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Rewilding Pre-Rehabilitation of Post-Industrial Landscape

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ABSTRACT

This research explores the concept of "pre-rehabilitation" for post-industrial landscapes, focusing on the application of rewilding principles as preparatory measures to unlock the ecological value of abandoned industrial sites. The study highlights the potential of rewilding to transform these sites into vibrant public spaces before their redevelopment. By selectively intervening to restore natural processes, such as introducing native plants and ecological corridors, rewilding can enhance biodiversity and create valuable public spaces for recreation. The research also emphasises the economic potential of rewilded sites through eco-tourism, urban agriculture, and renewable energy. Combining ecological restoration, community engagement, and economic viability, rewilding offers a pathway towards a resilient and thriving urban ecology. The research suggests that applying lessons learned from the case study to specified industrial sites in Hong Kong can contribute to sustainable urban development and the revitalisation of post-industrial landscapes.

1. Introduction

Post-industrial landscapes have become a worldwide phenomenon as the economy continues to reform [1]. Hong Kong, as a vibrant city with a rapidly changing economy, also presents a narrative

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of shifting industries and the subsequent challenges in restoring and repurposing post-industrial land uses [2].

A significant gap often exists between the decommissioning of industrial sites and the commencement of redevelopment works. This gap can be observed in various locations in Hong Kong, such as the former Kai Tak airport, quarrying sites, bus depots, shipyards, and more [3]. The duration these sites remain vacant can vary, encompassing the period required to generate new design proposals, obtain government permit approvals, and navigate land speculation [4]. During this interim period, the vacant land is often utilised for short-term auxiliary functions, including car parking, storage, and depots [4]. Necessary land treatment and preparatory works, such as decontamination and site restoration, may have already taken place in anticipation of future redevelopments [5].

Rewilding represents a transformative strategy, a reevaluation of traditional conservation approaches due to increasing awareness of irreversible environmental changes [5]. Rather than aiming to restore ecosystems to historical baselines, rewilding acknowledges the need to consider uncertain future scenarios and accept novel ecosystems. This paradigm shift challenges the conservationist perspective of pure preservation and calls for radical shifts in conservation interventions [5].

1.1 Significance of the Study

The research findings and proposed rewilding typologies serve as a valuable reference for cities, particularly in Asian contexts, to repurpose and revitalise post-industrial landscapes in a sustainable and ecologically conscious manner, through transforming vacant or underutilised spaces into vibrant, ecologically diverse areas. This not only enhances the aesthetics of the city but also promotes the efficient and temporary use of land for ecological restoration and community engagement.

In light of the post-COVID era, there has been an increased appreciation for nature and the benefits it provides to human health and well-being. By opening fenced-off vacant sites for broader uses and introducing rewilded landscapes, this research responds to the growing demand for accessible green spaces, offering opportunities for recreation, relaxation, and connection with nature.

Rewilding interventions also address climate change challenges by enhancing urban resilience. By maximising the temporarily available rewilded landscapes, cities introduce green infrastructure that improves stormwater management, reduces the urban heat island effect, and supports urban biodiversity conservation.

1.2 Research Objectives

This research is intended to comprehensively understand the application of rewilding principles from both an architectural and planning perspective, examining its implementation at both ecological and architectural scales, with an aim to explore the extent of rewilding's application in post-industrial landscapes, and its potential for revitalising urban environments. The study also devises rewilding strategies specific to Hong Kong by formulating site intervention proposals, selecting suitable sites for rewilding, considering their ecological potential, establishing design principles for rewilding interventions, and developing a phased design approach to guide the implementation process.

2. Literature Review

2.1 Definition of Rewilding

According to Pereira and Navarro, “Rewilding is the passive management of ecological succession with the goal of restoring natural ecosystem processes and reducing the human control of landscapes” [6]. Rewilding is usually implemented in large areas (e.g.10,000 hectares) [7] and embraces natural processes to regain dominance over landscapes. The typical transition period for semi-natural land is

approximately 15 years, while reforestation may take 15 to 30 years [8]. Rewilding initiatives speed up this process.

As discussed by Ceausu in the context of rewilding abandoned farmland in Europe [9], humans are also recognised as integral components of our landscapes. Rewilding can bring thriving ecotourism, create sustainable business opportunities and regenerate communities. The concept of perceived wilderness involves the experience of wilderness with feelings of solitude and remoteness for people to appreciate [9]. It is therefore important to establish the approach and focus for the proposed pre-rehabilitation of a district-scaled post-industrial landscape within a highly modified urban landscape to restore ecological processes and its coexistence with nearby human activities.

According to Corlett, the rewilding movement started in North America 25 years ago to restore large wilderness areas for diverse animals, especially carnivores [10]. Low population density and its shorter history of development make it ideal for creating self-sustaining ecosystems. Some approaches aimed to recreate conditions before European colonisation. Despite challenges with large carnivores, rewilding efforts in North America have shown promise.

Rewilding in a more developed Europe often involves passive approaches such as abandoning farmland, reducing livestock grazing, and protecting species with limited hunting. It focuses on restoring large connected landscapes and reintroducing large animal species, and allows ecosystems to develop autonomously without much human intervention. While traditional landscapes and cultural practices may be lost in the process, rewilding has generally promoted ecological balance in Europe [10].

The choice between active and passive management depends on rewilding goals. Active management is preferred for restoring specific species or maintaining habitats associated with human activities, while passive management emphasises dynamic ecological processes at large scales in the European rewilding context [8]. Summarized by Corlett, there are four common types of rewilding. Pleistocene rewilding focuses on reintroducing large, long-lived species from the past. Trophic rewilding aims to establish self-regulating and biodiverse ecosystems to restore top-down trophic interactions. Ecological rewilding promotes the dominance of natural processes within an ecosystem. Passive rewilding involves reducing human control over landscapes, allowing nature to take its course more freely [10].

As mentioned by Pettorelli, the prefix "Re" in rewilding traditionally signifies a return to a historical benchmark, but this may not always be feasible, as excluding all human intervention will lead to an approach known as "fortress conservation" [11]. The growing acknowledgment of irreversible environmental changes also challenges efforts to restore past ecosystems [10]. A new term "auto-rewilding" had also emerged, referring to the movement and relocation activities of animals themselves, in the context of post-industrial cities in urban Britain as suggested by Clancy and Ward [12]. 'Auto-rewilding' focuses on reorganising the biota and ecosystem processes within the social-ecological system, and anticipating future scenarios to guide the system towards a desired trajectory with minimal ongoing management. Damaged or lost parts are fixed in order to restore the smooth operation of ecosystems.

Rewilding efforts are not limited to farmland, but also semi-urban areas such as decommissioned military areas and suburbs according to Pereira and Navarro [8]. Rewilding can be a response to urban expansion by helping cities to reclaim green spaces, improving biodiversity and creating healthier environments. It also combats climate change by reducing urban heat and enhancing resilience during environmental crises [13]. In the post-COVID era, rewilding responses to the growing demand for nature as an extension of living space. People have rediscovered the benefits of connecting with nature for their mental and physical well-being. Rewilding provides opportunities for individuals to experience and engage with natural environments in urban settings for "growing biodiverse urban futures" as speculated by Lehmannm [13].

2.2 Decision Framework in Rewilding

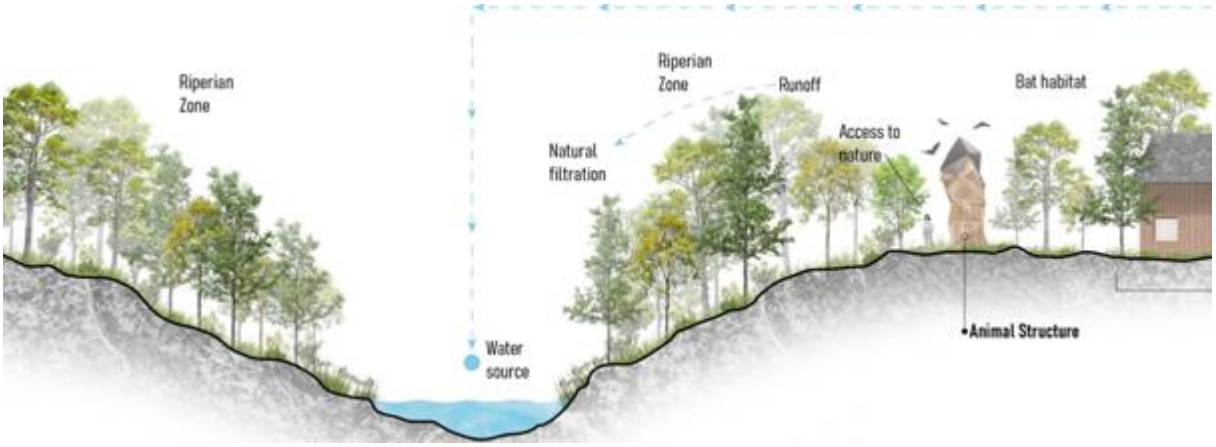
A decision framework is crucial for rewilding initiatives on "making rewilding fit of policy" according to Pettorelli [11]. First, setting targets and implementing actions lays the groundwork for future monitoring and adaptation. Second, assessing and minimising ecological risks with priorities given to low-risk targets and accounting for unpredictability. Third, evaluating the economic costs and benefits helps determine the feasibility and cost-effectiveness of rewilding projects. Fourth, understanding and addressing potential negative social impacts, especially in passive rewilding approaches, and impact to local communities. Lastly, establishing a strong monitoring system to assess outcomes, effectiveness, and cost efficiency [11].

Land sharing integrates biodiversity conservation with agriculture to create a mosaic of open spaces and forests, while land sparing designates areas solely for conservation [8]. Abandoned farmland located closer to high wilderness areas has a better chance of being repopulated by species, leading to a quicker recovery of its ecosystem [9]. Other land-use practices include limited hunting and tourism activities to promote biodiversity, enhance carbon sequestration and reduce maintenance costs [6]. New land use in rewilding should be economically viable and competitive. Areas with remains of physical infrastructure have larger potential in ecotourism, biofuel cultivation, and renewable energy industries, becoming "a new strategy for an old continent" in rewilding Europe as proposed by Helmer [14]. For example, introducing in situ breeding facilities not only contribute to biodiversity but also possess market value, attracting tourists and creating business opportunities for tour operators, guest houses, and community conservancies. A new generation of wilderness entrepreneurs have promoted entrepreneurship and educational programmes on wilderness-related ventures as suggested by Jobse [15].

Wilderness zones provide a range of ecological services benefiting both nature and people. They regulate and maintain the quality of air, water, soil, and climate. Wetlands, for example, act as natural sponges filtering pollutants and providing habitats for wildlife [16]. Wilderness also offers ecotourism, recreation and spiritual experiences. They can address societal challenges by hosting youth development and rehabilitation programmes, serve as valuable educational tools for the public to learn about nature and its processes, and also allow individuals to connect with the natural world to find solace as suggested by Cerqueira [16].

2.3 Design Intervention for Rewilding in Urban Context

Design interventions to achieve urban wilderness involves different scales as demonstrated by Rivera in his project "Urban Wilderness: Rewilding our Concrete Jungles", shown in Figure 1(a) and 1(b). Hybrid structures are designed to meet the needs of humans and wildlife. Structures are modified to accommodate non-human species. Green infrastructure, like filtration systems, fulfill the city's infrastructure requirements, while mitigating pollution and flooding. An urban landscape approach integrates natural elements into public spaces, using the landscape to organise and structure the city [17].



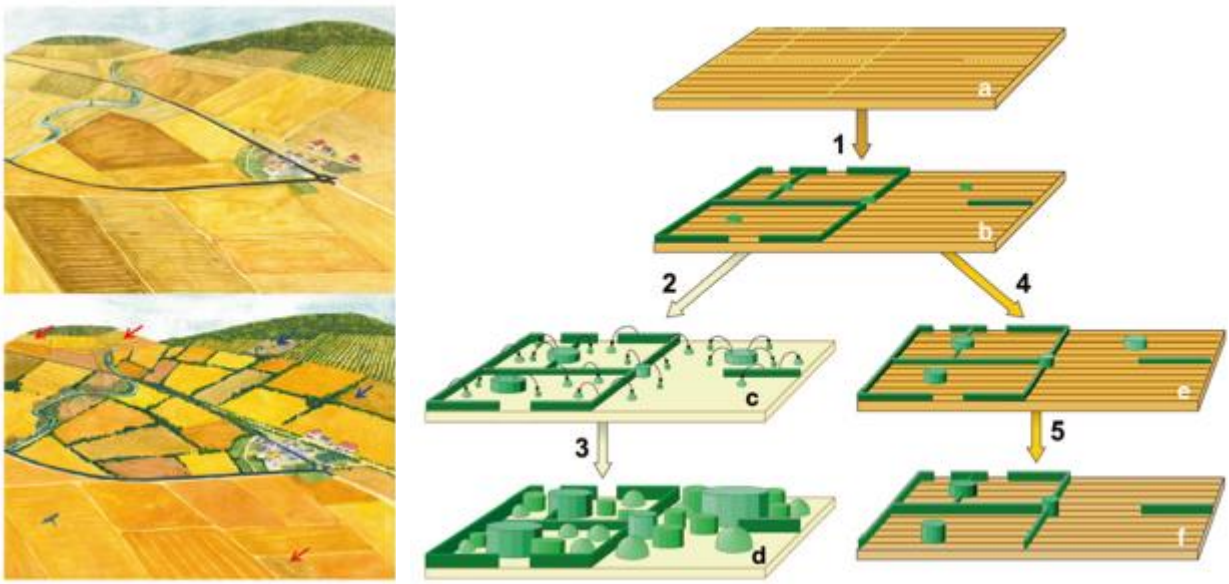
(a)

(b)

Fig.1. Sectional diagrams showing how design intervention may implement urban rewilding [17] (a) Animal structures (b) Hybrid structures and green infrastructure

The concept of wilderness has evolved from a merely aesthetic idea. It is characterised by remoteness, absence of artificial light pollution, distance from human-modified ecosystems, and the presence of natural vegetation with primary productivity. It offers a subjective experience of freedom, natural beauty, and retreat from the overwhelming aspects of modern life. Freedom in wilderness results from the absence of human control over ecological processes, while naturalness results from closeness to an accepted ecological benchmark. Collective memory also encompasses the concept of wilderness as suggested by Ceausu [9].

Tree recruitment is crucial in vegetation restoration to create a more diverse landscape. Wildlife-friendly farming and land sharing may promote ecological restoration with the collaboration between agriculture and forestry. Tree plantations can be established on crop land, creating a mosaic of landscapes and increasing environmental heterogeneity [18]. Nucleation is recommended by establishing small, densely-planted blocks with sparser arrangements of native shrubs and trees, considering their maximum dispersal distance (e.g. 1km). Colonisation may hence occur while maintaining flexibility in land use as demonstrated in Figure 2(b). Revegetation efforts, including planting trees along roadsides and roundabouts support the spread of vegetation. Other tactics include creating pollinator-friendly areas, introducing beetle banks, providing perches and nest-boxes for birds, establishing small ponds and drinking troughs as shown in Figure 2(a) as proposed by Benayas and Bullock [18].



(a) (b)

Fig. 2. (a) A hypothetical landscape implementing strategic revegetation (b) Model of the proposed woodland islet and hedgerow strategy to revegetate the site over time [18]

Fencing would be considered in rewilding practices in densely populated regions, serving as a physical barrier between unmanaged areas and highly managed, human-dominated landscapes, demarcating boundaries and regulating access to specific conservation areas. Virtual fencing offers an alternative approach without the need for physical construction and maintenance. Flexible modification of boundaries would respond to specific conservation needs, integrating monitoring, research, and management practices. Virtual fencing utilises sensory deterrents, biological barriers, training collars, and real-time tracking systems, and its approachability potentially increases community support on rewilding efforts [10].

2.4 Case Studies

Zollverein Park evolved from the Zollverein mine established in 1847 with a sprawling complex over eighty hectares with coal shafts and steel mills, and was closed down in 1993. Remote and fortified against trespassers, the site became a desolate no-man's-land and wildlife thrived being undisturbed by human presence. Nature reclaimed its territory, as birch trees, shrubs, ferns, and moss broke up the artificial ground and carpeted the landscape in vibrant green hues [19]. The transformation of Zollverein started in 2005, adopting “development through maintenance” for gradual intervention. Emphasis was given to pre-existing elements, with most interventions being discreet and almost imperceptible. The ambiguous nature of the site is open to interpretation by visitors [19].

The Landschaftspark Duisburg-Nord, evolved from the Thyssen Hochofenwerk Meiderich iron and steel works of 200 hectares, was founded in 1901 and ceased operation in the mid-eighties. Extensive land and water contamination was unveiled but the lack of activity in the site fostered a spontaneous ecological revival [20]. Transformation commenced in 1989 to address ecological and economic renewal of the area. Pollution of the land was cleaned up but was slow due to the irreversibility of serious pollution. The fluvial system and a network of green spaces were linked and given new uses and values, strengthening the ecological reserves and cultural development. Existing features on site with the vegetation and fauna grown spontaneously was considered. Local residents’

associations adapted existing features for recreational use, setting up educational farms and businesses for operation, opening up the area for public access [20].

The Benjakitti Forest Park is situated in central Bangkok and originally swamplands. The site of 40 hectares was a tobacco factory with single-story warehouses interspersed with canopy trees and a canal at the north contaminated by urban runoff and sewage. Heavy downpours in Bangkok caused urban runoff to overwhelm drainage systems, making the place prone to flooding [21]. The area was transformed in 2022 with a low budget and a short 18-month timeframe, envisioning a landscaped park capable of providing holistic ecosystem services to the city, such as regulating stormwater to adapt to the shifting monsoon climate, filtering polluted runoff and nurturing native species. Additionally, the community's demand for recreational and cultural spaces was met. The concrete-paved ground was transformed into porous spongy landscapes and wetlands with islets for water retention during the monsoon season. A linear water-quality remediating wetlands is built along the northern and western edge to filter contaminated water from the canal and sustains the wetlands in the dry season. A plant community is formed with a mosaic of low-maintenance vegetation and spontaneously enriched by native species to symbolise “messiness” [21].

3. Methodology

3.1 Literature Review and Case Studies

The methodology for this research paper begins with an extensive literature review and analysis of relevant case studies. The desk research conducted helps to establish the definition and scope of rewilding within the context of this study. By reviewing existing literature on rewilding, including scholarly articles, journals, and books, the research aims to gain a comprehensive understanding of the principles and extent of rewilding applications in various contexts.

The case studies selected for analysis play a crucial role in extracting applicable design principles and strategies that inform the design parameters in the later stages of this research. These case studies encompass a range of rewilding projects implemented in post-industrial landscapes in Europe and Asia, providing valuable insights into successful rewilding interventions. Through analysis and documentation of these case studies, the research aims to identify key design considerations, ecological restoration techniques, and community engagement approaches that can inform the design intervention proposals in later stages.

3.2 Site Identification

The site selection process for the design intervention proposal, where the rewilding processes will be tested, follows specific criteria. First, the stage of redevelopment of the site is considered, ranging from vacant to the commencement of decontamination, completion of decontamination, and site formation. Ideally, the site selected should be vacant and in the early stages of redevelopment to demonstrate the natural rewilding contributions without interference from extensive remediation processes.

Location and risk factors related to climate change are also important criteria. Given the proximity of Hong Kong and other Asian cities to the coast and their exposure to climate risks such as storm surges, typhoons, and sea-level rise, selecting a site along the coast becomes relevant as coastal areas are increasingly susceptible to climate change-induced hazards [x1 and x2]. By applying rewilding principles, the research aims to showcase how nature-based solutions enhance the resilience capacity of coastal cities facing climate change impacts.

Site selection is also based upon the provision of ecological services, its urban-nature interface, and presence of post-industrial landscape as discussed in the previous section. A matrix (Table 3.1) is thus developed to analyze the suitability of different potential sites for the development of design

schemes. Consequently, Potential Site 1 (Yau Tong Bay) presents a more suitable profile for subsequent design intervention.

Fig 3. The location of the three potential sites in Hong Kong

Table 1
Site selection matrix for site evaluation and analysis

Criteria	**Potential site 1 (Yau Tong Bay)**	**Potential site 2 (Ma Wan)**	**Potential site 3 (Kwai Tsing Container Terminals)**
Stage of redevelopment	The current Yau Tong Bay area is vacant and fenced off, a residential and commercial development is scheduled to commence by 2027	The existing Ma Wan Old Village is vacated, but it is expected that phase 2 of Ma Wan Park will be completed by 2028 [X]	No clear plans of relocation of the container terminal for further redevelopment
Susceptibility to coastal hazards	Highly susceptible - over 50% of the site area is projected to be below annual flood level by 2050 [X]	Moderately susceptible - over 20% of the site area is projected to be below annual flood level by 2050 [X]	Moderately susceptible - over 20% of the site area is projected to be below annual flood level by 2050 [X]
Presence of post industrial landscape	Yes	No - mainly residential use	No - mainly port backup uses
Provision of ecological services and interface between urban and nature	Loosely connected to Cha Kwo Ling Hill to the west and the mountain areas (Devil's Peak and Black Hill) to the north/north East	Loosely connected to the fragmented greenery areas on the Ma Wan Island	Situated in developed urban area without much natural interface nearby

3.3 Data Collection Methods

Data collection methods deployed in this research encompass multiple approaches. Firstly, site visits are conducted to analyse the possibilities for different design proposals. These visits involve detailed observation and documentation of the site's existing conditions, including its ecological features within and in close proximity to the site, topography parameters, spatial characteristics, neighbouring land use etc. Geo-referenced photos are also taken to retain site information.

Interviews with experts on land contamination are conducted to gather alternative perspectives and insights into natural ways of conducting rewilding in areas with contamination concerns. These interviews provide valuable input on how to navigate the challenges posed by contaminated sites and incorporate rewilding principles effectively.

Information readily available in previous planning applications concerning the site is collected. This includes data such as tree surveys, odour surveys, air ventilation assessments, land contamination surveys, seabed contamination surveys, and sea habitat surveys. These existing datasets provide essential information for understanding the environmental conditions of the site and help guide the design proposals in terms of ecological compatibility and feasibility.

4. Result

Fig 4. Rewilding Proposal of Yau Tong Bay

4.1 Design Principles

Upon literature review, case studies and interview with a land contamination remediation specialist, relevant design principles establish the approach and focus for the proposed pre-rehabilitation of post-industrial landscape.

4.1.1 Approach on Rewilding

Ecological rewilding is more appropriate in highly modified landscapes to promote the dominance of natural processes within an ecosystem. Active management may first be implemented due to its urban context, slowly transitioning to a more passive management [8]. It shall not return to the historical baseline but towards a trajectory that focuses on restoration, provision of ecological services on supply and regulation [16], to build resilience to adapt to dynamic ecosystems and reclaim green spaces [10]. Stormwater could be regulated by nature with porous landscapes and intertwining islets [21].

4.1.2 Approach on Design Intervention

The concept of perceived wilderness for the community to experience freedom and naturalness shall be the core of the design intervention [9], as the extension of living space for well-being. Land sharing approach balancing biodiversity and social needs [8] with cultural services shall be offered. Architectural intervention shall meet the needs of both humans and non-human species [17]. Tree recruitment and nucleation shall be implemented for revegetation [18]. Fencing shall be transformed

from a physical barrier and dissolve into a virtual barrier [10] to allow engagement with its surroundings. Interventions shall be gently added and classified with development by maintenance [19]. Recreational space is seen as compatible with the objective of rewilding [21].

4.1.3 Approach on Land Contamination Remediation

Ecological processes may assist the remediation of contaminants [20] as suggested in the case of Landschaftspark Duisburg-Nord in Germany. According to our interview with a specialist, while the current approach of excavating all contaminated soil for off-site treatment is the most cost and time effective, there are examples of remediation by nature-based solutions, especially at shallower depths accessible by vegetation roots. Upon further research, natural compounds could be added in situ to accelerate the biodegradation of hydrocarbons which is practised in Canada [22]. Other examples include phytoremediation that removes heavy metals and hydrocarbons by the combinations of plants and microorganisms. Plants capture heavy metal from soil in phytoextraction, while microorganisms living in the root system degrade hydrocarbons in photodegradation which is being implemented in Italy [23]. According to Khan, plants with high metal uptake ability and rapid biomass gain accelerates phytoremediation [24]; and their efficiency can be improved through the application of engineering and other assistance as discussed by Yan [25].

4.2 Site Appraisal and Analysis

4.2.1 Planning and Development History

In the late 1950s, the Hong Kong Government initiated a reclamation project at the southeastern Kowloon Peninsula in Kwun Tong [26] for new industrial sites, specifically for shipbuilding, sawmills, and timber yards. From 1970s to 1980s until 1990s, notable prosperity was witnessed in the area with evident shipbuilding activities and timber rafts prominently displayed in front of the sawmills [27]. Notably, the sawmills ceased operations in the 2000s, prompting the enclosure of the entire area [28]. Figure 5(a) to (e) presents historical aerial photographs documenting the transformation of the landscape.

(a)

(b)

(c)

(d)

(e)

Fig. 5. (a) Changes in landscape and land uses in Yau Tong Bay over time in 1956 prior to reclamation [29] (b) 1963 when the reclamation has completed [30] (c) Shipyard and sawmills in operations during 1980s [31] (d) Aerial photo in 1990s [32] (e) When nearly all operations have ceased in 2017 [33]

In the 1980s, a proposal emerged for additional reclamation in Yau Tong Bay to transform the site into a comprehensive residential and commercial zone, with the layout plan shown in Figure 6. The proposal was shelved due to significant public opposition protesting against any further reclamation activities impacting Victoria Harbour.

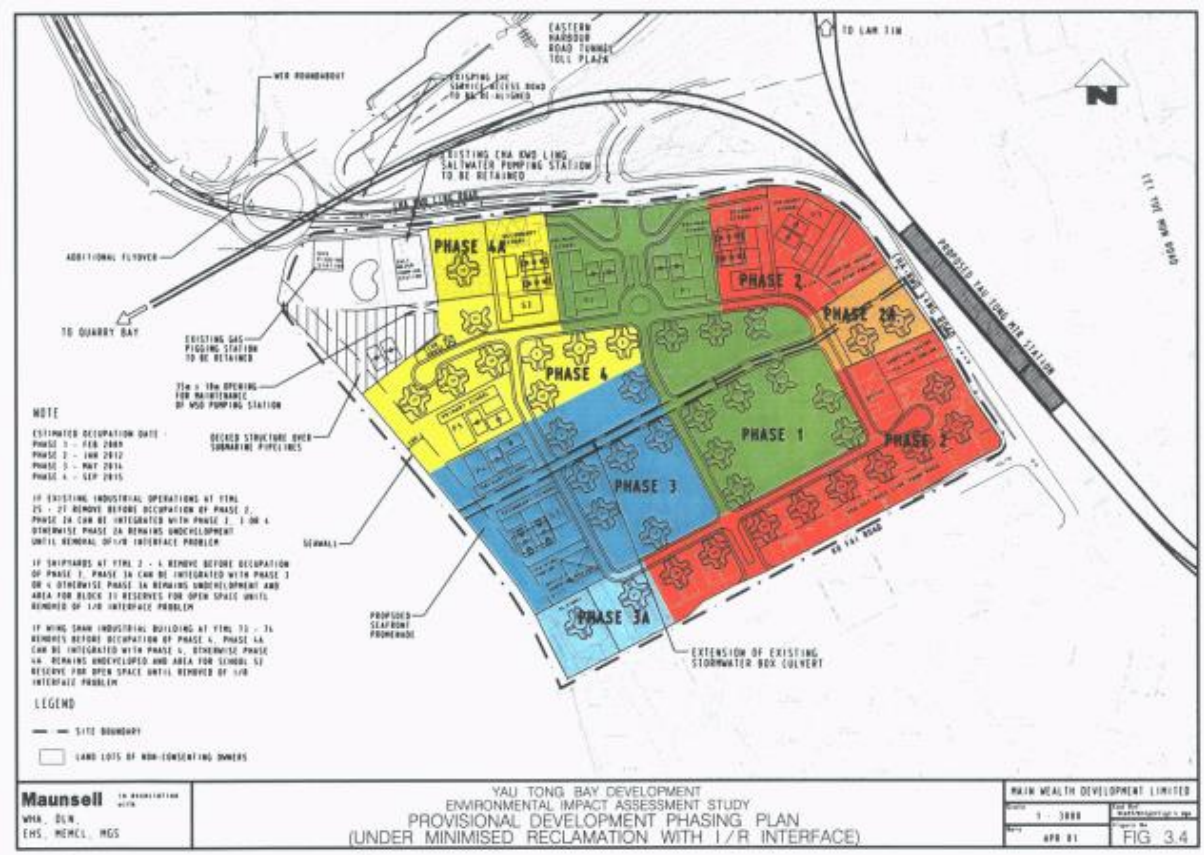


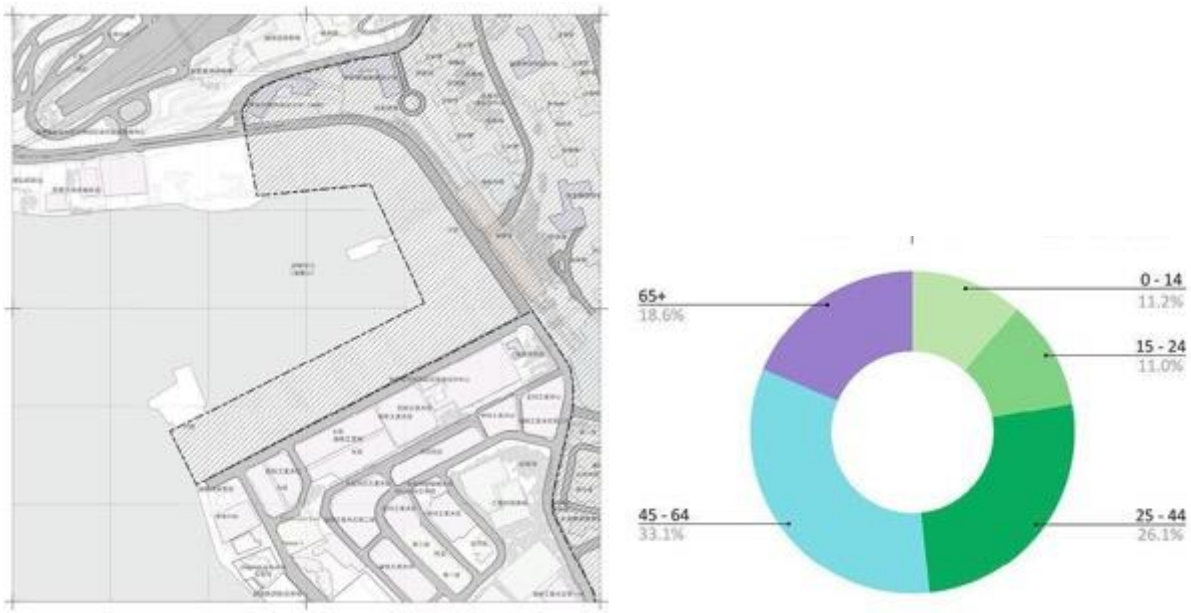
Fig. 6. Yau Tong Bay Provisional Development Plan [34]

The endeavor to transform the former industrial expanse into residential estates remains ongoing, albeit at a notably sluggish pace. The Town Planning Board granted planning permissions in 2013 and 2015, outlining a comprehensive development scheme encompassing 28 residential blocks, 4 hotel blocks, and a complex designated for government, institute, and community use (Figure 7). The fragmented land ownership hindered development progress in other sections of Yau Tong Bay, preventing the initiation of development within the stipulated timeframe. However, in late 2023, another planning permission was granted within the same site, given the consent of all remaining landowners. As a result, the development is anticipated to commence by 2027.

Fig. 7. Proposed scheme of the residential and hotel development complex in Yau Tong Bay [35]

4.2.2 Demographics and Neighouring Land Use Characteristics

The intervention site is in close proximity to several subsidised housing estates, namely Yau Tong Estate, Yau Lai Estate, Yau Mei Court, and Yau Chui Court (Figure 8(a)). The most recent census data in 2021 indicated a population of 43,403 individuals [36]. The area boasts a slightly higher proportion of young residents below the age of 24, accounting for 22.2% of the population (Figure 8(b)), compared to the average figure of 18% across Hong Kong [36]. This disparity may be attributed to the numerous kindergarten, primary, and secondary schools surrounding the area.



(a) (b)

Fig. 8. (a) Area where census data was obtained (subunit 290/14-16) and (b) Age distribution of the Yau Tong Bay Area

The north of the development site adjacent to Cha Kuo Leng Road situates the Eastern Harbour Crossing toll plaza and Lam Tin Interchange. Towards the further northwest lies the prospective Cha Kuo Leng Village, an upcoming public rental housing development. To the south, one encounters an industrial district characterised by automobile repair workshops and recyclable material processing facilities. Yau Tong station is positioned directly across the road and at the east of the site.

4.2.3 Assessment of Site Conditions and Challenges

The existing site is currently fenced off by hoarding erected during the demolition and decommissioning of the ship building yard and repairing facilities [37]. The majority of the site is vacant and paved with hard concrete surfaces. There is some hint of revegetation as captured from satellite images but is insignificant (see Figure 9) due to the lack of existing vegetation as initiatives and pollination from nearby vegetation across the road obstructed by fencing. If rewilding is to be initiated, active management and intervention shall be adopted with careful and positive human engagement for activation.

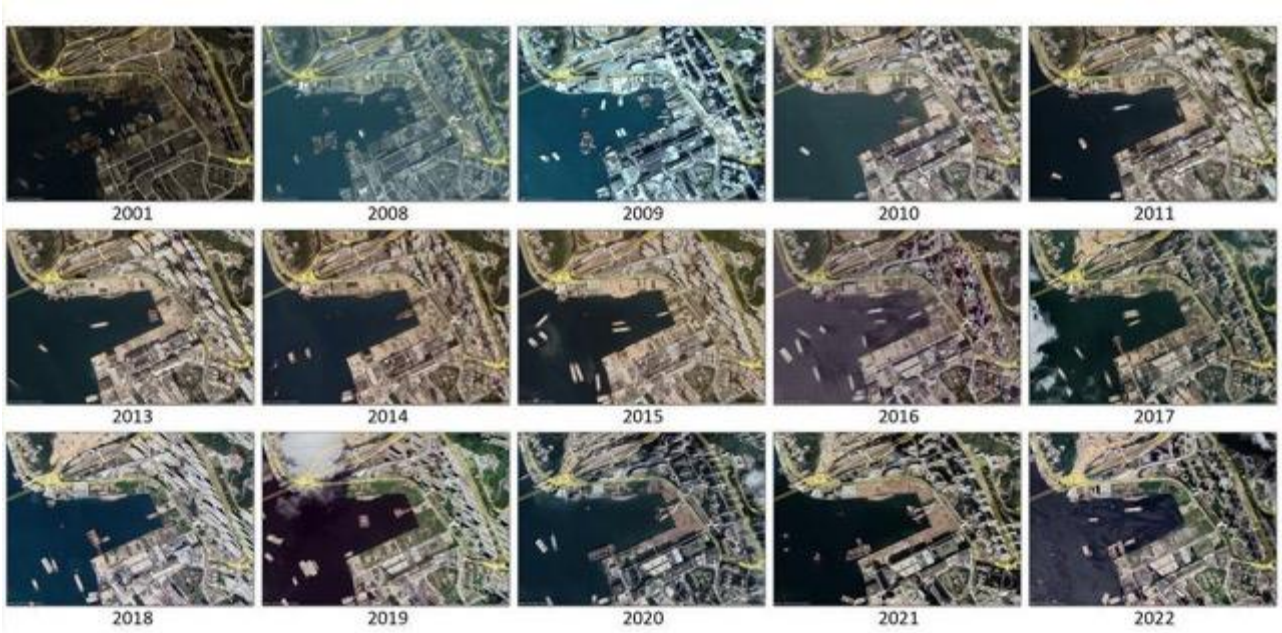
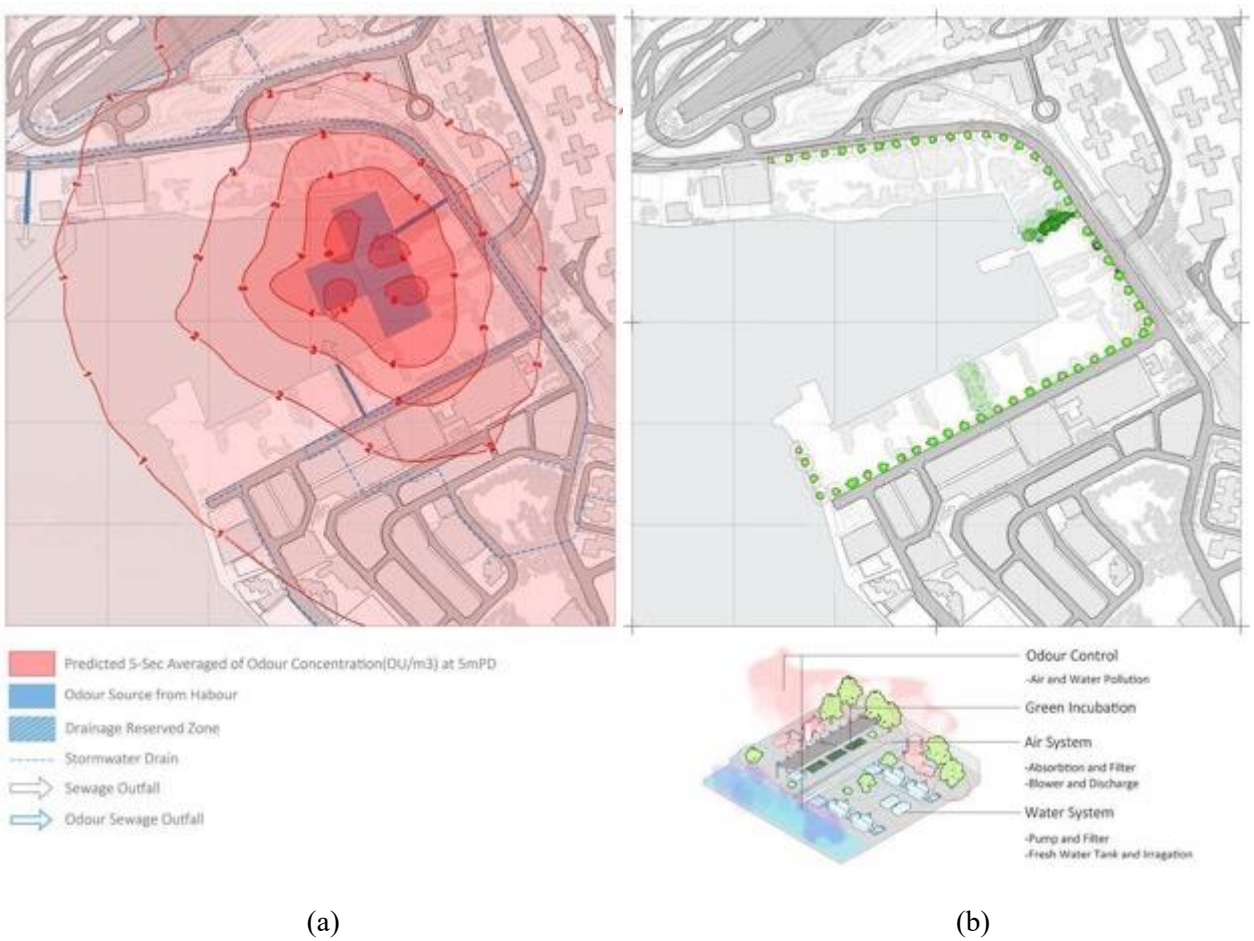


Fig. 9. History of vegetation regeneration [37]

The industrial site of more than 1 hectare at Yau Tong Bay had been decommissioned from 2011 to 2012, with contaminated soil found near underground fuel tanks mitigated. The contaminated soil was excavated out for biopiling and solidification to remediate hydrocarbon and heavy metals respectively. Soil with mercury and polychlorinated biphenyls are extracted and disposed of via landfill. Hydrocarbons found at groundwater surface are pumped into an oil / water separation unit with mitigated water re-injected back to the site [38].

Seabed at Yau Tong Bay was seen as a potential hazard as the contaminated sediment may endanger the public through the consumption of polluted fishes caught there. Based on monitoring, leaving the contaminated sediments in place without concealment would still comply with standards. Disturbance to the seabed shall be minimised to avoid adverse environmental impacts [39].

In terms of air quality, areas within the Yau Tong industrial area (FSP and RSP concentration) shown in Figure 10, and extents near the vent shaft and toll plaza of the Eastern Harbour Crossing (NO_2) cannot meet the acceptable criteria, likely originated from industrial activities and motor vehicles respectively. Odour below acceptable criteria was detected at the site, consisting of diesel smell from vessels, acid smell from metallic waste and construction waste on vessels, moldy smell from floating debris and sewage smell near an existing outfall. Most of them are not due to the contaminated sediment and shall cease after the stop of industrial activities. The odour near the outfall is unlikely caused by shipyards as there is no existing or previous operation record, but likely from sediments deposited from the outfall based on observation at the site [39].



(a) (b)

Fig. 10. (a) Identified current severe odour and pollution zones (b) In-situ decontamination strategies addressing odour problems on site

4.3 Design Objectives and Strategies

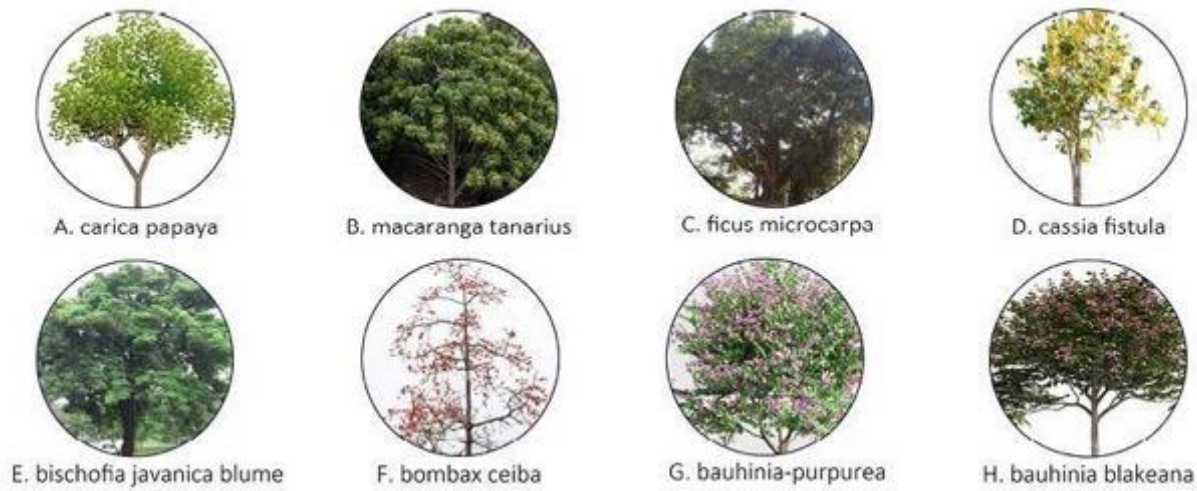
4.3.1 Establish Effective Zoning Strategies for Phased Rewilding

A comprehensive assessment is conducted to identify areas of existing contamination and pollution, as well as those that have undergone successful decontamination efforts, together with temporary infrastructure, including site offices, soil surveys, and boreholes (Figure 11). This assessment will serve as a foundation for subsequent phased rewilding plans, facilitate data collection, analysis, and monitoring, and provide valuable insights into the ecological potential and specific needs of different areas within the site. A phased development plan is devised, taking into account the readiness of the different land parcels. Development priority will be given to areas where decontamination has been successfully completed, while resources and efforts will be allocated to areas where buildings have recently been demolished, as these zones may require more extensive rewilding measures to restore natural habitats. Emphasising minimal human intervention, this approach aims to foster the restoration of natural ecosystems while preparing the site for future residential and hotel complexes.

4.3.2 Facilitate the Recolonisation of Existing Species

Existing native species surrounding the site are identified, which includes *Macaranga Tanarius* and *Bauhinia-purpurea*. These species are pollinated extensively by insects [40]. Notably, it has been observed that diverse tree species are prominently aligned across the road in close proximity to Yau Tong MTR station. Building upon this observation, parts of the existing fencing will be penetrated, while seeding platforms will be strategically created to enable the pollination of seeds by wind, insects, or occasional fauna, such as pigeons, from the periphery of the site towards the interior, effectively encouraging the recolonisation of existing species within the site (see Figure 11). These design strategies aim to foster the establishment of a biodiverse ecosystem, contributing to the successful rewilding of the site.

(a) (b)



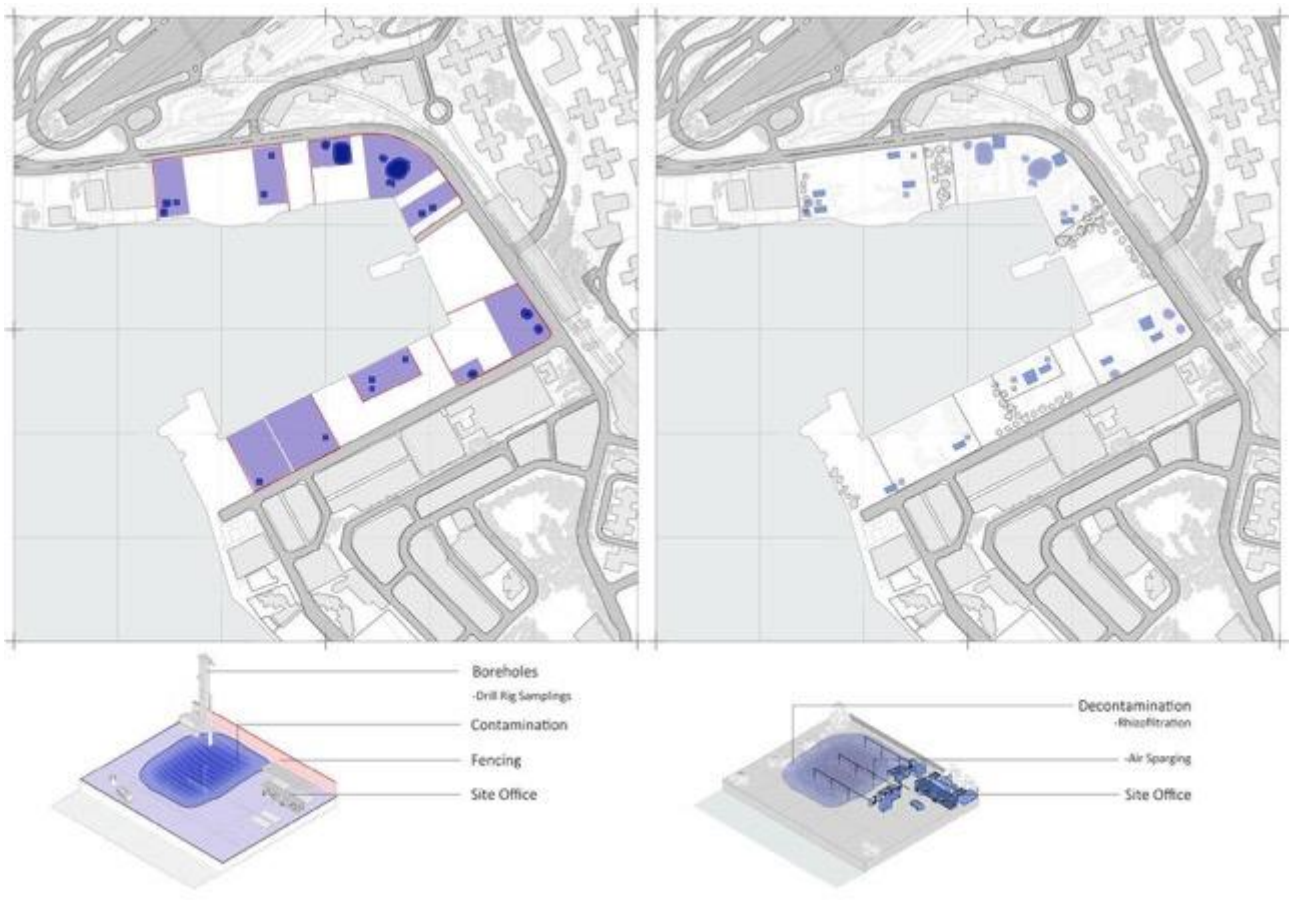
(c)

Fig. 11. (a) Neighbouring Tree Species and the Existing Site Vegetation (b) Recolonisation strategy on site over time (c) Existing on-site tree species

4.3.3 Create Capacity for In-situ Treatment of Contaminated Soil and Stormwater

Minor human intervention through the installation of air injection systems to aid soil vapor extraction facilitates the removal and treatment of volatile organic compounds and other contaminants as shown in Figure 12. Once the system is installed, air or a vapor mixture, such as steam or ozone, is injected into the subsurface through the designated injection points through air sparging. The injected air or vapor helps create a pressure gradient, facilitating the movement of contaminants from the soil matrix to the vapor phase.

Rhizofiltration is applied in the decontamination of in-situ stormwater which often carries pollutants and contaminants from industrial activities. By strategically planting suitable plant species with rhizofiltration capabilities, known as hyperaccumulators, stormwater runoff can be reduced and prevent further contamination to groundwater and soil. Hyperaccumulators have the ability to absorb and accumulate pollutants in their roots, stems, and leaves. Furthermore, the cleansed water obtained from the treatment system can be utilized as irrigation water, providing a sustainable water source for agricultural activities. The land where rhizofiltration is applied would act as a sponge, effectively storing water and enhancing resilience to climate change impacts, such as sea level rise and storm surges. By combining these benefits, the system serves as a comprehensive solution for stormwater remediation while simultaneously supporting ecological and agricultural sustainability.

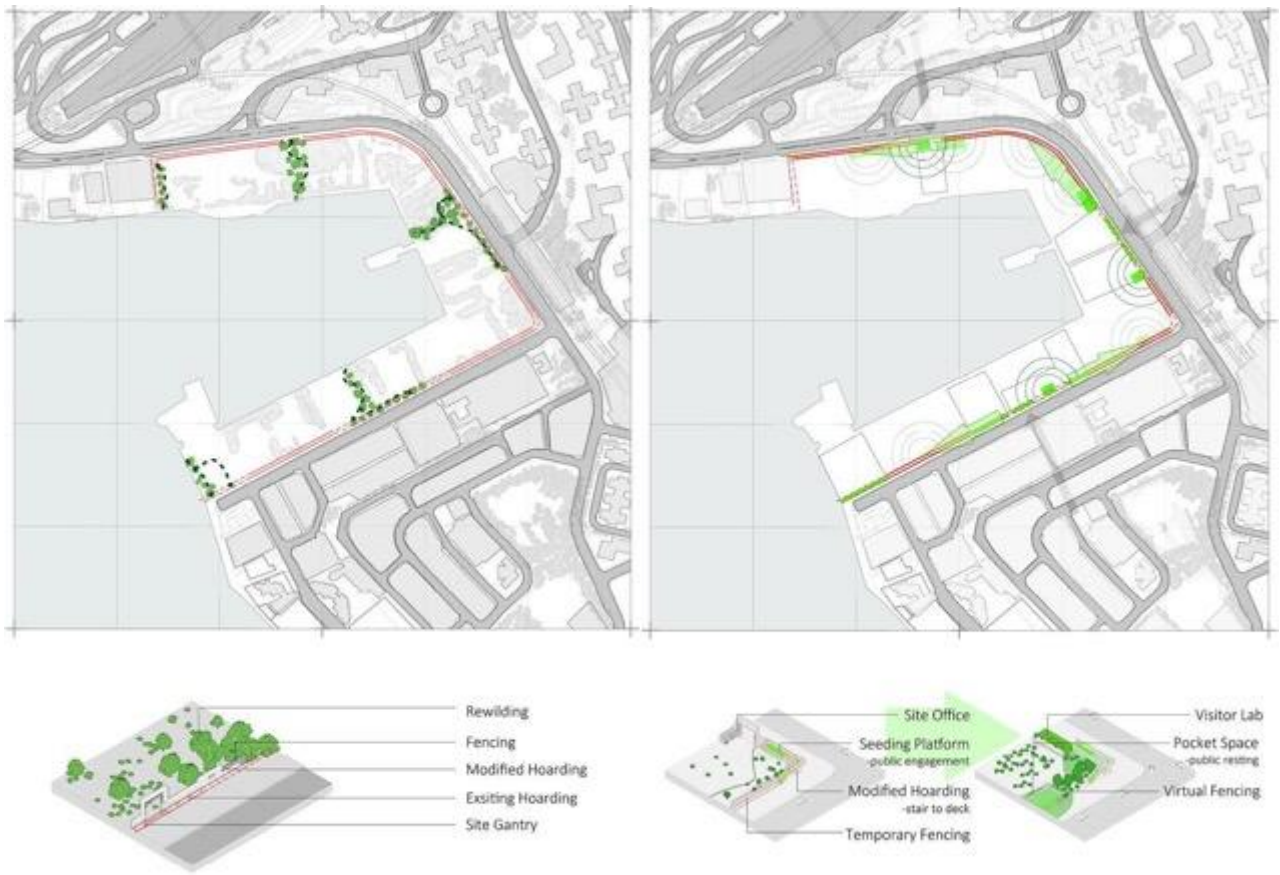


(a) (b)

Fig. 12. (a) Identify contamination zones (b) The in-situ decontamination focusing rhizofiltration and air sparging strategies on site

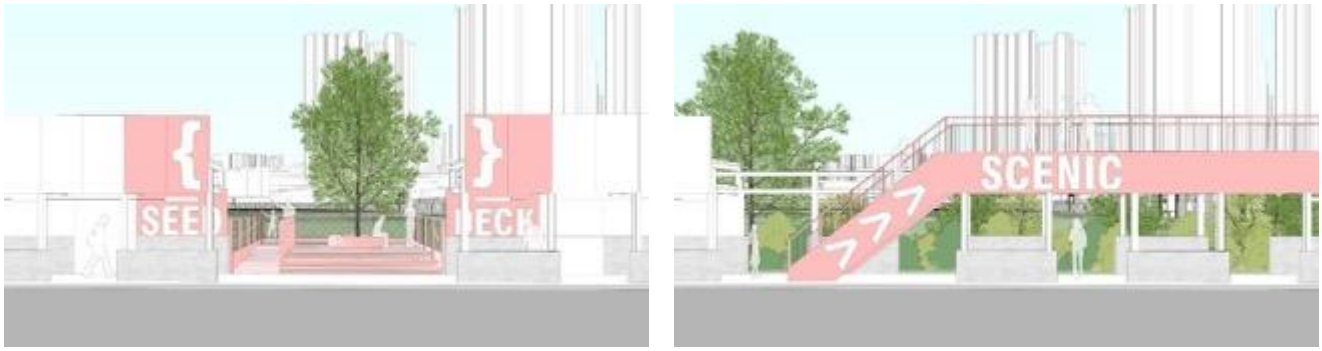
4.3.4 Enhancing Overall Site Permeability

The existing fencing and hoarding surrounding the site, which currently restricts visual and physical access, will be addressed. The intervention proposes the creation of different access points and platforms to blur the boundaries of the site, allowing for improved visual penetration and a sense of openness (Figure 13). This not only enhances visual connectivity but also promotes air ventilation within the site and the surrounding area. Additionally, the design proposes a phased approach to the evolution of fencing. As the rewilding operation progresses, the physical fence will transition into a permeable fence, and eventually, there will be minimal fencing to no fencing at all. This transformation ensures that the site becomes accessible to all, encouraging community engagement and interaction with the rewilded landscape.



(a) (b)

(c) (d)



(e) (f)

Fig. 13. (a) Hoarding iteration addressing rewilding status (b) Hoarding strategies driven by seeding with human engagement overtime (c) As-built hoarding condition at site with no visual connection (d) Introduction of transparent elements to create visual permeability during decontamination processes (e) Removing parts of hoarding to introduce trees with seeding deck for rewilding (f) Complete removal & Decking up of hoarding as scenic route to enjoy rewilded landscape

4.3.5 Innovate a New Form of Urban Pocket Space

Open spaces will be curated and communal programmes will be developed to cater to the public and different demographic groups, fostering social inclusion and interaction (Figure 14). The site will be transformed into a living museum, an experimental ground, and an urban laboratory, allowing the community to actively participate and witness the rewilding landscape's transformation. Collaboration with nearby schools will be encouraged, providing opportunities to engage citizen scientists and fostering a culture of environmental stewardship. The design will also prioritise the creation of areas of respite within the platforms and open space, enhancing overall social integration and providing spaces for relaxation and contemplation.

(a) (b)

Fig. 14. (a) Current neighbouring land use (b) Pocket space for communal interaction

4.3.6 Establish Comprehensive Monitoring Programmes

Data collection will be enhanced, providing valuable information for ongoing research and monitoring purposes. This will involve the implementation of a robust system that supports the collection, analysis, and storage of relevant data. A user-friendly dashboard or other forms of digital displays will be implemented to track and visualise the progress of the rewilding process (see Figure 15). This system will enable effective management and collaboration among scientists, facilitating informed decision-making and necessary adjustments to the rewilding efforts and planning.

(a) (b)

Fig. 15. (a) Identified other current borderline odour sources (b) Proposed constant monitoring to inform in-situ remedial measures

4.4 Rewilding Phases

4.4.1 Phase 0 - Current Site Conditions

At this stage, a certain degree of rewilding has already occurred in specific areas of the site, with the presence of local bush and grass species contained within the fenced hoarding area (see Figure 16(a)). However, the site remains fully fenced off, limiting physical access while allowing occasional visual penetration through openings in the hoarding. The focus of Phase 0 is to assess the existing rewilding efforts, understand the ecological dynamics within the site, and gather baseline data for future monitoring and evaluation.

4.4.2 Phase 1 - Removal of Physical Fencing

Phase 1 of the rewilding focuses on the gradual removal of physical fencing that surrounds the site (see Figure 16(b)). This phase aims to open up the space, creating new connections to nearby land uses and promoting ecological connectivity through the establishment of ecological corridors. As the fencing is removed, members of the community will have the opportunity to enjoy partial public open spaces in areas where decontamination has been completed. These accessible areas will provide a glimpse of the rewilding efforts and serve as spaces for recreation and interaction with nature. However, it's important to note that decontamination work may still be ongoing in other parts of the site, which will remain restricted to public access until deemed safe.

(a) (b)

Fig. 16. (a) Phase 0 - Current Site Conditions (b) Phase 1 - Removal of Physical Fencing

4.4.3 Phase 2 - Recolonisation of Key Species

Phase 2 focuses on the recolonisation of key species within the established ecological corridor (see Figure 17(a)). As the corridor becomes more mature and facilitates heightened pollination, a greater variety of species will recolonise the area, contributing to the restoration of biodiversity. Ongoing research will continue to study the effects of decontamination and rewilding efforts, allowing for constant monitoring and minor adjustments in the operational approach. The ecological corridor will not only reconnect eastward but will also extend to the harbour strips, expanding the impact area of rewilding. This extension will further enhance ecological connectivity, providing opportunities for species movement and the establishment of diverse habitats.

4.4.4 Phase 3 - Completion of Rewilding

Phase 3 represents the completion of the rewilding process, where the site has reached a level of maturity that allows nature to take the lead, and human intervention is minimised (Figure 17(b)). The rewilding efforts have successfully reached an equilibrium, creating a self-sustaining ecosystem. At this stage, the primary human activity associated with the site is to witness and appreciate the work of nature, as well as reap the benefits of the restored biodiversity and ecosystem services. This phase highlights the ultimate goal of rewilding—to restore the site to a state where it can function independently and thrive without constant human intervention.

(a) (b)

Fig. 17. (a) Phase 2 - Recolonisation of Key Species (b) Phase 3 - Completion of Rewilding

5. Findings and Discussion

5.1 Positioning the Proposal in the Broader Definition of Rewilding

5.1.1 Experimenting Rewilding in the Asian Context

Rewilding is usually implemented in large wilderness areas (e.g.10,000 hectares) [7] and large connected landscapes to restore diverse animals especially carnivores in North America, and often involves abandoning farmland, reducing livestock grazing, and protecting species with limited hunting in Europe, both on an ecological scale [10]. From the architectural scale, similar landscaping attempts focused on pre-existing elements, careful interventions emphasising on the processes instead of the product [19], addressing environmental needs [21] and adaptation by the local community was employed in the case studies [20].

Within the densely populated Asian context, the proposed pre-rehabilitation of post-industrial landscape of a 1-hectare area within a highly modified urban landscape is a hybrid rewilding experiment. The proposal tests how rewilding initiates in restoring natural ecosystem processes through reduction of human control [6], while the concept of perceived wilderness for wellbeing [9] could interact with the densely populated urban post-industrial context. Considering the reciprocal relation between nature and urbanity, the inhabitants and their behaviour are considered as an integral part of the environment [9], meaning their possible interaction with local fauna and flora has to be considered, hence a hybrid approach of preservation, decontamination and intervention.

5.1.2 Opportunity and Value of Rewilding in the Hong Kong Context

Considering the neighbourhood as part of the equation, rewilding can potentially be economically viable with land sharing, introduction of new land use and offering cultural services to the neighbourhood. In Hong Kong, a temporal gap between decommissioning of previous industrial sites and the start of construction of new development is observed. These sites are usually vacated and fenced off by hoarding for years either negotiating on sales agreement, seeking development permissions, liaising on land premium due to change of use or speculating for the rise of land value. There is a viable opportunity for rewilding to be implemented in these vacated sites with low opportunity cost as a form of prehabilitation prior to new developments.

This strategy aims to bring about two potential benefits. First, the process of rewilding may mitigate land contamination through in situ photodegradation by vegetation [23], where such remediation is a common planning condition imposed by the government for a post-industrial site for land use change prior to starting the construction of a new development. Secondly, the opening of fenced sites is also seen as an opportunity to maximize utilisation of space, aiding propagation of local flora, provide valuable public space for local communities, and creating social capital and new business opportunities [15].

5.2 Policy Recommendations and Best Practices Applicable for Other Sites with Similar Contexts

5.2.1 Connecting the Dots for Future Large-scaled Developments

The ongoing development of the Northern Metropolis in Hong Kong has necessitated the resumption of a substantial area comprising brownfield sites, which are set to be repurposed for future residential, commercial, government, and innovation and technology land use [41]. However, due to the predominant presence of brownfield operations such as recyclables handling facilities, open storage of construction materials, and vehicle repair workshops, extensive decontamination efforts are imperative to prepare the vast area of the Northern Metropolis for construction and subsequent development [41]. In this context, a more significant allocation of the decontamination process could be executed through the proposed hybrid rewilding strategy. This approach would facilitate a more transient transformation of the land, augmenting its overall compatibility with neighbouring land use. Moreover, the establishment of a network of rewilding landscapes within the redeveloped areas can further serve as an ecological corridor, effectively amplifying the provision of ecological services.

5.2.2 Enhance Ecological Services with Community Participation

By proposing a nature-based solution, the hybrid rewilding hopes to not only facilitate the maturation of land for future development, but also provide an opportunity for public involvement in the transformation process [42]. Within this framework, community participation can be fostered through initiatives such as community farming, which contributes to pollination processes [43]. Additionally, the creation of open platforms allows immersion with the natural environment, providing an opportunity for the community to witness and take record of rewilding processes[44]. Moreover, in coastal areas, the establishment of an urban buffer zone offers the potential to enhance overall climate resilience. This open space can serve as a natural wave attenuation mechanism during flooding or extreme climate events, while maintaining as publicly accessible open space during normal weather, thereby bolstering the area's capacity to withstand and adapt to changing climate conditions [45].

5.3 Limitation of the Research

Being an urban context, the lack of keystone species introduction within the site poses a challenge to the effectiveness of the rewilding process. Consequently, the design proposals acknowledge a certain level of human management to compensate for the absence of keystone species. Despite human intervention being kept to a minimum, it may be challenging to achieve the concept of perceived wilderness in an urban landscape. When comparing the intervention site with other overseas rewilding projects, a notable limitation is the confined rewilding extent. Unlike larger-scale rewilding initiatives, the intervention site's limited area (1 hectare) restricts the extent to which rewilding influence can be exerted on the surrounding landscape.

The vacated nature of the site leaves little room for design with existing architecture, except for the fencing structure. It is worth also mentioning that this design intervention only focuses on land decontamination, not on tackling marine and sea bed contamination, which can also be an important consideration for a comprehensive rewilding effort, especially for a site located within an inner bay.

5.4. Future Research Opportunities

Several future research directions can be explored to overcome these challenges and enhance the rewilding efforts. One possible research can be conducted on the potential introduction of keystone species or other fauna, by investigating the ecological interactions and dynamics that could arise from the presence of these species, including their impact on vegetation, biodiversity, and ecosystem functions in other post-industrial land use requiring imminent nature-based decontamination endeavours.

Opportunities for expanding the rewilding boundaries and enhancing connectivity with neighbouring landscapes can be explored, especially for scattered brownfields in Hong Kong or other similar contexts. The feasibility of establishing wildlife corridors or habitat linkages in the greater urban context could also be assessed to allow for the movement of species and genetic diversity. This could involve collaboration with landowners, conservation organisations, and government agencies to create a larger interconnected network of rewilded areas.

6. Conclusion

This research has explored implementing rewilding in a densely populated urban district with man-made landscapes, expanding rewilding to the realm of architecture and planning discourses. This is in contrast to orthodox practices bound by biological and environmental knowledge that are implemented in fauna-or-flora-dominated landscapes devoid of human endeavour. Rather than disregarding previous rewilding practices, this reinforces the possible scope and discourse of rewilding by accepting human activity as part of the ecosystem of the place, which would adversely impact on local development trajectories. Combining the spirit of ecological rewilding practices, while including urban interaction as part of the big picture, a regionally critical rewilding strategy is conceptualized that is specific to cultural habits and land practices in Hong Kong.

Encouraging community participation also transforms a traditionally passive and long-spanning rewilding process into an urban event or living exhibit that promotes bureaucratic transparency, generates real-time feedback and a possible deterrent to malpractice and negligence during the entire decontamination and rewilding process. It also serves as an educational ground for the city and strengthens awareness of specific natural processes that are often neglected by urban dwellers, and is a good litmus test to whether urbanisation necessarily leads to the degradation of nature, while experimenting on new forms of urban-nature coexistence.

Although limited by scale and by diversity of fauna and flora, it is believed that through parcelized response, public engagement and collective monitoring, the urban rewilding strategy of ‘pre-

rehabilitation' can be scalable and applied to similar harbourfront, brownfield and temporary vacated sites with relatable climates and urban context in Southeast Asia, providing a toolset for practitioners to design and balance the degree of human intervention mixed with biological processes. With a focus on dissolving default urban thresholds and opaque fencing, this 'pre-rehabilitative' rewilding hopes to activate vacant land stuck in 'limbo' status of land speculation, restoring the land and natural processes closer to the accepted nature.

By borrowing the image of perceived wilderness, this preparatory process aims to prime potential development zones with enough flexibility and resilience, after its long planning stage, for its eminent transformation into new urban districts or urban buffer zones.

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