

Article

Sustainable Space Transformation Design Strategies for Post-Landfill Closure

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Abstract: This study explores strategies for promoting sustainable development in urban public spaces by focusing on transforming and reusing closed landfill sites. Using landscape regeneration theory and the genius loci principle from architectural phenomenology, this research investigates spatial redesign techniques to facilitate the sustainable utilization of these sites. Through the analysis of three representative case studies and the specific application of these strategies to the Zhangjiawan Landfill site in Xining City, Qinghai Province, northwest China, this study elucidates practical approaches for spatial function transformation, constructing community networks, and heritage preservation and cultural continuity. From an urban macro-planning perspective, the post-closure design of the Zhangjiawan Municipal Landfill emphasizes organic linkages with adjacent city parks, fostering community integration and enhancing recreational opportunities for residents. The transformed area facilitates social interaction and cultivates a harmonious community atmosphere by repurposing the site to incorporate community farms, cultural centers, and outdoor sports facilities. Moreover, integrating leisure spaces, cultural exhibitions, and ecological restoration initiatives contributes to ecosystem rehabilitation while providing residents with leisure, social engagement, and cultural enrichment spaces. This research demonstrates how effective spatial transformation can promote environmental education, heritage preservation, and urban functionality in redeveloping closed landfill sites. The theoretical insights and practical design strategies presented contribute to advancing sustainable practices in urban planning and public space utilization.

Keywords: landfill; sustainable; urban parks; genius loci; environmental education



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1. Introduction

With the rapid urbanization in China over the past three decades, the significant increase in the urban population has led to the generation of a substantial amount of municipal waste [1]. Consequently, numerous landfill sites have emerged on the outskirts of cities to manage this waste. Typically, the lifespan of a landfill is around ten years, after which it undergoes closure procedures. According to data from the Ministry of Housing and Urban–Rural Development of China, many landfill sites have ceased operations. Between 2021 and 2030, an estimated 280.7 square kilometers of landfill sites will be closed in China [2]. Therefore, post-closure landfills face challenges such as occupying urban land and impacting the ecological landscape of surrounding areas [3]. Effectively repurposing post-closure landfills has become a pressing issue for many Chinese cities in the new era [4].

The Zhangjiawan Landfill, which is the focus of this paper, is a typical example. It is located in Xining City, Qinghai Province, northwest China. It operates in a hilly and mountainous area, utilizing natural ravines for waste disposal. Established in 2017 and designed to last eight years, it closed ahead of schedule due to rapid waste accumulation, covering 15 hectares by early 2023. Post-closure, sustainable utilization of this space for urban development is essential.

When we are exploring the issue of sustainable development after landfill closure, there are three main aspects to consider: a sustainable ecological environment, sustainable

economic benefits, and the sustainable use of urban space. Retrofitting requires first treating the established pollution of the landfill to make it a safe space for urban activities. It also requires an effective transformation of the use function to create new economic value and more employment opportunities for urban development. This is an integrated and complex endeavor requiring multiple disciplines' involvement. In this study, we referenced three quarterly reports from the Feasibility Study Report on the Closure Project of the Zhangjiawan Municipal Solid Waste Landfill in Chengxi District, Xining City [5] conducted by the CSCEC AECOM CONSULTANTS CO., LTD. According to the soil testing results obtained from these quarterly reports, the soil pollution risk screening values and control values (fundamental parameters) align with the Soil Environmental Quality Standards for Construction Land Soil Pollution Risk Control Standards (GB36600-2018) [6]. Therefore, we are focusing on the principles of landscape planning and design for the sustainable use of urban space after landfill closure, primarily from an architectural perspective.

Some studies and existing cases suggest that applying landscape regeneration theory to post-closure landfill redevelopment projects can effectively address environmental pollution from the landfill process [7]. During the redevelopment process, the unique spatial memories of landfills can be responded to through specific design techniques, thereby inheriting the historical memory and establishing community identity while also serving as valuable resources for environmental education [8].

This paper explores multi-level transformation strategies based on landscape regeneration and placemaking theories [9–11]. On the basis of theoretical analyses, this paper summarizes three effective transformation strategies, namely spatial function transformation [12], community network construction [13], and historical and cultural preservation and inheritance [14], using the case study method on existing successful transformation cases. A practical study was also carried out in the Zhangjiawan Landfill renovation project to explore the specific design approach of these three strategies in real projects (as shown in Figure 1). The research outcomes are expected to provide theoretical guidance and design references for the sustainable utilization of post-closure landfills in the foreseeable future.

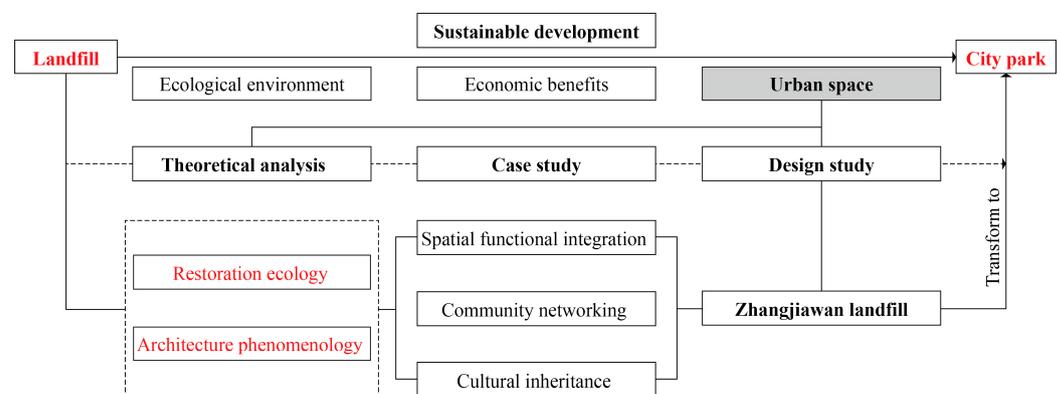


Figure 1. Research ideas, methodology, and framework.

2. Related Theoretical Foundations and Case Analysis

The concept of landscape regeneration design for abandoned sites traces its roots back to the 1960s, when global environmental protection efforts began focusing on restoring the ecological balance in such areas [15,16]. In the 1980s, the American scholar John Simonds explored landscape planning and design methods through the lens of abandoned site planning in his book *Landscape Architecture: Site Planning and Design Manual* [17]. The establishment of the International Society for Ecological Restoration in 1985 further advanced the integration of ecological restoration principles into landscape regeneration designs for landfill sites [18]. Lyle J.T. explores the cultural, social, and economic impacts of regenerative systems based on the theory of self-renewing regenerative systems in *Regenerative Design for Sustainable Development* [19]. Melly P. and Cathart T., in *Regenerative Design Techniques: Practical Applications in Landscape Design*, discuss human landscapes

and natural ecosystems as well as some of the challenges of designing and managing shelters and landscapes in sustainable landscapes [20]. Alan Berger's book *Drosscape: Wasting Land in Urban America* (2006) advocated for exploring industrial wastelands' unique historical features and spiritual significance. Berger proposed using artistic interventions to showcase distinctive ecological landscapes, fostering urban renewal and healthy urban development [18]. This theoretical framework is equally applicable to the post-closure transformation of landfill sites.

Since the onset of the 21st century, there has been a notable trend toward repurposing closed landfill sites into urban parks or green spaces, representing a significant focus on site regeneration design. However, it is essential to recognize that landfill sites possess distinctive spatial characteristics, and their relationship with the surrounding environment and communities evolves significantly before and after closure. While active landfill sites often create a sense of isolation from surrounding communities due to pollution, post-closure spaces retain historical significance and functions, intertwined with the concept of "genius loci" as described by Christian Norberg-Schulz in his book *Genius Loci: Towards a Phenomenology of Architecture* [21]. Norberg-Schulz delineates a "place" as a holistic entity comprising tangible elements such as materials, forms, textures, and colors, embodying its physical structure and spirit. According to his perspective, individuals cannot envision themselves outside of a place, nor can a place lack a specific atmosphere [21]. Therefore, exploring the unique atmosphere of particular places and discovering organic renewal strategies while integrating sustainable development concepts contributes to healthy urban development. Places with historical significance hold intrinsic value in the space and spirit they embody, fostering a sense of belonging and identity among individuals. The transformation of spaces previously marred by garbage and foul odors into pleasant urban environments reflects humanity's determination and capacity to impact the environment positively in the pursuit of aesthetic natural settings. After closure, landfill sites can be developed and repurposed in various directions, including urban green spaces, residential areas, commercial districts, and cultural heritage display areas, to meet diverse needs in sustainable urban spatial development [22]. However, it is crucial to acknowledge that the transformation process presents numerous challenges that must be addressed effectively.

Three case studies of transforming landfill sites into urban parks are presented. Drawing from landscape regeneration theory and the spirit of place theory, we analyze how to achieve spatial function transformation, build community networks, and preserve and inherit historical culture during the transformation process.

2.1. Spatial Function Transformation

Repurposing post-closure landfill spaces into urban parks necessitates achieving functional diversity [12]. It involves restoring a site's degraded natural ecosystem and providing spaces for leisure and recreation to facilitate the transformation of spatial functionality. Freshkills Park is an exemplary case study of transforming the world's largest garbage dump into a green oasis. Located on the western shore of Staten Island, New York, Freshkills Park underwent a remarkable transformation from being a landfill utilized from 1947 until its closure in 2001 to becoming a dynamic urban environment [23]. Led by Field Operations, a prominent design firm, and in collaboration with multiple teams and experts, the landfill was reimagined as a large-scale urban park spanning approximately 891 hectares [24]. Guided by the thematic concept of "LIFESCAPE" [25], Freshkills Park has been divided into five distinct sections: the North, South, West, and East Parks and a Confluence Area. Each section offers unique amenities and attractions designed to cater to specific user experiences. The design and planning of Freshkills Park adhere to the principles of sustainable development, adopting a phased construction approach grounded in the cyclical rhythms of plant life. The park aims to facilitate the site's degraded environmental conditions through ecological restoration efforts and repurposing the abandoned landfill into a multifunctional space for public activities. For instance, the Confluence Area serves as a cultural and waterfront recreation hub, showcasing repurposed landfill machinery

creatively. The North Park highlights natural landscapes with intersecting roadways forming a network, while the East Park incorporates park infrastructure and connections to other urban spaces. The South Park provides sports and leisure facilities, and the West Park features a natural preserve, with the landfill mound transforming into a monumental earthwork art installation [26]. Harmonizing with the surrounding urban spaces, Freshkills Park enhances the area's ecological integrity and yields economic benefits for the city.

2.2. Constructing Community Networks

Constructing a community network is vital for the healthy development of urban neighborhoods, especially in landfill closure projects [27]. Landscape regeneration and sense-of-place theories can create an inclusive community network, fostering community interactions and considering ecosystem health. The Esmeralda Garden project in Chile transformed a landfill into a city garden that connected and activated the community. Strategically placed green plants at visual intersections between roads and the site created the perception of being “surrounded by greenery”, fostering community integration and participation [28].

2.3. Heritage Preservation and Cultural Continuity

Preserving the historical memory is also a way to continue the spiritual connotation of a site. Renovations not only preserve the physical space but also perpetuate the intangible spiritual values. Preserving and inheriting historical and cultural values are also essential in landfill closure projects. Integrating historical culture with ecosystem restoration achieves healthy and sustainable development. Figure 2 illustrates the integration of historical culture with ecosystem restoration in the Crissy Field project in San Francisco. The Crissy Field project in San Francisco restored a historically significant grassland airfield while preserving its cultural memory, demonstrating how historical culture can be integrated into landfill closure projects [29]. The land on which the project is located was originally a salt marsh and estuary with a history of landfills and military airfields. The design team proposed the challenge of “restoring a culturally significant grass military airfield” in the project plan [30]. By replanning the marshes, creating dunes, and restoring the grass airfield, the preservation of the historical memory was achieved, as depicted by the orange line and dark green, light green, and orange areas in Figure 2.

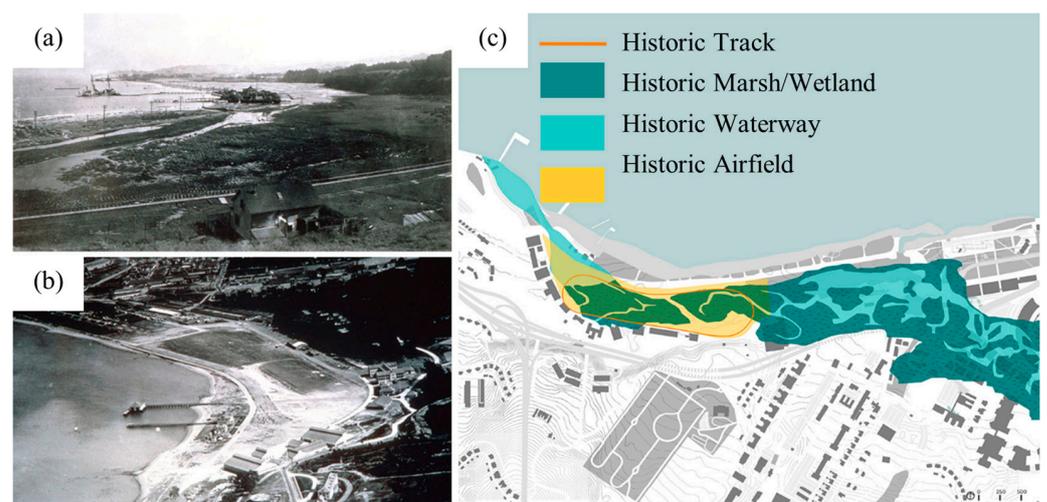


Figure 2. Integration of historical culture and ecosystem restoration in the Crissy Field project in San Francisco: (a) Historic traces of marsh; (b) Historic traces of airfield; (c) Schematic plan of the historic site (<http://www.gooood.cn/2022-asla-landmark-award-crissy-field-an-enduring-transformation-hargreaves-jones.htm> (accessed on 19 April 2024)).

Drawing from the three cases above, landscape regeneration and place-based theories offer valuable perspectives on repurposing landfill closure projects into multifunctional and sustainable urban public spaces. Comprehensive restoration initiatives can breathe new life into former landfills by integrating community participation and the preservation of historical and cultural elements, fostering healthy and sustainable urban development. The following section elucidates the practical application of transformation strategies through the closure design of the Zhangjiawan Landfill in Xining, Qinghai Province, northwest China.

3. Sustainable Transformation Design for the Zhangjiawan Municipal Landfill

3.1. Overall Design Concept

The Zhangjiawan Municipal Landfill is located in Chengxi District, Xining City, is surrounded by mountains, and is about 15 km from the city center. It was once the largest landfill in Xining, with a closed area of 80,000 square meters. The whole site consists of three parts: the landfill area, the office area (a production and living support area), and the leachate pond treatment area, as shown in Figure 3. It adopted a sanitary landfill method to treat domestic waste, with a daily treatment scale of 676 t/d.

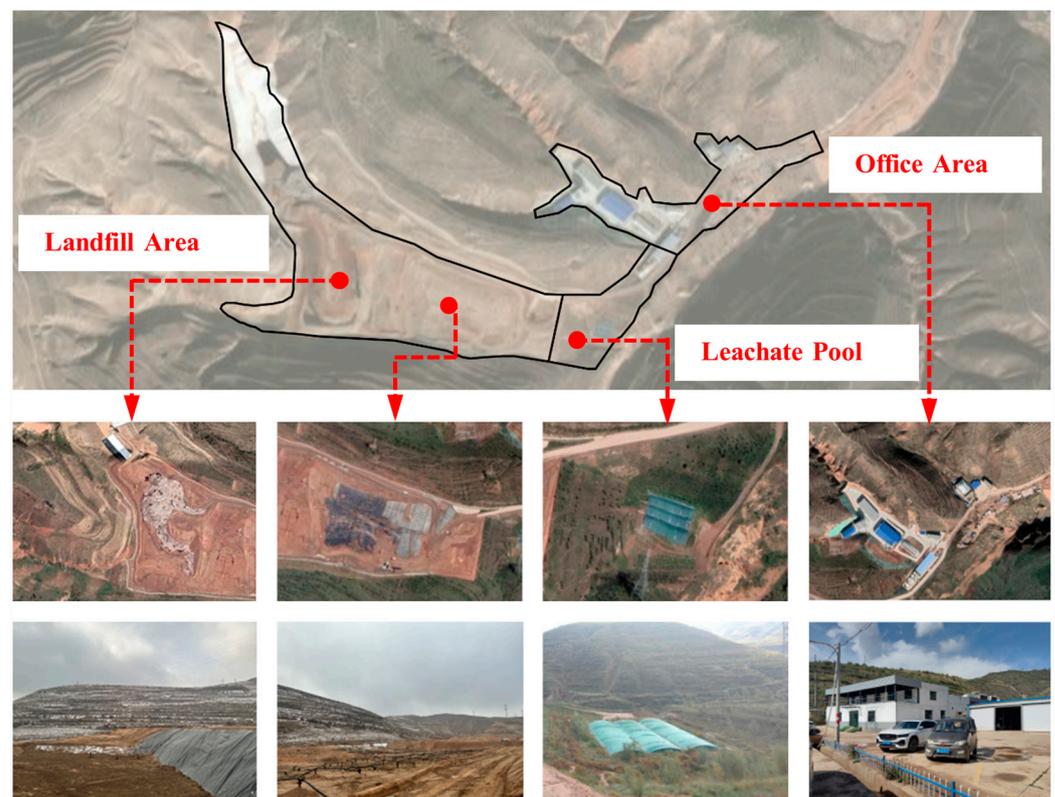


Figure 3. Google map location and photograph of the Zhangjiawan Landfill.

Groundwater was not revealed during the pre-construction exploration of the landfill, so the impact of groundwater on the construction of the project may not be considered. The maximum height of the dam is 21 m, the width of the top of the dam is 5 m, the slope of the inner and outer slopes of the dam is 1:2.5, and the axial length of the dam is about 38 m. The outer slope of the dam is protected against soil erosion, and the slope is planted with sod. The seepage control structure of the inner dam slope is consistent with the seepage control structure of the reservoir area. Interceptor ditches are set up along both sides of the hillside at the edge of the field, and the catchment water of the hillside slopes is discharged to the downstream of the dam through the interceptor ditches on both sides of the hillside.

The interceptor ditch has a rectangular cross-section. The other parameters of the ditch are shown in Table 1.

Table 1. Parameters of the ditch.

Parameters	Quantity
Vegetation cover	15–35%
Slope of the upper part of the hillside	20–30°
Slope of the lower part of the hillside	30–45°
Main ditch bottom width	10–15 m
Upstream branch ditch bottom width	5–10 m

Due to stringent disposal protocols, such as compaction, watering, and dust reduction, the Zhangjiawan Landfill maintained a quiet and orderly environment during its operational phase. Consequently, this resulted in minimal impact on the design considerations and remediation efforts. At present, the landfill height is not higher than the top elevation of the rubbish dam and, according to the observations of the operation unit over the years, there have been no cracks, collapses, settlements, or seepages in the rubbish dam or the upstream temporary rubbish check dam. Various features of the original site indicate that the landfill has the potential to be transformed into an open urban public space. The retrofit design will continue to use the original trash dam, and the stability of the dam will continue to be monitored after the closure of the site.

Figure 4 presents the landfill site's operational process and renovation intention diagram. Segregated waste in the landfill goes through metering, unloading, paving, and compacting processes and is also subject to disinfection and mulching. Landfills produce pollutants such as biogases, leachates, concentrates, and rainwater. Ecological restoration techniques can treat these pollutants through biogas generation, leachate collection and treatment, and the installation of reasonable storm drains. At the same time, these ecological restoration facilities can become landscape elements with ecological characteristics and educational significance. For example, the biogas power generation plant can be transformed into a greenhouse, the leachate collection and treatment space can be transformed into an artificial wetland and an ecological education base, and many waterfront recreational green spaces can be constructed by combining storm drains. By combining ecological restoration techniques and artistic landscape design, the landfill can be transformed into a beautiful urban park after closure.

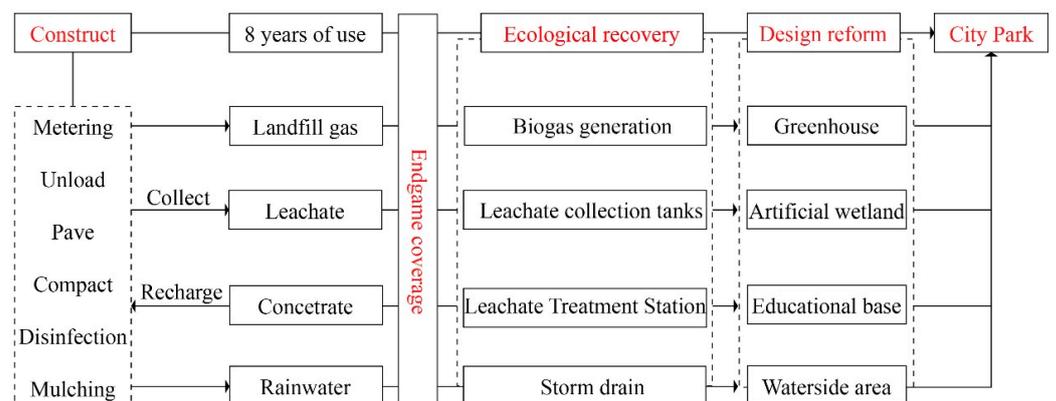


Figure 4. The operational process and renovation intention diagram of the landfill site.

Different renewal strategies must be implemented for each section when designing the closure plan. The landfill area, being the largest, requires careful planning and design to determine the primary spatial functions post-closure. By incorporating leisure activity green spaces, cultural exhibition areas, and community farms, the landfill area can serve as a space for leisure, social interaction, and cultural experiences while facilitating ecosystem

restoration. Adhering to the principles of sustainable development, the existing office buildings in the comprehensive office area can be repurposed into community service centers, offering administrative and cultural education services to the surrounding residents. By organizing diverse community activities, these centers can foster communication among residents and enhance community cohesion. The leachate pond treatment area's low-lying terrain characteristics can be utilized to construct artificial wetland landscapes using pollution treatment and ecological restoration techniques. This area can serve as a thematic educational site related to waste management and environmental protection, allowing community residents and visitors to learn about the landfill's history and experience the technological advancements in ecological restoration. Therefore, the transformed urban space can realize a more diverse spatial value while promoting environmental awareness and community engagement.

3.2. Methods for Data Acquisition and Design Programming

A multifaceted methodology was utilized to comprehensively address the objectives of this study. It began with a thorough literature review, where landscape regeneration theory and the genius loci principle were identified as key frameworks providing theoretical support for the design process [31,32]. Concurrently, literature searches were conducted to identify symbolic elements representing the major ethnic groups within the Hehuang culture, which were then integrated into the design of cultural walls to showcase the region's historical heritage and cultural diversity [33,34]. Furthermore, transformation strategies from prominent cases such as the Freshkills, Esmeralda Garden, and Crissy Field projects were extracted and incorporated into the proposed design through a case study analysis [35,36]. The focus was on spatial function integration, community network construction, and historical and cultural inheritance. In addition, observational methods, questionnaire surveys, and interviews were employed to gather primary data, including site characteristics and community preferences [37]. These data were used to inform and refine the design. By integrating these methodologies, this study aimed to develop a comprehensive and contextually informed design proposal for landfill site transformation in the Hehuang region. The emphasis was placed on sustainability, cultural preservation, and community well-being.

3.3. Sustainable Urban Space Design

As depicted in Figure 5, the post-closure Zhangjiawan Municipal Landfill can establish organic linkages with two nearby large-scale city parks, namely Huangshui Forest Park and Huoshao Gou Park. The transformed area can meet the public's demand for communal activity by developing green spaces, recreational facilities, and cultural exhibition areas. Introducing innovative technology, ecological landscaping, and cultural education elements can transform the renovated park into an open space for leisure and recreation and a showcase window for Xining City's image. Furthermore, by constructing cultural exhibition halls and historical and cultural theme parks, the post-closure area of the landfill can evolve into an urban space that integrates traditional culture with modern life. This will provide new economic benefits, create more employment opportunities, and help achieve sustainable development.

As can be seen in Figure 5, the Zhangjiawan Landfill site is strategically located. Mountains surround it, and there is also an important east–west traffic artery, G0612, on the north side, which makes it relatively isolated from the neighboring residential communities of Zhangjiawan Village, Yangjiawan Village, and so on. The landfill did not cause significant adverse impacts on the daily lives of the neighboring communities during its lifetime. Through interviews, we found that the neighboring residents have a high degree of tolerance toward the Zhangjiawan Landfill, which is an important basis for building a community network. Meanwhile, it can be observed that the landfill site is situated no more than 2 km away from Yangjiawan Village, Zhangjiawan Village, and the Industrial Park. Therefore, the post-closure design of the Zhangjiawan Municipal

Landfill underscores the importance of promoting community integration and enriching recreational opportunities for residents. This transformational approach aims to foster social interaction and cultivate a harmonious community atmosphere by repurposing the site to accommodate community farms, cultural centers, and outdoor sports facilities. Furthermore, integrating leisure spaces, cultural exhibitions, and initiatives for ecological restoration contributes to ecosystem rehabilitation while providing residents with spaces for leisure, social interaction, and cultural enrichment.

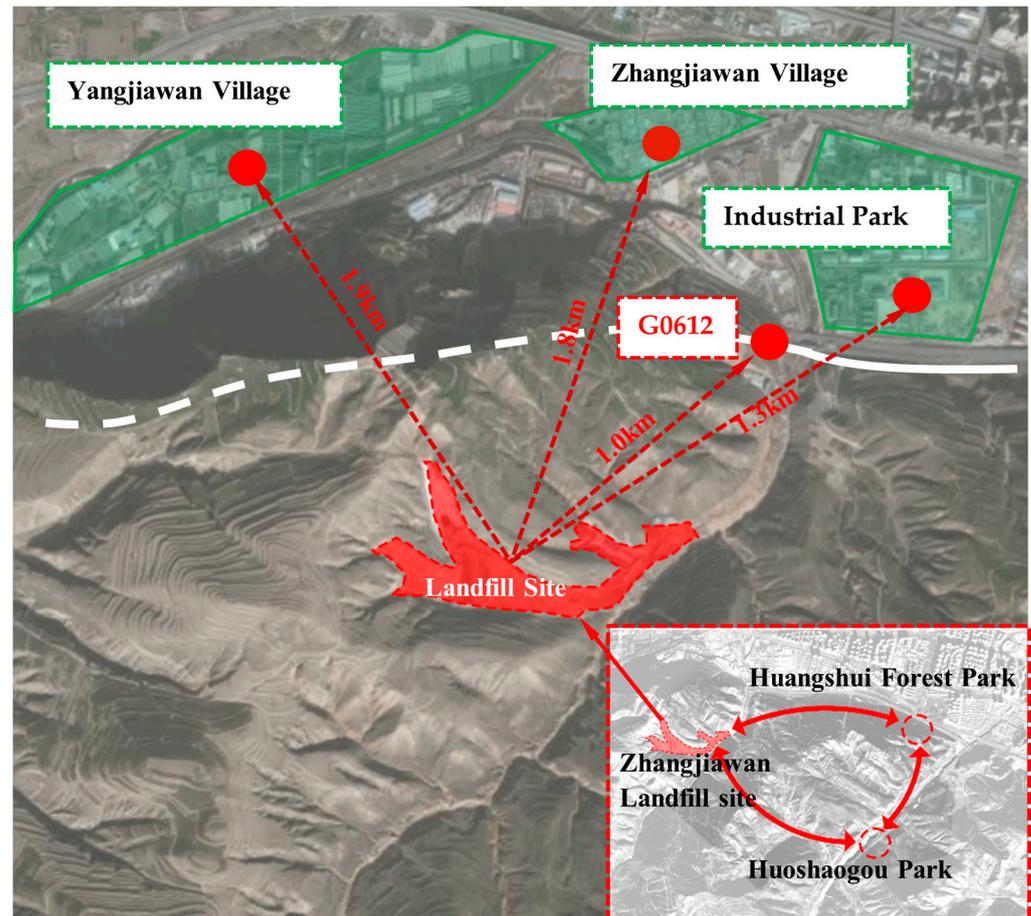


Figure 5. Relationship of the Zhangjiawan Landfill to surrounding communities.

3.3.1. Implementing Spatial Integration through Ecological Corridors

The ditch where the landfill is located has a total length of 1.26 km, and the ditch valley has a “Y” shape. The bottom of the main ditch is 10–15 m wide, and the upstream branch ditch has a bottom width of 5–10 m. The ditch in the landfill area is “V”-shaped, with an average slope drop of about 12%. The varied terrain and elevation differences present opportunities for creating diverse three-dimensional landscape levels, allowing for various recreational activities [38]. Based on this topography, an east–west, multi-functional, and interesting ecological corridor can be created to integrate the landfill with the surrounding mountain ecosystem. Its primary objective is to mitigate the ecological disruption caused by the landfill and facilitate ecosystem restoration.

Figure 6, which depicts the self-designed landscape, outlines three primary zones within the revitalized park: the office and science education zone, the ecological leisure zone, and the cultural entertainment zone. The office and science education zone features essential amenities, such as the visitor service hall, parking lot, souvenir shop, and science education base. This design segment aims to cater to visitors’ needs while imparting knowledge about the landfill’s history and waste management practices through educational initiatives. The visitors are educated on sewage treatment processes, fostering greater

public awareness and engagement in environmental conservation efforts (see numbers 1 to 5). The ecological leisure zone is a public sewage treatment and waste management education platform, featuring amenities like artificial wetlands and buffer waterfront areas. Enveloped by reed beds, it offers a serene space for leisure activities and promotes connectivity through a waterfront slow-walking system. Facilities such as the ecological museum, constructed wetland, and environmental protection art creative park are integral to preserving and enhancing the ecological system, facilitating the landfill site's ecological restoration (see numbers 6 to 8). Hehuang Square is a cultural hub showcasing local folklore through landscape elements. The camping site and Parent–Child Botanical Garden provide residents and visitors with outdoor recreational spaces for camping and other activities. By offering diverse cultural and leisure experiences, the ecological corridor aims to transform the area into a vibrant public space, blending traditional culture with modern amenities and revitalizing urban development (see numbers 9 to 13).



Figure 6. Self-designed landscape highlighting three primary zones in the redeveloped park.

3.3.2. Building Community Networks through Theme Park Development

The construction of community networks is crucial for creating livable urban spaces. As a negative space and a “facility to be avoided”, which raises social issues, the transformation of a landfill site requires the active participation and recognition of community residents. In the redesign process, promoting closer connections and cultural exchanges among residents can be achieved by creating multi-level and diversified community service spaces. The community network aims to provide a platform for integrating resources, exchanging information, and coordinating actions. The community network fosters a sense of belonging. It promotes social cohesion by laying out various leisure spaces and facilities, creating pleasant landscape environments, and enhancing residents’ enthusiasm for participating in community activities.

The self-designed environmental art creative park shown in Figure 7 conveys the importance of environmental protection by showcasing public art pieces. These sculptures are made from recycled materials, such as plastic bottles, car lights, and other metals, and serve as artworks (a robot, a sphere, a dolphin, a cube, etc.) and ambassadors of environmental awareness. Regular activities, such as ecological creative art contests and DIY experiences,

attract tourists and nearby community residents, bringing environmental concepts closer to daily life and facilitating the transition from theory to practice. Furthermore, the design includes establishing multiple theme parks and organizing community events, such as literary and artistic performances, to provide residents with more attractive opportunities for interaction and communication, thus effectively promoting closer community relationships. Considering the diversity of the community population, efforts are made to provide suitable social venues and activities for residents of different age groups and cultural backgrounds, making the community park a truly shared space. Community residents can better understand and collectively inherit their cultural traditions through diverse cultural activities, thereby changing their perceptions of the landfill site and fostering closer connections between the community and surrounding areas. Such designs involve transforming the landfill site and represent beneficial attempts at the sustainable development of the entire urban space.

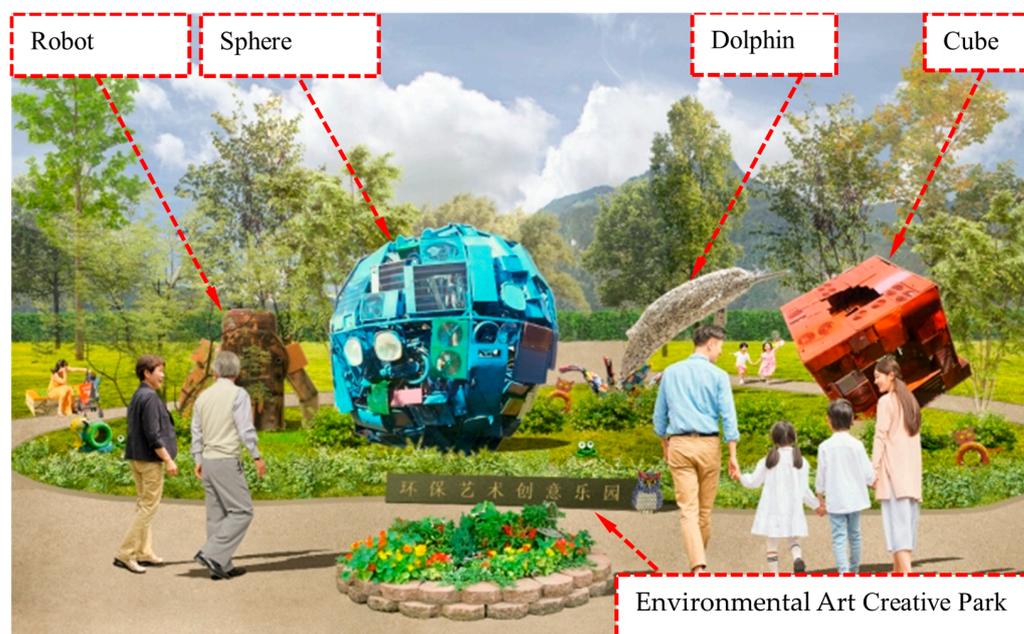


Figure 7. Self-designed environmental art creative park.

3.3.3. Theme Plaza Reflecting Cultural Heritage Continuity

As shown in Figure 8, Xining City, where the Zhangjiawan Landfill is located, is located in the eastern part of Qinghai Province in northwestern China and is a historical city in the Huangshui River Basin. As the eastern gateway to the Qinghai–Tibet Plateau, it is pivotal along ancient trade routes, like the Silk Road. With a population exceeding one million, Xining boasts abundant natural resources and a vibrant tapestry of folk customs. Nestled within the Hexi Corridor Cultural Region, spanning the Gansu, Qinghai, and Ningxia provinces, its name is derived from the Yellow River and Huangshui River. This area is distinguished by a mosaic of religious traditions, including Tibetan Buddhism, Islam, and Taoism. Moreover, the languages and scripts found in the Hexi Corridor Cultural Region are diverse, encompassing Chinese, Tibetan, and Uighur scripts. To showcase the city’s rich historical and cultural tapestry, the central square within the park is thematically rooted in Hexi Corridor culture.

As depicted in Figure 9, the design of the Hehuang central plaza within Hehuang’s historical and cultural exhibition area is envisioned to encapsulate the diverse and inclusive essence of Hexi Corridor culture through carefully selected landscape elements, sculptures, and lamp posts. The objective is to seamlessly integrate the region’s multifaceted historical heritage and cultural legacy into the plaza’s design, paying homage to local traditions and perpetuating the diversity and synthesis inherent in Chinese culture. In Figure 9a, the

sculpture depicts scenes of Tibetan compatriots singing and dancing, celebrating festivals, and showcasing their love and reverence for nature, life, and deities, thus emphasizing cultural celebration and vitality (see the green arrow in Figure 9a).

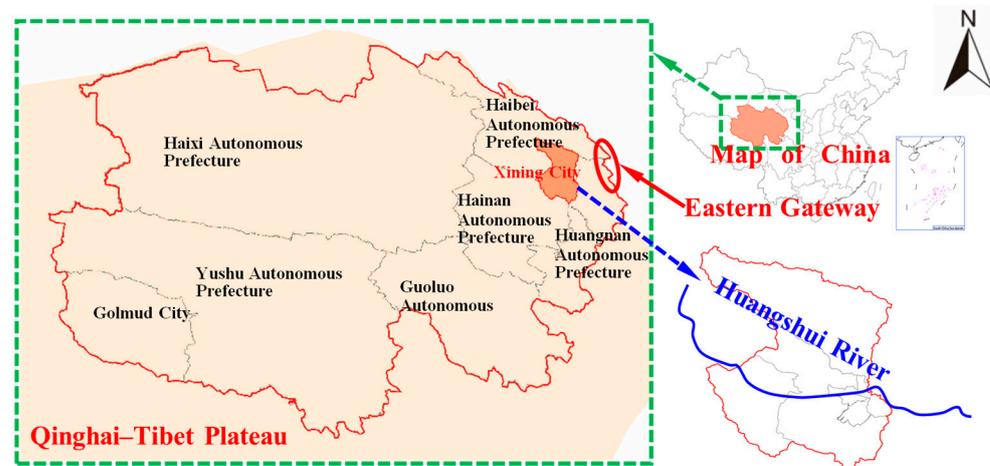


Figure 8. Location of Xining in China: Huangshui River Valley as the Eastern Gateway to the Qinghai–Tibet Plateau (<http://www.guihuayun.com> (accessed on 19 April 2024)).

Following the sculptures, the self-designed multicultural totem exhibit wall aims to comprehensively showcase the rich historical heritage and diverse cultural characteristics of the Hexi Corridor Region by featuring various ethnic groups and symbols, as depicted in Figure 9b. According to the literature review, Hehuang culture is the main minority, and its representative totem in the design of a cultural wall will be used as a carrier of the display to showcase the rich historical heritage of the Huangshui region and its multicultural characteristics. Therefore, the design concept of the cultural wall (see the red arrow in Figure 9a and the details in Figure 9b) aims to create a display space deeply rooted in history that is vibrant and inclusive. Through various ethnic totems and contents, it comprehensively showcases the rich historical heritage and diverse cultural characteristics of the Hehuang region, presenting a cultural panorama with depth and breadth. The totems on the cultural wall encompass the main ethnic groups of the Hehuang culture, including the Tu, Hui, Tibetan, Sala, Han, and Mongolian ethnicities. The Tu symbol is a rainbow. Rainbows in the sky connect the sky and ground, and the display shows the spirit of the Turkish “earth” characteristic. The Hui symbol is a mosque, which is a place for Muslims to conduct religious activities and daily activities [39]. The Tibetan symbol is the Potala Palace, the iconic building of the Tibetan people [40]. The Salar symbolic motif is the camel spring [41]. The Han symbol is a dragon and a phoenix, which are the favorite decorative motifs of the Han people. The Mongolian symbol pattern comprises a yurt, blue sky, white clouds, and sheep, which form the unique scenery of grassland in Inner Mongolia [42]. The emphasis on the integration and interactions of different languages not only makes the cultural wall more vivid and interesting but also conveys the friendly exchanges among different ethnic groups and cultures in Huangshui.

Various languages, including Chinese, Tibetan, and Uyghur, are incorporated into the design of the lamp posts (see the orange arrow in Figure 9a and the details in Figure 9c), reflecting the linguistic diversity of the Hehuang culture. This multilingual coexistence embodies the communication and integration between different ethnic groups and cultures within the region. The overarching aim of all the aforementioned designs is to visually depict the integration and coexistence of diverse ethnic cultures within this area, thereby presenting a rich cultural panorama that offers depth and breadth to the Hehuang central plaza.

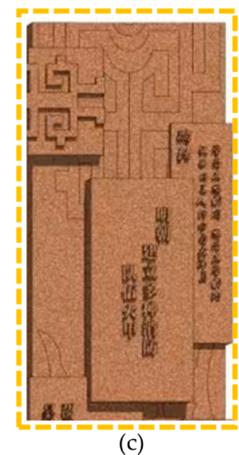
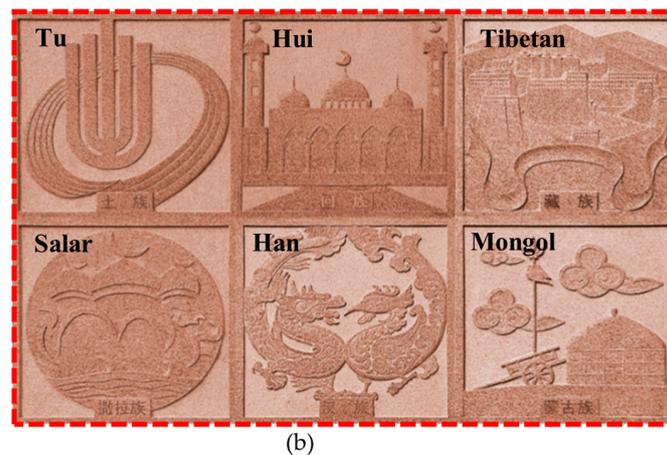
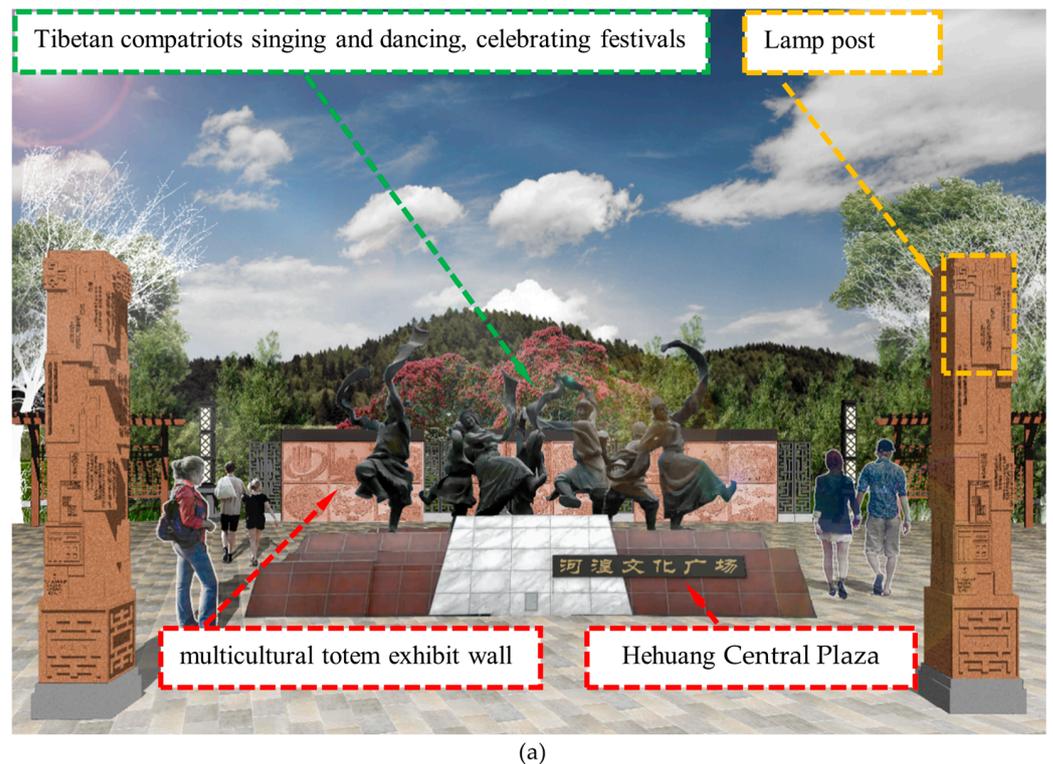


Figure 9. Self-designed central plaza of the Hehuang historical and cultural exhibition area: (a) Panoramic illustration; (b) Details of the cultural wall; (c) Details of the lamp post.

Incorporating an archway at the park's entrance reflects traditional Chinese architectural culture while functioning as a visual guide and landmark. By integrating distinctive Tibetan and Hui architectural styles indigenous to the local area, the archway showcases the diversity and uniqueness of Hexi Corridor culture in architecture. Moreover, including architectural models and cultural products related to Tibetan and Hui architecture in the visitor service hall and souvenir shop serves dual purposes. Not only does it promote Hexi Corridor artistry, but it also generates economic benefits by amalgamating cultural dissemination with economic development. Through these artistic design elements, the Hexi Corridor Culture Plaza exhibits the region's rich cultural heritage through architectural and creative expression. Additionally, it aims to achieve cultural preservation and advancement through strategic planning and commercial activities.

4. Conclusions

The authors of this paper have applied theories of landscape regeneration and architectural space phenomenology to analyze three case studies, proposing critical strategies

for the sustainable transformation and utilization of closed landfill sites. These strategies encompass the conversion of spatial functions, the establishment of community networks, and the preservation of historical and cultural heritage. By synthesizing specific planning and design methods, this study has further demonstrated their application in the renovation project design for the Zhangjiawan Landfill site in Xining. Given the rapid pace of urbanization in China, the closure of more landfill sites is inevitable, making effective renewal and utilization imperative for the sustainable development of urban spatial environments and society.

We explored the specific operation and design methods of the above three strategies in our closure and modification project for the Zhangjiawan Landfill. The research findings presented herein offer a theoretical foundation and practical spatial design strategies for the sustainable utilization and transformation of closed landfill sites. From an urban macro-planning perspective, an emphasis on organic linkages with adjacent city parks fosters community integration and enhances recreational opportunities for residents. Repurposing these sites to incorporate community farms, cultural centers, and outdoor sports facilities promotes social interaction and cultivates a harmonious community atmosphere. Moreover, integrating leisure spaces, cultural exhibitions, and ecological restoration initiatives contributes to ecosystem rehabilitation while providing residents with leisure, social engagement, and cultural enrichment spaces. The careful design of specific zones within the revitalized park ensures that each area serves a distinct function, whether providing visitor amenities, facilitating environmental education, or fostering cultural experiences. Incorporating environmental art within these spaces further reinforces the importance of sustainability and environmental awareness, engaging tourists and community residents in ecological dialogue and practice. Ultimately, the design of cultural exhibition areas within the park celebrates the region's diverse heritage while promoting cultural synthesis and inclusivity.

It should be noted that the specific practical design methodology proposed in this paper is based on an analysis and judgement of the pre-existing conditions of the Zhangjiawan Landfill. The Zhangjiawan Landfill itself has some good attributes, such as an appropriate scale, rich topographic variations, and no significant conflicts with the neighboring communities. For landfills that do not have these advantages, it will be necessary to find effective strategic transformation methods for their respective characteristics.

This research demonstrates how effective spatial transformation can promote environmental education, heritage preservation, and urban functionality in redeveloping closed landfill sites. The theoretical insights and practical design strategies presented herein contribute to advancing sustainable practices in urban planning and public space utilization, paving the way to a more environmentally conscious and socially cohesive future. However, it should be noted that, although our research did consider soil pollution factors, it is crucial to recognize the significant limitations associated with this aspect.

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