the Seattle Natural Gas Production Plant in the United States was the precondition for reusing the industrial wastes using the landscape design method.It has had a general impact on the landscape design in terms of park form, industrial landscape style, and cultural value. In the 1990s, people tried to use landscape design techniques to solve the historical puzzlement of the landscape industry, which has caused the ecological environment deterioration and has fallen behind, resulting in a large number of design patterns [15, 14]. Designers have utilized a comprehensive approach of science and art to achieve the goals of environmental renewal, ecological restoration, cultural reconstruction, and economic development in industrial wasteland. As shown in Figure 1.1:

2. Literature Review. Industrial waste land, in a broad sense, was once used for industrial production, with the continuous growth of technology and urban renewal, many sites have been forced to transfer to the surrounding areas of the city, resulting in many industrial waste sites, most of these industrial legacy sites have serious industrial pollution, and the industrial traces are very obvious. It includes many types, including abandoned storage equipment, industrial equipment, and open spaces formed by long-term storage of materials containing pollutants.

Most of this part of the land no longer has useful value, and the heavily polluted part is difficult to reuse, resulting in a series of ecological and economic problems. Industrial wasteland is a part of Urban culture economy, which has the function of extending the urban context and belongs to Urban culture heritage. Although the emergence of industrial waste land appears to be an economic recession, it has generated a series of social and environmental problems. In order to find out the treatment methods of different industrial wastelands is a problem that we have been exploring. It should not only conform to the local cultural background and be able to be well integrated into the urban development to conform to the urban development, but also play a positive role in the environment. It can improve the air quality of the park, reduce noise, and

beautify the environment. Economically, reducing the waste of land resources has established a positive urban image and promoted economic development, bringing economic benefits through resource development. In society, the impact of the environment on urban development has been reduced, people's living space has been optimized, and people's needs for urban environmental development have been met. Leirpoll, M. E. proposed that ecological reuse is a rigorous test of ecological theories, focusing on the characteristics, destruction processes, and restoration methods of ecosystems [8]. Hu, Z. B. believes that ecological reuse refers to a series of management activities that use modern restoration methods to restore damaged ecosystems to their pre damaged state [6].

3. Methods.

3.1. Design principles and methods for the reuse of industrial waste land.
Respecting the natural growth state and using the above ecological and ecological restoration methods to transform the abandoned land, the first thing to do is to preserve the characteristic Natural landscape of the site. Continuing to update the visual landscape in the venue for people to enjoy and rest, the combination of functionality and visual landscape has jointly created a new way of life [11, 16]. Based on the above analysis and summary, the reconstruction and restoration of industrial waste land can be adjusted from the following five principles: Ecological priority principle, respect for the site principle, adaptation to local conditions principle, people-oriented principle, and harmonious coexistence principle.

(1) Ecological priority principle

Firstly, summarize the specific reasons for the polluted environment on the site and carry out targeted adjustments and reconstruction, it is best to give the site a brand new look with minimal mobilization to ensure the balance of the natural ecosystem [12]. Secondly, on the basis of ensuring the continuity of the entire ecology, the maximum effort should be made not to cause secondary damage, the principle of fully utilizing the original terrain and landforms of the site to not damage the existing good vegetation style of the site is to use leftover materials and usable materials for design, reconstruction, and restoration to achieve sustainable development of the site. The Shanghai World Expo Houtan Wetland Park is a clear case in point. There are approximately 16 hectares of wetlands in the park, which can accommodate many wild birds as their habitats, the original old park's wetlands are mostly isolated with hard paving around them, the rebuilt park has abandoned the hard paving and replaced it with wild plants suitable for wetland growth, which has prevented wetland flooding and greatly improved the ecological integrity of the entire park [4].

(2) Respect the principle of venue

The regeneration of abandoned land should first consider respecting the characteristics of the site, in order to maintain sustainable ecological stability, it is necessary to start from the natural laws of plant growth and protect the plant communities left over from the original site, and try not to damage its existing ecological environment. The preservation of distinctive landscapes and the integration of fresh cultural enterprises enable the long-term development of the park, and drive the economic benefits of the entire park. For example, the Qijiang Park in Zhongshan City, formerly a waste shipyard in Zhongshan City, is also polluted to a corresponding degree in different scales, adhering to the principle of restoring the ecological space of Urban green space and inheriting industrial history and culture [9]. The park retains representative landmarks from the original shipyard as symbols of the new park, including the preservation of plants and structures such as railway tracks in the original factory area.

(3) Principle of adapting to local conditions

Adapting to local conditions in a broad sense means renovating the landscape to varying degrees based on the local natural and cultural characteristics, including different areas, the diversity of surrounding users and the type of venue to be updated. This requires effective analysis based on the actual local situation during design, and different methods should be adopted to update and rebuild the landscape [3, 1].

Firstly, before updating and designing, it is necessary to conduct a firsthand investigation and analysis of the surrounding environment, the economic situation of the surrounding users, and the current situation of surrounding pollution. Based on the pollution situation in the park and the analysis of the problems and advantages in the surrounding terrain, an effective method is proposed. Secondly, after meeting the needs of different locations and regions, it is more important to consider the ecological status of the park in the next

ten to twenty years, different plots or industrial waste land have diverse characteristics, and no factory area is copying the achievements of others.

For example, if the pollution level in the factory area is relatively low and the geographical location of the park is relatively superior, the buildings that are preserved are relatively intact. Based on the actual situation, they can be transformed into projects that can drive economic development, such as art museums, historical museums, and other enterprises of different scales. Not only can it promote the development of the surrounding economy, but it also makes reasonable use of various factors available in the factory area. As an important design principle, adapting to local conditions stipulates that designers must be people-oriented and start from their own unique perspective, aiming to establish urban public green spaces that are more suitable for a region [10, 17].

3.2. Design method for industrial waste land transformation and reuse. The transformation of industrial waste land into urban public green spaces requires considering many factors that are relatively difficult to design, when designing for renovation and reuse, attention should be paid to the following aspects:

(1) The preservation and renovation of abandoned industrial buildings, shopping and industrial facilities, most of the remaining machinery or structures in the factory area that have original industrial park functions, how to effectively preserve and reuse them is a key part that we should pay attention to when designing, achieving a unified style between preservation and reconstruction [2].

One is overall preservation. The preservation of this part mostly refers to buildings with important usage functions in the park or well preserved buildings and structures in the park. After the renovation, the overall production process of the original industrial park can be further felt.

The second is selective retention. When encountering structures that can be preserved or have preservation value, appropriate and selective preservation can be carried out based on the principle of preserving the style and features of industrial sites. These parts are mostly industrial buildings with obvious characteristics or well preserved buildings [7].

The third is the preservation of components. There are a large number of structures left behind in the park that have been repaired and can be reused. This not only updates the landscape of the factory area, but also allows people to truly feel the original industrial style and the sense of the times brought by history.

(2) Treatment of surface relics after industrial production

Regardless of the type of industrial production, traces will be left on the surface to some extent, however, there are many unique industrial surface relics that can be effectively protected to form a unique landscape. For ordinary surface relics, preservation and restoration methods can be chosen to enhance their overall industrial style as a new landscape.

(3) Waste utilization and pollution treatment

The waste and unused raw materials on the site can be reused, provided that they do not cause further pollution to the park, for materials that pollute the environment, they can be recycled through technical treatment methods. Ultimately, choosing local materials according to local conditions reduces economic pressure while also increasing ecological benefits.

(4) Soil testing

Conduct professional testing on the soil of different plots in the park, and develop different remediation methods based on specific circumstances. It is recommended to transfer the most severely polluted soil. By analyzing the current situation of soil and using technical techniques to identify the main sources and pollutants of pollution, targeted remediation can be carried out. From the local to the overall, gradually forming a harmonious ecosystem, using different treatment methods to achieve good soil planting status.

3.3. Genetic algorithm recommendation method for reuse of abandoned land in industrial scenic spots. The author proposes a genetic algorithm for the reuse of abandoned land in industrial scenic areas. The algorithm mainly consists of two steps: a. Combining user stable preferences with short-term preferences generated by external stimuli to calculate the user's preference for scenic spots; b. Design a ranking method for recommended scenic spots, recommending the top N favorite scenic spots to users. Next, we will explain step (1) of the algorithm through the definition of the UPT graph, and then introduce the sorting method.
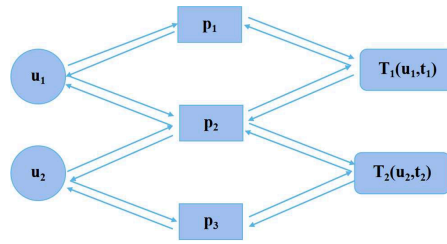
Fig. 3.1: Example of UPT diagram

Definition 2: (User Scenic Area Time Period Relationship Graph, UPT Graph) A UPT graph is a directed tripartite graph G (U, P, T, E, w, where: U is the set of user u; P is the scenic area P; Set of; T is the set of time periods T (u. t). E is the set of edges in the graph, with edges between u and p, if and only if user u has visited p, p; There is an edge between and T, if and only if user u has visited the scenic area p during time t; W represents the weight of the edge, which is defined as follows formula (3.1):

$$w < v_i, v_j \geq \begin{cases} \frac{N(p_i)}{\sum_{i=1}^{n} N(p_i)} \\ \frac{1}{\sum_{i=1}^{n} N(u_i)} \\ w_p \\ w_1 \end{cases} \tag{3.1}$$

A UPT graph is a directed graph, with weights $w < v_i$ and $v_j >$ calculated separately based on the vertices associated with the directed edge. The weight value of edge $< u_j, p_i >$ measures the long-term preference of user u_i for scenic spot p_i, which is calculated from the proportion of p_i scenic spots in user u_i's historical data; The weight of edge $< u_i, p_i >$ measures the special degree of the scenic area p_i to the user u_i, calculated by the reciprocal of the number of visitors to the scenic area p_i. The higher the value, the more special the p_i is to the u_i. Similarly, during a certain period of time, the user's preference for the scenic area and the special degree of the scenic area to the user are expressed in w_p and w_t respectively.

Figure 3.1 shows the UPT diagram composed of users, scenic spots, and time period nodes. The similarity between scenic spots can also be calculated through this graph. If two scenic spots are associated through the user node U_I, their similarity can be calculated based on the user's long-term preferences; If two scenic spots are associated through the time period node T_i, their similarity can be calculated based on users' short-term preferences.

After the construction of the UPT graph is completed, a new recommendation method is designed based on the idea of random walk, taking into account the characteristics of nodes in the UPT graph [5]. The main idea of the R-UPT method is to start from the node u_i and follow the edges between the vertices, then randomly walk to an unknown scenic spot, which matches the user's long-term preferences; On the contrary, if you randomly walk from node T_i, you can reach a scenic spot that matches the user's short-term preferences. The user's preference for a certain scenic spot pi can be calculated by taking the u_i node or T_i node as the tail of the arc and the pi node as the end of the arc, the scenic spot pi with the maximum sum of edge weights will be recommended to the user u_i. Given that a user u_i starts from a user node or a time period node, there are many paths to reach the scenic spot node pi, the algorithm only considers the shortest path to reach the scenic spot node from the user node or time period node, which is a path with a length of 3, there are four situations where the shortest path to reach the scenic spot node on the UPT diagram is as follows:

a. User → Scenic Area → User → Scenic Area: Starting from user node u_1, reach a certain scenic area p_2 that the user has browsed, and then reach scenic area p_3 through user u_2 who has browsed the scenic area, as shown in the path $u_1 \rightarrow p_2 \rightarrow u_2 \rightarrow p_3$ in the Figure;

b. User → Scenic Area One Time Period → Scenic Area: Starting from user node u_1, reach a certain scenic area p_1 that the user has browsed, and then pass through time period node T_1 to reach scenic area node p_1, as shown in the path $u_1 \rightarrow p_1$ one $\rightarrow T_1$ one $\rightarrow P_2$ in the Figure;

c. Time period → scenic area → user → scenic area: Starting from time period node T_1, reach scenic area p_1, and reach scenic area p_2 through user u_1 who has browsed scenic area p_2, as shown in the path $T_1 \rightarrow p_1 \rightarrow u_1 \rightarrow P_2$ in the Figure;

The user's preference level $r(u_i; p_i;)$ for a certain scenic area can be expressed as equation (3.2):

$$r(u_i, p_i) = \sum w < v_i, v_j > \tag{3.2}$$

Using PageRank's improved algorithm to calculate the ranking of scenic spots, we recommend Top n users' favorite scenic spots. Formula (3.3) shows the calculation method for sorting nodes in the graph.

$$PR = \alpha \cdot M \cdot PR + (1 - \alpha) \cdot \tilde{d} \tag{3.3}$$

In order to achieve the idea of recommending Top N scenic spots to each user, a personalized vector is first constructed for each user, and then the scenic spot nodes in the UPT graph are sorted according to formula (3.3), the Top-N node is recommended to users, the algorithm is based on Breadth-first search and implemented by queue structure, after walking to a node, the sum of path length and path weight is updated; Finally, call the sorting function to find Top-N scenic spots to be recommended.

4. Experimental Analysis. The author's experiment was conducted on two datasets, CiteULike and JD. This experiment divides the dataset into a test set and a training set, the user's most recent purchase record is used as the test set CUL-Test, JD Test, and the remaining purchase records are used as the training set CUL-Train, JD Train. The experimental environment is Windows 7 operating system, Inteli5 3.3G CPU, and 8GB memory.

Measurement parameters:

The author uses' Hit Ratio '(HT) to measure the accuracy of Top N recommendations. Firstly, generate a top N recommended product list for user u during the time period t, denoted as $P(u,t)$. If a product appears in the top N recommended product, it is recorded as a hit [13]. The hit rate formula (4.1) measures:

$$HT = \frac{\sum_u (p_u \in P(u,t))}{|U|} \tag{4.1}$$

From Figure 4.1(a), it can be seen that with the β as the value changes, the hit rate of algorithm URT-R increases first and then decreases, stay β when the value is set to 0.6, it approaches the peak. Due to the relationship between the other three algorithms and β it is irrelevant, therefore, the data will not fluctuate, as can be seen, without considering timeliness, the hit rate of the CF-T algorithm is between UserKNN and ItemKNN.

Figure 4.1(b) shows that on the JD dataset, the hit rate varies with β the overall trend of changes in values is similar to Figure 4.1(a), only corresponding to the peak value β the values are different. Due to the high density of the JD dataset, its average hit rate is higher than that of the CiteULike dataset.

In addition, the author also focuses on the coordination parameters α conducted experiments, stay $\beta=$ Under the premise of 0.5, change k and α observe the change in hit rate based on the value of, and the experimental results are shown in Figure 4.1(b).

This article will compare the genetic algorithm proposed by the author with two classic algorithms: the user-based filtering algorithm UserKNN and the object-based collaborative filtering algorithm ItemKNN. and the object-based collaborative filtering algorithm ItemKNN. Firstly, in β Testing the changes of the attribute value while taking different values and processing the algorithm of the two datasets. The experimental results are shown in Figure 4.2(a)(b).

The experiment in Figure 4.2 shows the coordination parameters α the relationship with hit rate is best in the CiteU Like dataset at a=0.4, while in the JD dataset at o=0.6. When k=6, the hit rate significantly decreases by about 50%.

5. Conclusion. In response to the strong timeliness of optimization simulation for the reuse of abandoned industrial scenic spots, the author proposes two genetic algorithms, CFT and URT-R. The CF-T algorithm improves the traditional system filtering algorithm and the definition of similarity between users and industrial
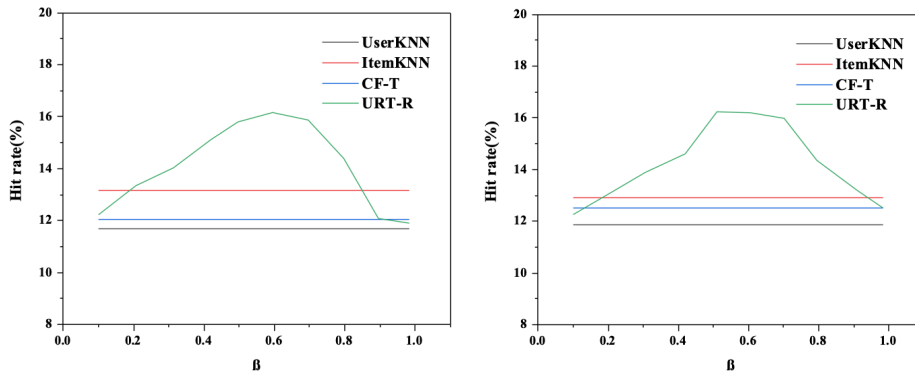
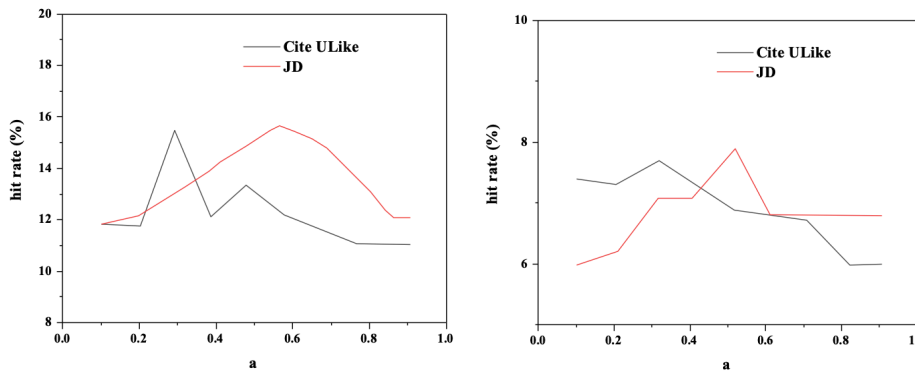Fig. 4.1: (a) Hit rate β Changes in values (Cite ULike dataset); (b) Hit rate β Changes in values (JD dataset)

Fig. 4.2: (a) Coordination parameters α Relationship with hit rate (k=10); (b) Coordination parameters α Relationship with hit rate (k=5)

scenic spots, and adds time factors to obtain the recommended Top N industrial scenic spots; The URT-R algorithm is based on random walks, combining users' long-term and short-term preferences, calculate the Top-N algorithm that is most suitable for users at the current time, and recommend it through optimization simulation of industrial waste land reuse. Finally, experimental verification was conducted on the dataset for the two algorithms proposed in this article. In terms of timeliness recommendations, the URT-R genetic algorithm showed a high recommendation hit rate, further improving the recommendation accuracy on the data.

REFERENCES

[1] S. R. ABELLA AND T. A. SCHETTER, *Variation in characteristics and conservation values of plant communities on abandoned agricultural lands with and without fires*, Applied Vegetation Science, 24 (2021), p. e12629.

[2] A. BEN, E. PUSHPALAKSMI, J. SAMRAJ, AND A. GURUSAMY, *Biodegradation of tannery effluent dyes by using aspergillus niger isolated from the tannery effluent and reuse of biotreated water in agricultural field*, Journal of Biodiversity and Environmental Sciences, 18 (2021), pp. 74–80.

[3] D. CHEN, B. ZHANG, C. FADDA, D. JARVIS, N. BERGAMINI, G. HAN, M. ZHAO, K. BAI, AND Z. ZHANG, *Spontaneous grassland recovery on abandoned croplands in northern china: Different vegetation patterns in desert and typical steppe*, Science of The Total Environment, 790 (2021), p. 148155.

[4] P. COSTA, E. BRITO-HENRIQUES, AND C. CAVACO, *Interim reuse in urban derelicts: Uncovering the community's attitudes and preferences through scenario-elicitation*, Cities, 111 (2021), p. 103103.

[5] M. Di Nardo and T. Murino, *The system dynamics in the human reliability analysis through cognitive reliability and error analysis method: A case study of an lpg company*, Int. Rev. Civ. Eng, 12 (2021), pp. 56–68.

[6] A. Hu, S.-H. Chang, X.-J. Chen, F.-J. Hou, and Z.-B. Nan, *Temporal heterogeneity has no effect on the direction of succession in abandoned croplands in a semiarid area of northwest china*, Land Degradation & Development, 32 (2021), pp. 91–100.

[7] A. Kaleli and H. İ. Akolaş, *The design and development of a diesel engine electromechanical egr cooling system based on machine learning-genetic algorithm prediction models to reduce emission and fuel consumption*, Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science, 236 (2022), pp. 1888–1902.

[8] M. E. Leirpoll, J. S. Næss, O. Cavalett, M. Dorber, X. Hu, and F. Cherubini, *Optimal combination of bioenergy and solar photovoltaic for renewable energy production on abandoned cropland*, Renewable Energy, 168 (2021), pp. 45–56.

[9] D. Li, X. Zhang, J. A. Dungait, X. Wen, T. A. Quine, and Q. Wang, *Changes in the biological n2-fixation rates and diazotrophic community as vegetation recovers on abandoned farmland in a karst region of china*, Applied Soil Ecology, 158 (2021), p. 103808.

[10] ———, *Changes in the biological n2-fixation rates and diazotrophic community as vegetation recovers on abandoned farmland in a karst region of china*, Applied Soil Ecology, 158 (2021), p. 103808.

[11] J. S. Næss, C. M. Iordan, H. Muri, and F. Cherubini, *Energy potentials and water requirements from perennial grasses on abandoned land in the former soviet union*, Environmental Research Letters, 17 (2022), p. 045017.

[12] A. V. Prishchepov, E. V. Ponkina, Z. Sun, M. Bavorova, and O. A. Yekimovskaja, *Revealing the intentions of farmers to recultivate abandoned farmland: A case study of the buryat republic in russia*, Land Use Policy, 107 (2021), p. 105513.

[13] M. Qin, *Evolution of labor relations in the development of human resources based on improved genetic algorithm*, Journal of Circuits, Systems and Computers, 31 (2022), p. 2250272.

[14] G. Rong, H. Wu, P. Yang, G. Duan, X. Shen, N. Ge, and X. Wei, *Dynamics of new-and old-soil organic carbon and nitrogen following afforestation of abandoned cropland along soil clay gradient*, Agriculture, Ecosystems & Environment, 319 (2021), p. 107505.

[15] L. Wang, Q. Tian, C. Wu, H. He, C. Guo, J. Wang, and H. Zhao, *Study on soil microorganism of abandoned land in qingtu lake in different years*, Journal of Environmental Protection and Ecology, 22 (2021), pp. 1408–1415.

[16] R. Wang, J. Zhang, H. Sun, S. Sun, G. Qin, and Y. Song, *Effect of different vegetation on copper accumulation of copper-mine abandoned land in tongling, china*, Journal of Environmental Management, 286 (2021), p. 112227.

[17] G. Yang, R. Xu, Y. Chen, Z. Wu, Y. Du, S. Liu, Z. Qu, K. Guo, C. Peng, J. Chang, et al., *Identifying the greenhouses by google earth engine to promote the reuse of fragmented land in urban fringe*, Sustainable Cities and Society, 67 (2021), p. 102743.