

Ecological Environment Restoration and Landscape Regeneration Design of Urban Industrial Wasteland based on big data model

Haibo Dong

Department of art and design, College of Art, Weifang University of Science and Technology,
Shouguang Shandong 262700, China

CA Haibo Dong email: donghaibo@wfust.edu.cn

Abstract: Abandoned urban industrial lands have been industrially polluted to varying degrees and they always have the characteristics of reduced soil fertility, deteriorated water quality, destructed surface environment, single plant species, and degraded ecosystem function, which have brought a series of social, ecological and environmental problems. Therefore, the ecological environment restoration and landscape regeneration design of urban industrial wasteland is of vital research significance for adjusting urban spatial layout, improving urban ecological environment, reflecting urban cultural history, and promoting new industrial construction. However, while the previous research results have gained a certain understanding of this content, there are still many shortcomings of them, such as how to maintain the stability of ecological environment after the restoration of industrial wasteland, how to integrate the landscape regeneration design of industrial wasteland with circular economy and sustainable development, and other related questions have not been well answered. Therefore, on the basis of summarizing and analyzing previous research works, this paper expounded the research status and significance of the ecological environment restoration of urban industrial wasteland, elaborated the development background, current status and future challenges of the landscape regeneration design of urban industrial wasteland, introduced the methods and principles of circular economy, sustainable development, landscape ecology and industrial ecology, proposed the functional positioning for the ecological environment restoration of urban industrial wasteland, conducted the solution optimization for the ecological environment restoration of urban industrial wasteland, explored the implementation plan for the ecological environment restoration of urban industrial wasteland, performed the model establishment for the landscape regeneration design of urban industrial wasteland, analyzed the realization path for the landscape regeneration design of urban industrial wasteland, and finally discussed the ecological significance for the landscape regeneration design of urban industrial wasteland. The study results show that the land renewal rate ranges from 0.280 to 0.515; for the facility retention rate, the sustainable development is the highest with 0.506 and the circular economy is the lowest with 0.038; the pollutant treatment rate is from 0.205 to 0.440; for new energy development rate, the landscape ecology is the highest with 0.224 and the industrial ecology is the lowest with 0.007. Hence, the ecological environment restoration and landscape regeneration design of urban industrial wasteland can integrate protective design methods, sustainable design methods, and suitable design methods into the transformation of urban industrial wastelands, realizing the sustainable development of urban industrial wasteland resources, ecological environment and historical culture; this can also combine the ecological restoration with landscape reconstruction, shape open space environment, enhance economic value, and make it renewably utilized and become a brand-new urban public space with rich meaning and a large-scale natural ecological system. The study results of this paper provide a reference for further researches on ecological environment restoration and landscape regeneration design of urban industrial wasteland.

Keywords: Urban industrial wasteland; Ecological environment restoration; Landscape regeneration design; Landscape and industrial ecology

1. Introduction

Abandoned urban industrial lands have been industrially polluted to varying degrees and they always have the characteristics of reduced soil fertility, deteriorated water quality, destructed surface environment, single plant species, and degraded ecosystem function, which have brought a series of social, ecological and environmental problems [1]. The restoration of the ecological environment for the urban industrial wasteland can create a new balance of ecological significance through a series of human behaviors, and can improve the factors that have had an adverse effect on humans one by one [2]. However, after long-term disposal of some industrial wastelands, natural vegetation gradually recovered and became habitats for wild animals, which also improved the ecological environment [3]. For this kind of site that has little impact on the environment, but the nature of the land has not yet been determined, it can be considered as ecological land or urban development reserve land for preservation. Under the new situation, the ecological environment restoration and landscape regeneration design of urban industrial wasteland can use ecological restoration theory as a guide and comprehensively apply ecological multidisciplinary knowledge such as science, landscape architecture and

aesthetics to solve the problem of landscape regeneration, which can integrate protective design methods, sustainable design methods, and suitable design methods into the transformation of urban industrial wastelands, hence turning waste into green and treasure and realizing the sustainable development of urban industrial wasteland resources, ecological environment and historical culture [4]. Therefore, the ecological environment restoration and landscape regeneration design of urban industrial wasteland is of vital research significance for adjusting urban spatial layout, improving urban ecological environment, reflecting urban cultural history, and promoting new industrial construction [5].

From a macro point of view, the status quo of industrial wasteland bases often loses part or all of their natural vitality, and the environment is severely traumatized, often including broken factories and exposed mines [6]. This historical information, as the old landscape structure and constituent elements have great social and historical value in their natural characteristics, and the choice of these structures is also one of the key points in the restoration and regeneration of industrial wasteland landscapes [7]. From the perspective of environmental protection, the damage of traditional industrial production to the environment is not only manifested in visible pollution and destruction on the surface, but the most serious is the gradual deterioration of soil base and groundwater system under long-term industrial pollution [8]. Therefore, the treatment and restoration of the remaining deep pollutants is the top priority of the ecological restoration and regeneration of industrial wasteland. How to maintain a stable restoration of the ecological environment between the sites after restoration is to use reasonable technical reconstruction and transformation for the purpose of sustainable development, using the current excellent biotechnology combined with the theory of ecological restoration, and applying it to the site to improve the overall Ecological environment [9]. Due to the different usability of each section of the industrial wasteland, the land parcels are decomposed in different areas and the corridors are separated from the relationship. Such a relationship will only accelerate the rate of wasteland being abandoned, which requires a large landscape design and various factors should be linked with the planning to avoid a single situation. Only with a full understanding of the element composition in the industrial site, can landscape design achieve a multiplier effect, and can propose an update and reuse strategy for various elements [10].

Based on the summary and analysis of previous research works, this paper expounded the research status and significance of the ecological environment restoration of urban industrial wasteland, elaborated the development background, current status and future challenges of the landscape regeneration design of urban industrial wasteland, introduced the methods and principles of circular economy, sustainable development, landscape ecology and industrial ecology, proposed the functional positioning for the ecological environment restoration of urban industrial wasteland, conducted the solution optimization for the ecological environment restoration of urban industrial wasteland, explored the implementation plan for the ecological environment restoration of urban industrial wasteland, performed the model establishment for the landscape regeneration design of urban industrial wasteland, analyzed the realization path for the landscape regeneration design of urban industrial wasteland, and finally discussed the ecological significance for the landscape regeneration design of urban industrial wasteland. The study results of this paper will provide a reference for further researches on ecological environment restoration and landscape regeneration design of urban industrial wasteland. The detailed chapter arrangement is as follows: Section 2 introduces the methods and principles of circular economy, sustainable development, landscape ecology and industrial ecology; Section 3 discusses the ecological environment restoration of urban industrial wasteland; Section 4 analyzes the landscape regeneration design of urban industrial wasteland; Section 5 is conclusion.

2. Methods and principles

2.1 Circular economy and sustainable development

Circular economy is completely different from traditional economy. The traditional economy is a linear economy with a unidirectional flow of resources-products-waste, a movement that continuously turns resources into garbage, and achieves quantitative economic growth through the natural cost of reverse growth. Circular economy uses the laws of ecology to guide the economic activities of human society, which is essentially an ecological economy. Therefore, the theory of circular economy has great theoretical guiding significance for the renewal and revival of urban industrial wasteland, and can avoid the repeated waste of resources [11]. Sustainable development involves the coordination and unity of sustainable economy, sustainable ecology and sustainable society, which requires human beings to pay attention to economic efficiency, pay attention to ecological harmony and pursue social justice in their development, and finally achieve the all-round development of human beings. Sustainable development requires the protection and improvement of the earth's ecological environment while development, ensuring the use of natural resources and environmental costs in a sustainable manner, and keeping human development within the carrying capacity of the earth. Sustainable development emphasizes that social equity is the mechanism and goal for environmental protection to be achieved [12]. The essence of development should include improving the quality of human life, raising the level of human health, and creating a social environment that guarantees equality, freedom, education, human rights,

and freedom from violence. Figure 1 shows the framework of the ecological environment restoration and landscape regeneration design of urban industrial wasteland.

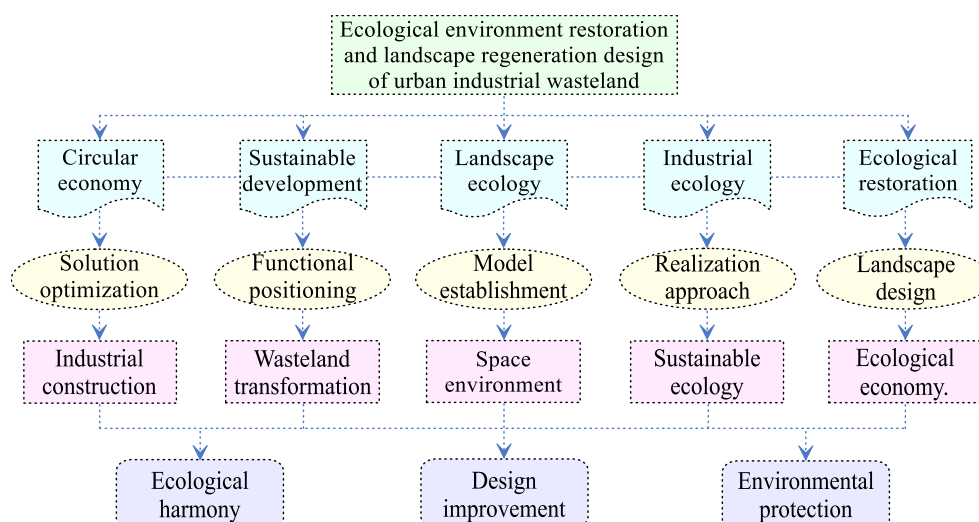


Figure 1 Framework of the ecological environment restoration and landscape regeneration design of urban industrial wasteland

Many designs in the transformation of urban industrial wasteland are based on the theoretical system of ecological design, such as creating a sustainable landscape that uses material and energy recycling, building a multi-purpose wetland sewage treatment system, creating a variety of biological habitats, and adapting to special plant cultivation in the environment [13]. Niche refers to all the living conditions required by a biological population, including biological and non-biological, which includes not only the physical space occupied by organisms, but also the functional role of organisms in the community, and their position in environmental gradients such as temperature, humidity, and soil. In this way, the niche is not only determined by the species living there, but also by how they live and how they are constrained by other organisms [14]. The selection of plants should give priority to the use of regional tree species, which have good ecological advantages and are better adapted to the local climate and environmental conditions for growth. In the selection of plant tree species in industrial wastelands, native tree species with resistance and ecological restoration are the main plant resources to speed up the restoration and balance of the wasteland ecosystem. The energy flow of an ecosystem is an important manifestation of ecosystem functions, and the climax community with the largest biomass is the ultimate value goal of system evolution [15].

2.2 Landscape ecology and industrial ecology

The design of landscape as infrastructure is a design method and means of landscape regeneration design of urban industrial wasteland. In the field of landscape science, landscape infrastructure together with social infrastructure and engineering infrastructure constitute infrastructure. It is a brand-new method formed by the integration of various elements such as infrastructure construction supporting the development of urbanization under the guiding framework of landscape science [16]. The new system is also a way to treat infrastructure construction as a new type of infrastructure for a special landscape from the beginning. Combining landscape reconstruction and wasteland management to re-service urban development through landscape planning and design, simulating the natural topography of the area to achieve harmony and unity with the surrounding environment; adopting minimal intervention methods to dilute the artificial traces through the natural system itself; respecting and using engineering traces, and using the design techniques of land art to create new landscapes. Based on the topography of urban industrial wasteland, industrial ecology uses landscape design to combine the ecological restoration of the wasteland with landscape reconstruction to shape the open space environment, enhance the economic value, restore the vitality of the area, enable it to be restored, utilize and become a brand-new urban public space with rich meaning and a large-scale natural ecological system.

The basic theories of landscape ecology mainly include ecological evolution and ecological succession theory, spatial differentiation and biodiversity theory, landscape heterogeneity and heterogeneous symbiosis theory, scale effect and natural hierarchical organization theory, biogeochemistry and landscape geochemistry theory, ecological construction and ecological location theory [17]. Its theory can guide the restoration of degraded ecosystems, such as the restoration of various elements to be restored, so that it has a suitable spatial configuration, so as to achieve the purpose of restoration of degraded ecosystems and guide the degraded ecosystems through the configuration of landscape spatial patterns recovery (Figure 2). Ecological aesthetics

believes that the natural ecological process is beautiful, and the activities of wild animals and plants in nature show a natural ecological picture. Designers began to advocate wilderness protection and the creation of wildlife landscapes in landscape design. The long-abandoned urban industrial site grows wild vegetation adapted to the environment with its own natural resilience, which is preserved and organized into the landscape, which has ecological and economic value and creates a new aesthetic landscape [18]. The post-industrial landscape is accompanied by the evolution of human civilization, is the product of the background of the transformation of industrial society to post-industrial society, and is based on human introspection on the destruction of the natural status quo by industrial civilization.

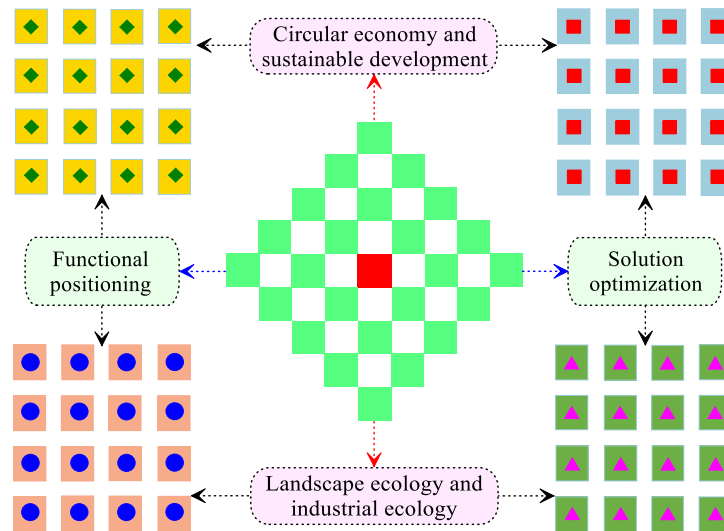


Figure 2 Landscape ecology and industrial ecology used in the ecological environment restoration and landscape regeneration design of urban industrial wasteland

3. Ecological environment restoration of urban industrial wasteland

3.1 Functional positioning of ecological environment restoration

The transformation of urban industrial wasteland can promote the completion of land replacement in cities. Some industrial wasteland is built in the central area of the city or in areas with relatively good environmental resources due to the limitation of the land level difference. Greater economic benefits can be obtained through land replacement and the transformation of urban industrial wasteland improves the urban landscape level, which is conducive to the development of tertiary industries such as tourism, and stimulates the economic vitality of the city [19]. The land renewal rate ranges from 0.280 to 0.515; for the facility retention rate, the sustainable development is the highest with 0.506 and the circular economy is the lowest with 0.038; the pollutant treatment rate is from 0.205 to 0.440; for new energy development rate, the landscape ecology is the highest with 0.224 and the industrial ecology is the lowest with 0.007 (Table 1). The restoration of the ecological environment of the urban industrial wasteland can create a new balance of ecological significance through a series of human behaviors, and can improve the factors that have had an adverse effect on humans one by one. However, after long-term disposal of some industrial wastelands, natural vegetation gradually recovered and became habitats for wild animals, which also improved the ecological environment. For this kind of site that has little impact on the environment, but the nature of the land has not yet been determined, it can be considered as ecological land or urban development reserve land for preservation.

Table 1 Ecological environment restoration indicators in Circular economy, sustainable development, landscape ecology and industrial ecology

Ecological environment restoration indicators	Circular economy	Sustainable development	Landscape ecology	Industrial ecology
Labor input rate	0.345	0.030	0.279	0.582
Land renewal rate	0.283	0.515	0.430	0.280
Waste utilization rate	0.147	0.142	0.183	0.012
Facility retention rate	0.038	0.506	0.152	0.245
Social investment rate	0.559	0.047	0.237	0.494
Pollutant treatment rate	0.319	0.238	0.440	0.205
Government investment rate	0.154	0.171	0.480	0.529
Affiliated land elimination rate	0.083	0.334	0.156	0.020
New energy development rate	0.025	0.200	0.224	0.007

Water resources protection rate	0.573	0.004	0.441	0.162
Industrial structure change rate	0.345	0.142	0.023	0.275
Industrial culture retention rate	0.216	0.314	0.628	0.381

In the process of the landscape regeneration design of urban industrial wasteland, local materials can be used as much as possible. For buildings and facilities that still have use value, the method of preservation and transformation can be adopted, and the demolishing should be as little as possible. If solar energy, wind energy and water energy can be effectively used in the design, energy consumption can be greatly reduced, and the greatest economic benefits can be obtained with the least amount of money. In the urban landscape environment, the following types of plant leaves, unpolluted or lightly polluted river dredging, animal excrement, abandoned buildings and landscape hard materials, etc. can be reused. The above wastes are being harmless and they can be reused after treatment or disinfection [20]. For most of the buildings that remain intact, only regular repair work is enough; for buildings that are damaged, changed or need to be relocated, the restoration work is mainly carried out, which can be divided into in-situ restoration and off-site restoration. The models provide further research or perfect theoretical frameworks and technical systems for the restoration or reconstruction of landscapes in different regions, types, periods, and degrees of damage (Figure 3). At the same time, it explores new discipline systems is conducive to the in-depth study of landscape branch systems, and is conducive to landscape science and the intersection, integration and development of other disciplines such as ecology, environmental psychology, visual aesthetics, landscape morphology.

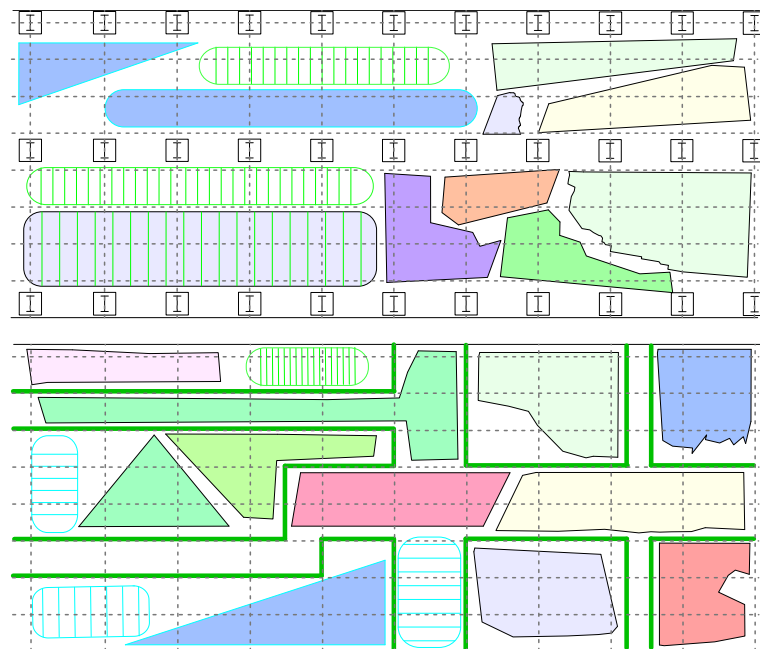


Figure 3 Functional positioning of ecological environment restoration of urban industrial wasteland

The landscape regeneration design of urban industrial wasteland refers to the use of landscape architecture, architecture, aesthetics, ecology, engineering and other multidisciplinary knowledge by designers to carry out surface restoration, vegetation reconstruction, ecological restoration, and cultural emphasis on the original urban industrial wasteland. Landscape design approaches such as architecture, to realize the renewal and conversion of urban industrial wasteland from gray industrial patches to green post-industrial ecological patches with multiple meanings [21]. Ecological restoration is the process by which people purposefully transform a place into a well-defined, inherent, and historical ecosystem. The purpose of this process is to try to imitate the structure, function, biodiversity, and change process of a specific ecosystem. The construction of factory buildings, the opening of raw material storage sites, and the establishment of factory production infrastructure on the native land of the industrial zone have added a lot of landscape elements to the native land, which has significantly strengthened the landscape heterogeneity of the originally relatively homogeneous native ecological environment. The industrial production process requires production sites, raw materials, water, and labor, etc. and the industrial production process will destroy the soil, vegetation and topography of the native land. These industrial actions destroy the biological habitat environment and species diversity of the native land, and affect the native land ecology. The stability of the system reduces its ability to interfere with the outside world, thereby destroying the ecological balance of the original industrial wasteland.

3.2 Solution optimization of ecological environment restoration

Due to years of pollution, the urban industrial wasteland has destroyed the urban ecological environment and the soil, water body, plant and other ecosystems of the base urgently need to be restored. The treatment methods of non-building factors in industrial wasteland should be integrated with ecological restoration theory to carry out comprehensive restoration, and finally the ecological environment in industrial wasteland can be self-purified and self-renewed. The regeneration design focuses on the functional layout of the facilities and the transformation of urban industrial wasteland is partial, small-scale, and biologically microscopic. While the industrial wasteland is ecologically restored, it is difficult for people to distinguish before and after the industrial wasteland transformation. The single plant species ranges from 0.085 to 0.147; for the reduced soil fertility, the protection rate is the lowest with 0.222 and the regeneration rate is the highest with 0.038; the deteriorated water quality is from 0.006 to 0.315; for degraded ecosystem function, the risk assessment rate is the highest with 0.581 and the purification rate is the lowest with 0.177 (Table 2). The model is to adopt the method of not retaining the original facilities and structures of the original industrial relics and abandoned land, instead of abstractly extracting certain landscape characteristics of the original industrial abandoned land, and pay attention to the transformation and beautification of the industrial abandoned land. The redesign of the original building space can be redesigned to be suitable for high-tech enterprises, entrepreneurial industries, commercial finance and other knowledge-intensive urban space with high return rate and high efficiency development. At the same time, it should have the versatility and high efficiency of urban space and the new buildings should be controlled from the building volume to avoid affecting the original urban style [22].

Table 2 Industrial pollution treatment indicators of urban industrial land

Characteristics of urban industrial land	Risk assessment rate	Purification rate	Protection rate	Regeneration rate
Single plant species	0.147	0.113	0.121	0.085
Reduced soil fertility	0.229	0.242	0.222	0.373
Deteriorated water quality	0.315	0.006	0.140	0.025
Degraded ecosystem function	0.581	0.177	0.363	0.425
Destructed surface environment	0.206	0.334	0.151	0.143

With the continuous development of industrialization, distinctive local cultures have formed in the industrial zone, and these unique cultures truly reflect the historical development process. Therefore, these cultural characteristics should be respected and preserved in the process of protective regeneration of industrial wasteland. In addition to building structures, native plant communities also follow the development and changes of the times, and truly show the cultural environment characteristics of the industrial age. Therefore, in the process of landscape design, the subversive and destructive transformation of the original landscape should be eliminated, cultural connotations should be respected, and the original plant community space should be reasonably optimized to create a plant landscape with local cultural characteristics [23]. The resource-environment-friendly type mainly refers to the maximum recyclable utilization of environmental resources and the maximum ecological and environmental benefits. In the process of selecting plant species, try to select plant types that are suitable for the site environment to grow, avoid selecting plant species that are more invasive and likely to cause ecologically sensitive issues, and treat the existing plants on the site that have fully adapted to the local climate and soil environment (Figure 4). In the selection process of plants, appropriate consideration is given to the use of economical plants, and on the basis of conforming to the topography, climatic conditions, and local culture; they can exert their ecological functions and produce certain economic value of production.

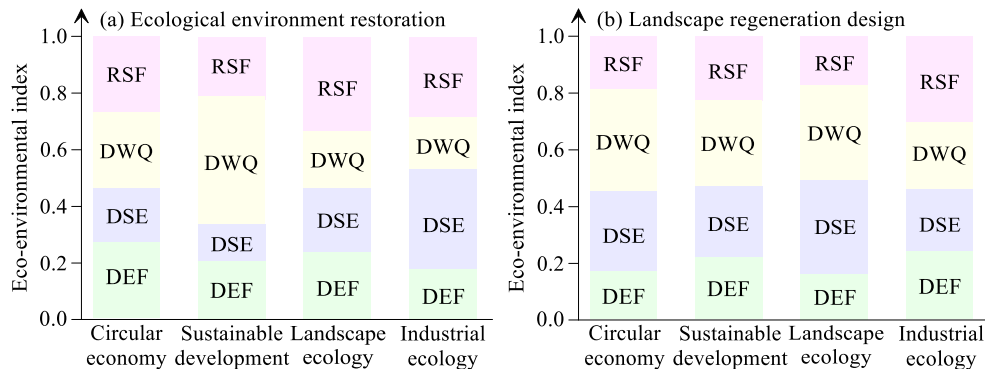


Figure 4 Ecological environmental indexes of five typical characteristics of urban industrial land in ecological environment restoration (a) and landscape regeneration design (b)

To fully reflect the urban industrial style, it is necessary to retain and reuse each component and industrial production equipment and production workshops are witnesses to industrial activities. The rough texture of the facade of the industrial building and the unique landscape features are both the embodiment of the industrial style. There are also some less noticeable in the industrial wasteland and seemingly mediocre or even unpleasant landscape elements also have their use value. Before the renovation, the scattered and decayed industrial relics in the site were sorted out, and the industrial aesthetic value was highlighted through landscape design [24]. Analyzing the definition of urban industrial wasteland, it can be seen that industrial wasteland must be generated after the site used by production activities is abandoned and different types of production activities lead to different industrial buildings and facilities in industrial sites. Therefore, the renewal and transformation of urban industrial wasteland should not only pay attention to the transformation of society, culture, and economy, but more importantly, the transformation of the physical environment of the site. The transformation of the physical environment is a comprehensive result of social, cultural and economic transformation and its visual reflection. Therefore, the transformation of the physical environment of industrial wasteland is the main object of landscape design. Only with a full understanding of the element composition in the industrial site, can landscape design achieve a multiplier effect, and can propose an update and reuse strategy for various elements.

4. Landscape regeneration design of urban industrial wasteland

4.1 Model establishment of landscape regeneration design

The approach of landscape design to the surface traces caused by industrial production is to adopt industrial landscape elements on the basis of fully respecting the landscape features of the site, and transform it by means of protection, artistic transformation and ecological treatment. Due to its special surface environment, urban industrial abandonment has gradually become a favorite place for artistic creation by some artists. These artists use artistic techniques to process the surface traces in the site, thereby retaining the unique surface traces on the site, which not only enhances the landscape value of the plot, but also leaves the history of the plot permanently on the ground. The overall reservation is to keep all the industrial buildings and facilities in the site, as well as the original municipal facilities and the original rail transit system in the site and all the factories including all industrial elements [25]. The art fusion rate from 0.053 to 0.367; for the relic retention rate, the artistic design is the lowest with 0.033 and the ecological design is the highest with 0.490; the plant landscaping rate is from 0.464 to 0.887; for space utilization efficiency, the place design is the highest with 0.534 and the social design is the lowest with 0.182 (Table 3). Through scientific analysis, rational transformation and redesign, the model is displayed in the post-industrial landscape park after ecological restoration in a new posture, so that future generations on the site can understand the historical evolution and industrial culture of the area. In order to highlight the sense of power and huge volume in the industrial era, it is possible to abandon its use function in processing the elements of the industrial landscape, and to split and reorganize it to become a visually iconic sculpture landscape.

Table 3 Landscape regeneration design indicators in ecological design, place design, artistic design and social design

Landscape regeneration design indicators	Ecological design	Place design	Artistic design	Social design
Art fusion rate	0.053	0.367	0.223	0.082
Traffic design rate	0.263	0.432	0.322	0.112
Building repair rate	0.179	0.352	0.865	0.242
Relic retention rate	0.490	0.151	0.033	0.435
Soil purification rate	0.297	0.540	0.245	0.163
Plant landscaping rate	0.594	0.887	0.464	0.605
Plant regeneration rate	0.021	0.218	0.855	0.232
Sightseeing attraction rate	0.245	0.363	0.300	0.532
Space utilization efficiency	0.428	0.534	0.186	0.182
Water resources protection rate	0.143	0.290	0.654	0.042
Geological risk assessment rate	0.339	0.853	0.848	0.242
Radiological risk assessment rate	0.040	0.124	0.347	0.118

From a micro point of view, long-term industrial activities have caused more or less environmental problems such as water pollution, soil pollution, air pollution, and vegetation destruction in urban industrial wastelands. Due to the differences in the production methods, production processes, production processes, and selected raw materials and processed products of various factories, the types and degrees of pollution formed are also different. Its potential characteristic pollutants roughly include heavy metals, volatile organic compounds, semi-volatile organic compounds, persistent organic compounds and petroleum hydrocarbons. From a macro

point of view, the status quo of industrial wasteland bases often loses part or all of their natural vitality, and the environment is severely traumatized, often including broken factories and exposed mines. These historical information, as the old landscape structure and constituent elements, have great social and historical value in their natural characteristics, and the choice of these structures is also one of the key points in the restoration and regeneration of industrial wasteland landscapes. From the perspective of environmental protection, the damage of traditional industrial production to the environment is not only manifested in visible pollution and destruction on the surface, but the most serious is the gradual deterioration of soil base and groundwater system under long-term industrial pollution. Without long-term restoration measures, these deep pollutions will not only persist, but will also pose a great threat to the physical health of residents along with the water cycle. Therefore, the treatment and restoration of the remaining deep pollutants is the top priority of the ecological restoration and regeneration of industrial wasteland [26].

The landscape regeneration design of urban industrial wasteland re-uses these industrial remains to reproduce the working scenes and work processes at the time, making it a rare landscape element in the construction of post-industrial landscapes. In industrial sites involving the mining industry, raw material mining sites often leave traces of industrial excavation, and can also become a natural landscape of industrial wasteland. With the continuous expansion of cities, much industrial land that was originally located in the suburbs of the city has gradually evolved into land in the center of the city. As the land has been in a state of long-term human intervention and continuous unrepaired industrial production, environmental problems such as a sharp decline in biodiversity and a break in the ecological chain have emerged [27]. It occupies good resource conditions and has the benefits of land location difference, but in the process of its own development, which has seriously affected the construction of the urban ecological environment. Even in the process of urban renewal, the original land use can no longer meet the new use needs and structural adjustments must be made along with urban land use. Landscape regeneration design refers to the restoration and regeneration of the ecological environment on the basis of industrial wasteland. Through modern landscape design techniques, natural elements and industrial elements are organically combined to transform, reorganize and regenerate, and inherit industrial history. Culture, and finally form an environmental landscape place with brand-new use functions.

4.2 Realization path of landscape regeneration design

The buildings in the urban industrial wasteland have lost their original use functions. Through the methods of enrichment, expansion, functional replacement, and internal space reconstruction, the existing buildings can not only be functionally perfect, but also bring beauty to people. The updated building should have a more sense of belonging and place, so as to maintain the continuity of the industrial context. The abandoned space in the abandoned land is usually updated and regenerated based on this method, but the operation is more difficult than the construction on the ground. Before the renewal and regeneration, the space structure experts should be asked to measure and repair the collapsed internal space, and after the soil structure is stabilized, the designer can design the interior [28]. When designing the regeneration of the abandoned space, they use modern materials and techniques to reset part or the whole of the abandoned space and the restored part is different from the original part in style and contrasts (Figure 5). The new and the old are intertwined and juxtaposed and exist in the space and most of the existing building functions serve the mining and production of minerals. Under the new regeneration model, they are often transformed into buildings with different functions and these new functions give the building new life. The new function should be determined on the basis of the existing building type, the original use of the space, the potential use, and the value of cultural relics.

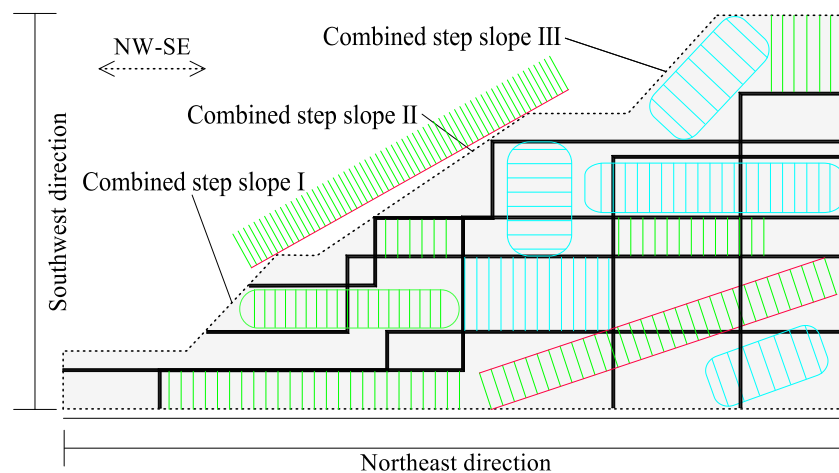


Figure 5 Realization path of landscape regeneration design of urban industrial wasteland

The preservation of facilities in some industrial wasteland with historical significance and cultural value can make it a symbol of the industrial age. They have a strong iconicity and sense of age, which can evoke people's memories and perceptions of the industrial age. Retention means that the original lighting landscape of the industrial wasteland should be modified as little as possible, and part of the ecological landscape of the original industrial wasteland will be preserved to restore the old look of history. Abandoned industrial facilities are design elements that can be used in the ecological landscape regeneration design, which can be appropriately deleted through the use of functions and visual effects of some industrial elements. They reduce complexity, restore the essence of industrial landscape, and create a new era of ecological landscape regeneration design that not only has industrial characteristics, but also has modern ecological landscape attributes [29]. For the original abandoned industrial facilities in the industrial wasteland, some modern scientific and technological elements, artistic elements and functional elements can be added to its foundation. The models supplement and perfect the original ecological landscape design, and at the same time complete the functional and aesthetic enhancement of the original ecological landscape. They also split and reorganize the original industrial materials of the site, change the single landscape structure and visual effect of the original ecological landscape, and combine to form a new ecological landscape appliance, so that the regeneration design of the ecological landscape will continue the sense of history and bring innovative visual impact to the people.

The landscape redesign of urban industrial wasteland should not only pursue economic benefits, but should comprehensively consider the social, economic, cultural, urban planning, cultural relics protection, environmental landscape, architectural design and other aspects of the city. The renewal, restoration and reuse of the landscape will regenerate the landscape and ecology, drive economic development, and improve the overall benefits of landscape, ecology, and society. The principle of ecological environment restoration should be based on a deep understanding of ecological thinking, with minimal intervention on the site, maximizing the utilization of energy and materials, reducing environmental pollution in the process, and improving the ecological environment of the site [30]. At the same time, it is necessary to maintain and improve the ecological balance of the surrounding areas to ensure the harmony and stability of the natural environment and ecosystem. Many successful practices show that under certain policy encouragement and guidance from government departments, projects that not only retain the historical characteristics of the region, but also meet the needs of the market can often create more economic benefits. In the landscape renewal of many industrial abandoned sites, the designer will choose to keep the original wild vegetation as much as possible in some areas with less tourist activities, and properly dispose of the less polluting industrial waste, so as to combine the two through presenting a landscape effect with strong visual impact.

5. Conclusions

This paper proposed the functional positioning for the ecological environment restoration of urban industrial wasteland, conducted the solution optimization for the ecological environment restoration of urban industrial wasteland, explored the implementation plan for the ecological environment restoration of urban industrial wasteland, performed the model establishment for the landscape regeneration design of urban industrial wasteland, analyzed the realization path for the landscape regeneration design of urban industrial wasteland, and finally discussed the ecological significance for the landscape regeneration design of urban industrial wasteland. Many designs in the transformation of urban industrial wasteland are based on the theoretical system of ecological design, such as creating a sustainable landscape that uses material and energy recycling, building a multi-purpose wetland sewage treatment system, creating a variety of biological habitats, and adapting to special plant cultivation in the environment, etc. Through the configuration of landscape spatial pattern to guide the restoration of degraded ecosystems, the restoration work is successful.

To fully reflect the urban industrial style, it is necessary to retain and reuse each component; industrial production equipment and production workshops are witnesses to industrial activities. The rough texture of the facade of the industrial building and the unique landscape features are both the embodiment of the industrial style and the specific changes of the industrial wasteland are preserved to the greatest extent possible. The regeneration design focuses on the functional layout of the facilities and the transformation of urban industrial wasteland is partial, small-scale, and biologically microscopic. While the industrial wasteland is ecologically restored, it is difficult for people to distinguish before and after the industrial wasteland transformation. Abandoned industrial facilities are design elements that can be used in the ecological landscape regeneration design, which can be appropriately deleted through the use of functions and visual effects of some industrial elements. The models can reduce complexity, restore the essence of industrial landscape, and create a new era of ecological landscape regeneration design that not only has industrial characteristics, but also has modern ecological landscape attributes.

The study results show that the land renewal rate ranges from 0.280 to 0.515; for the facility retention rate, the sustainable development is the highest with 0.506 and the circular economy is the lowest with 0.038; the pollutant treatment rate is from 0.205 to 0.440; for new energy development rate, the landscape ecology is the highest with 0.224 and the industrial ecology is the lowest with 0.007. Hence, the ecological environment

restoration and landscape regeneration design of urban industrial wasteland can integrate protective design methods, sustainable design methods, and suitable design methods into the transformation of urban industrial wastelands, turning waste into green and treasure and realizing the sustainable development of urban industrial wasteland resources, ecological environment and historical culture; this can also combine the ecological restoration with landscape reconstruction, shape open space environment, enhance economic value, and make it renewably utilized and become a brand-new urban public space with rich meaning and a large-scale natural ecological system. The study results of this paper provide a reference for further researches on ecological environment restoration and landscape regeneration design of urban industrial wasteland.

Acknowledgements

The authors acknowledge the XXX and XXX.

References

- [1] Hu, X., & Lima, M. F. (2019). Ecological value of abandoned wild landscapes in Chinese cities. *WIT Transactions on Ecology and the Environment*, 238, 331-342.
- [2] Wirth, P., Chang, J., Syrbe, R. U., Wende, W., & Hu, T. (2018). Green infrastructure: a planning concept for the urban transformation of former coal-mining cities. *International Journal of Coal Science and Technology*, 5(1), 78-91.
- [3] Marin, J., & De Meulder, B. (2018). Urban landscape design exercises in urban metabolism: reconnecting with Central Limburg's regenerative resource landscape. *Journal of Landscape Architecture*, 13(1), 36-49.
- [4] Amenta, L., & Van Timmeren, A. (2018). Beyond wastescapes: Towards circular landscapes. Addressing the spatial dimension of circularity through the regeneration of wastescapes. *Sustainability*, 10(12), 4740.
- [5] Kaae, B. C., Holm, J., Caspersen, O. H., & Gulsrud, N. M. (2019). Nature Park Amager—examining the transition from urban wasteland to a rewilded ecotourism destination. *Journal of Ecotourism*, 18(4), 348-367.
- [6] Ivanova, N., & Ganzha, O. (2016). The architectural and ecological features of the underground development of the ravine network in a riverside city (on the example of Volgograd). *Procedia Engineering*, 165, 1006-1015.
- [7] Leifsen, E. (2017). Wasteland by design: Dispossession by contamination and the struggle for water justice in the Ecuadorian Amazon. *The Extractive Industries and Society*, 4(2), 344-351.
- [8] Bortolotti, A., & Ranzato, M. (2018). Wasteland rehabilitation in rural landscape: A design project in the Verona plain. *Ri-Vista. Research for Landscape Architecture*, 16(1), 90-101.
- [9] Pickett, S. T., Cadenasso, M. L., Childers, D. L., McDonnell, M. J., & Zhou, W. (2016). Evolution and future of urban ecological science: ecology in, of, and for the city. *Ecosystem health and Sustainability*, 2(7), e01229.
- [10] Anderson, E. C., & Minor, E. S. (2017). Vacant lots: An underexplored resource for ecological and social benefits in cities. *Urban Forestry and Urban Greening*, 21, 146-152.
- [11] Peng, Y., Qian, J., Ren, F., Zhang, W., & Du, Q. (2016). Sustainability of land use promoted by construction-to-ecological land conversion: a case study of Shenzhen city, China. *Sustainability*, 8(7), 671.
- [12] Beckett, C., & Keeling, A. (2019). Rethinking remediation: Mine reclamation, environmental justice, and relations of care. *Local Environment*, 24(3), 216-230.
- [13] Cross, A. T., Young, R., Nevill, P., McDonald, T., Prach, K., Aronson, J., Wardell-Johnson, G. W. & Dixon, K. W. (2018). Appropriate aspirations for effective post-mining restoration and rehabilitation: A response to Kaźmierczak et al. *Environmental Earth Sciences*, 77(6), 1-6.
- [14] Riley, C. B., Perry, K. I., Ard, K., & Gardiner, M. M. (2018). Asset or liability? Ecological and sociological tradeoffs of urban spontaneous vegetation on vacant land in shrinking cities. *Sustainability*, 10(7), 2139.
- [15] Draus, P., Haase, D., Napieralski, J., Sparks, A., Qureshi, S., & Roddy, J. (2020). Wastelands, Greenways and Gentrification: Introducing a Comparative Framework with a Focus on Detroit, USA. *Sustainability*, 12(15), 6189.
- [16] Berruti, G., & Palestino, M. F. (2020). Wastelands as an opportunity for managing Naples' sustainable transition. *European Spatial Research and Policy*, 27(2), 33-42.

- [17] Włodarczyk-Marciniak, R., Sikorska, D., & Krauze, K. (2020). Residents' awareness of the role of informal green spaces in a post-industrial city, with a focus on regulating services and urban adaptation potential. *Sustainable Cities and Society*, 59, 102236.
- [18] Evered, E. (2016). The role of the urban landscape in restoring mental health in Sheffield, UK: service user perspectives. *Landscape Research*, 41(6), 678-694.
- [19] Ge, X., Jiao, L., Qu, J., & Guo, F. B. (2020). Sustainable urban regeneration based on industrial heritage conservation in Dalian, China. *Test Engineering and Management*, 83, 19353-19359.
- [20] Guo, K., Zhang, X., Liu, J., Wu, Z., Chen, M., Zhang, K., & Chen, Y. (2020). Establishment of an integrated decision-making method for planning the ecological restoration of terrestrial ecosystems. *Science of the Total Environment*, 741, 139852.
- [21] Rizzo, A., & Sordi, J. (2020). Resources and urbanization in the global periphery: Perspectives from urban and landscape studies. *Cities*, 100, 102647.
- [22] Ignatieva, M., Haase, D., Dushkova, D., & Haase, A. (2020). Lawns in cities: from a globalised urban green space phenomenon to sustainable nature-based solutions. *Land*, 9(3), 73.
- [23] Garmendia, E., Apostolopoulou, E., Adams, W. M., & Bormpoudakis, D. (2016). Biodiversity and green infrastructure in Europe: boundary object or ecological trap? *Land Use Policy*, 56, 315-319.
- [24] Schwerk, A., Wińska-Krysiak, M., Przybysz, A., Zaraś-Januszkiewicz, E., & Sikorski, P. (2020). Carabid Beetle (Coleoptera: Carabidae) response to soil properties of urban wastelands in Warsaw, Poland. *Sustainability*, 12(24), 10673.
- [25] Zhang, Q., Zhang, T., & Liu, X. (2018). Index system to evaluate the quarries ecological restoration. *Sustainability*, 10(3), 619.
- [26] Foster, J. (2018). Dancing on the grave of industry: Wenders, Bausch and the affective re-performance of environmental history. *Cultural Geographies*, 25(2), 319-338.
- [27] Anguelovski, I. (2016). From toxic sites to parks as (green) LULUs? New challenges of inequity, privilege, gentrification, and exclusion for urban environmental justice. *Journal of Planning Literature*, 31(1), 23-36.
- [28] Mathey, J., Arndt, T., Banse, J., & Rink, D. (2018). Public perception of spontaneous vegetation on brownfields in urban areas—Results from surveys in Dresden and Leipzig (Germany). *Urban Forestry and Urban Greening*, 29, 384-392.
- [29] Patel, B., Gami, B., Patel, A., & Patel, P. (2019). Wasteland utilization for B. Balcooa cultivation: Socio-economic and environmental impacts through bamboo-based product development. *European Journal of Sustainable Development Research*, 3, 1-11.
- [30] Brice, M. H., Pellerin, S., & Poulin, M. (2016). Environmental filtering and spatial processes in urban riparian forests. *Journal of Vegetation Science*, 27(5), 1023-1035.