

Article

Spatial Planning Strategies for Urban Ecology and Heritage Conservation in Macau: An Investigation of Ultra-High-Density Cities

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Abstract: Urban ecology and heritage-protection space are important parts of urban land and should be highly emphasized in urban planning. Improving and upgrading the level of urban ecological and heritage-conservation space will directly affect the level of spatial quality of the built environment of the city. As a high-density city, Macau suffers from “urban diseases” such as a low per capita green space rate and poor quality of the human environment. Therefore, in order to solve this kind of urban disease, the green environment quality of Macau’s heritage space should be improved and more leisure and recreational space should be provided for urban residents. This paper examines the layout of cultural heritage open spaces in Macau and suggests strategies for planning the preservation and use of these critical resources. This study investigated the current status of open space resources in Macau’s offshore islands, cultural heritage space resources, eight Largo spaces (“Largo” is a unique term for urban public open space in Macau) in Macau’s historic city, site-based cultural heritage open spaces, and the current status of rural walking trails in the offshore islands’ ecological reserves, and used GIS technology to visualize the survey results. Last, this paper investigates the planning strategy for the sustainable use of Macau’s outlying island ecological reserves and proposes a “green network” to connect the main mountains, green areas, and coastal wetlands in Coloane with the natural space. In view of the heritage-conservation space of the Macau Peninsula, this paper proposes the planning strategy of constructing linear landscape and cultural routes and planning characteristic heritage streets and alleys. Through using cultural heritage buildings as nodes and connecting pedestrian streets and alleys, the planning mode of combining heritage attractions and streets and alleys is realized.

Keywords: urban ecological conservation space; urban heritage-conservation space; high-density cities; habitat quality enhancement; information processes in urban planning; Macau



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1. Introduction

1.1. Research Background

As Macau is a high-density city, it is particularly important to rationalize the planning of urban heritage-conservation space and urban ecological conservation space to enhance the quality of the urban habitat. The Urban Planning Law of Macau, implemented in 2014, marked a significant step towards the strategic development and management of urban spaces in the region. Building on this foundation, the Macau Land and Urban Construction Bureau introduced the inaugural Draft Urban Master Plan (2020–2040) in 2020, seeking extensive community input [1]. This plan, approved in 2022, outlines a comprehensive

framework for the next two decades, addressing key areas such as land use, spatial layout, residential development, economic growth, transportation, environmental conservation, and cultural heritage. It is designed to tackle the unique challenges of Macau, capitalize on future opportunities, and align with the national strategic development plan. A central goal of the Master Plan is to foster a happy, smart, sustainable, and resilient city, while also integrating urban open spaces with the natural ecological environment, forming an interconnected blue-green network system (Article 4) [2–5].

A central goal of the Macau Master Plan is to foster a happy, smart, sustainable, and resilient city, while also integrating urban open spaces with the natural ecological environment, forming an interconnected blue-green network system. In the context of this urban transformation, the research presented in this article aims to explore the intricate relationship between urban ecology and heritage conservation in Macau, especially within the ultra-high-density urban setting. The study delves into the current status of open space resources, cultural heritage spaces, and the ecological reserves of Macau's offshore islands. It employs a multi-faceted approach, utilizing GIS technology for data visualization and conducting on-site inspections to gather empirical evidence. The research also reviews relevant literature to understand the broader implications of integrating ecological and heritage-protection spaces in urban planning.

The primary objective of this study is to propose effective spatial planning strategies that enhance the quality of life for Macau's residents by improving environmental conditions and providing more recreational spaces. This involves investigating the sustainable use of ecological reserves and the potential development of linear landscape and cultural routes that connect significant natural and cultural landmarks. The research endeavors to contribute to the discourse on urban planning by offering innovative solutions that balance ecological conservation, heritage preservation, and the needs of a densely populated urban center. Through this comprehensive approach, the study aims to provide actionable insights for policymakers and urban planners in Macau and other similar urban contexts. The findings of this study are significant for policymakers and urban planners. By analyzing the current state of Macau's urban ecological resources and cultural heritage spaces, this paper proposes specific planning strategies, such as enhancing ecological conservation of mountains and wetlands, making full use of established rural walking trails, and improving supporting facilities. These strategies not only provide new directions for Macau's urban planning but also offer viable solutions for other cities facing similar challenges.

1.2. Literature Review

In recent years, the compartmentalization of heritage conservation and spatial planning has been identified as an outdated approach, particularly in the context of urban ecological conservation space and urban heritage-conservation space [6,7]. There is a growing consensus that heritage conservation must reassess its objectives to remain integral to broader urban and rural development [8,9]. Urban ecological planning, intrinsically linked to heritage protection, is a crucial component of spatial planning [8].

In the Chinese mainland, studies on the preservation and inheritance of historical and cultural heritage within the framework of territorial spatial planning have yielded significant findings. The case of Xi'an, for instance, has underscored the importance of identifying heritage value from a regional perspective, establishing a cultural ecological protection pattern based on urban historical landscape theory, and creating a land space centered around cultural heritage [10,11]. This approach achieves comprehensive lifecycle management through a unified mapping approach, aligning with the principles of diversity, adaptability, symbiosis, humanism, system, and balance [12].

The concept of high-density cities, such as Macau, presents unique challenges in urban ecological and heritage-protection spatial planning [3]. Macau, as a quintessential ultra-high-density city, requires tailored strategies that consider its specific characteristics and the broader geographic reality in China [3]. Scholars have conducted objective evaluations of ecological forest-protection areas and architectural heritage group environments, such as

at Zhejiang University's Zhijiang Campus, using advanced tools like ArcGIS analysis [13]. They employed a multi-factor superposition evaluation system to assess the ecological environment surrounding the architectural heritage group, proposing spatial guidance and control plans that align with the school's development strategy while preserving the ecological environment, original planning patterns, and architectural heritage [13].

The challenge of habitat quality enhancement is central to urban ecological planning, especially in dense urban settings [4]. The integration of nature-based solutions (NbSs) with urban built heritage presents both challenges and opportunities for enhancing habitat quality [4]. Built heritage can both benefit from and contribute to the wider implementation of NbSs, delivering environmental, economic, and social co-benefits [4,14].

Legislative aspects are crucial in urban ecology and heritage conservation, with the establishment of a national heritage spatial protection system in China being a step towards safeguarding the spatial carriers of Chinese civilization [3]. This requires a multi-departmental approach to protect national heritage, essential for the nation's rejuvenation and modern civilization construction [3,15].

In this research, the integrated approach to heritage conservation and spatial planning is emphasized, adopting a holistic view of urban cultural ecology, and considering the unique characteristics of Macau when developing spatial planning strategies for ecological and heritage protection [10]. The principles of diversity, adaptability, and balance have been particularly influential in shaping the approach to urban conservation and development. This paper aims to provide a comprehensive multidimensional analysis of Macau's urban ecology and heritage-conservation spaces through the innovative application of both quantitative and qualitative research methods, an area that has been relatively underexplored in existing literature. Most studies in the field of urban ecology and heritage conservation tend to focus on a single domain, such as ecological protection or heritage preservation, with a lack of systematic research on the combined impact of both. This paper fills this research gap by offering a holistic analysis, especially in the context of ultra-high-density cities, on how to balance urban development with ecological and cultural heritage conservation.

2. Study Area and Methods

2.1. Study Area

The Macau Special Administrative Region is located on the west side of the Pearl River Delta estuary and consists of two parts, the Macau Peninsula and the outlying islands (Figure 1), with a total area of about 32.9 km². In 2020, the population density of Macau's urban area was about 20,800 people/km², which is one of the highest in the world [16]. Among them, the urban area of Macau Peninsula is only 9.3 km², and the population density is about 58,300 people/km², which is one of the most densely populated cities in the world. In 2020, the urban green area of Macau Peninsula was 1,817,215 km², with a greening rate of 16.08 percent. Comparing Macau's urban greening rate with that of other international city centers, Macau's urban greening rate is significantly lower; for example, Tokyo's city center has a greening rate of 26.6%, Sydney's city center has a greening rate of 30.2%, and Singapore's city center has a greening rate of 25.9%. With a resident population of 532,700 in 2021, the average green space per person on the Macau Peninsula was a mere 3.3 km². Conversely, the Macau outlying island boasted an urban green area of 10,511,160 square meters and a greening ratio of 46.5 percent. With a population of 149,700 residents in 2021, the per capita green space on the Macau Outlying Island was a substantial 65.79 km², which is markedly higher than that of the Macau Peninsula, approximately 20 times greater. The study area of this paper is the ecological and heritage-conservation space of the whole territory of Macau.

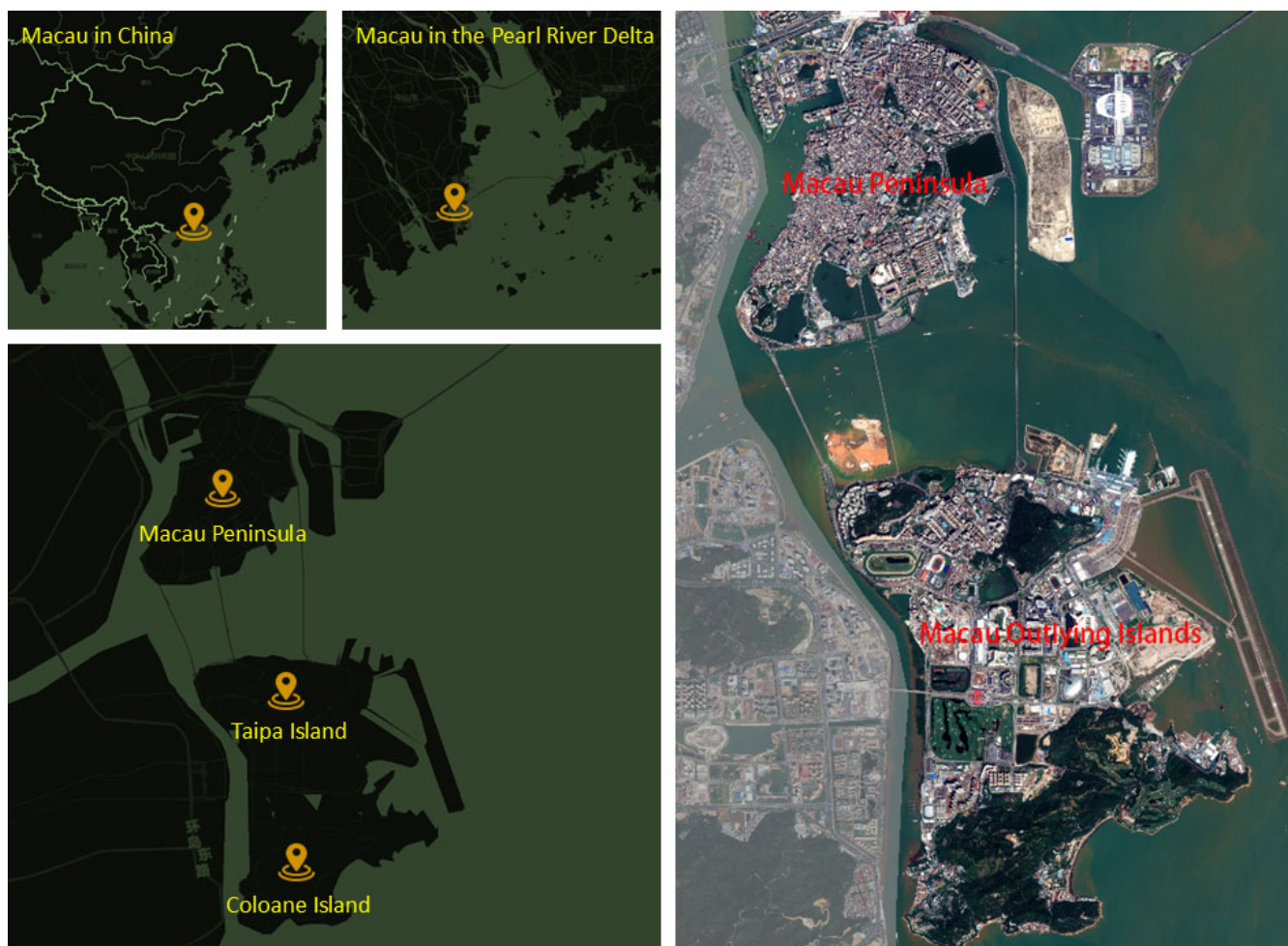


Figure 1. Location of the Macau Peninsula and Macau Islands. The small amount of Chinese text is from Zhuhai City, but it is not within the scope of this study. (Image source: the author's annotations are based on Google satellite images).

2.2. Research Methods

The central aim of this study is to delve into the intricacies of urban ecology and heritage conservation in Macau, especially within the framework of spatial planning for ultra-high-density cities. Our approach is a synthesis of quantitative and qualitative methodologies, designed to yield a thorough and multidimensional analysis of the data at hand. In the realm of urban planning, the unique challenges posed by densely populated cities like Macau demand creative and innovative methodological strategies to grasp and improve the spatial quality of the built environment. The study's approach is distinctive in its emphasis on the integration of urban planning with information processing and exploitation. This integration is crucial for addressing the complex challenges of urban ecology and heritage conservation in Macau, particularly in the context of spatial planning for ultra-high-density cities. By leveraging advanced information technologies, we aim to enhance the decision-making processes involved in urban planning, ensuring that our strategies are data-driven and responsive to the dynamic needs of the city.

This research endeavors to offer a nuanced examination of Macau's green open spaces and cultural heritage locales, shedding light on their current condition and their capacity for sustainable evolution. To achieve this, we have strategically chosen a blend of map analysis and empirical research methods, harnessing the power of advanced technological tools and software to efficiently process and analyze the data.

- (1) **Map Analysis Method:** Our methodology incorporates a combination of map sampling analysis and field inspections to compile an ArcGIS database dedicated to Macau's green open spaces and selected urban research areas. This approach allows for a quantitative assessment of Macau's green open space resources, categorizing and summarizing the diverse types of public open spaces. We employ visual aids such as charts and case studies to enhance the analysis of research data, providing a solid foundation for planning paradigm research.
- (2) **Empirical Research Method:** We have selected case studies of green open space planning and construction from typical cities within China for in-depth analysis and study. For pivotal cases, we utilize tools like ARCHICAD to facilitate the calculation, verification, and analysis of relevant heritage spaces. In conjunction with our involvement in research projects organized by the Macau SAR Government's Municipal Affairs Bureau, we have conducted extensive on-site research into the background resources of various urban open spaces across Macau. This has enabled us to gather primary information, comprehend the current layout of green open spaces in different research sample cities, and carry out further empirical research on the derived values of Macau's heritage space.

In the methodology section of our study, we meticulously crafted a comprehensive workflow consisting of several interlinked steps, designed to process and analyze data pertaining to urban ecological and heritage-conservation spaces. Commencing with the utilization of AutoCAD software (2020 version), we systematically organized the research data, categorizing it based on the various types of green open spaces. This initial organization laid the foundation for subsequent analysis.

Moving forward, we established a Personal Geodatabase within ArcGIS, where we imported DWG files and seamlessly converted them into Shapefile layers. The conversion process was pivotal, as it allowed for the integration of spatial data into our analytical framework. With the aid of ArcToolbox, we executed polygonization on the features, transforming line data into area data, and conducted rigorous topological checks on the Shapefile files to ensure the integrity and accuracy of our spatial data.

Subsequently, we transcribed the foundational information of the green open spaces into an Excel spreadsheet. This spreadsheet was meticulously linked to the attribute table in ArcGIS, enabling us to enhance and refine our data with greater precision. We also performed error rate checks on the green space data within the ArcGIS attribute table, ensuring that our dataset was free from discrepancies. To further enrich our analysis, we conducted a thorough statistical analysis to uncover insights and identify trends within the data.

Throughout this meticulous process, we employed a suite of digital tools, including AutoCAD (2020 version), ArcGIS (10.7 version), ArcToolbox (10.7 version), Microsoft Excel (2019 version), and specialized software for data validation and statistical analysis. These tools were instrumental in achieving the high level of precision required for data processing and the depth necessary for our analysis.

To enhance the clarity and accessibility of our methodology, we have incorporated a flowchart (referred to as Figure 2) that encapsulates the entire workflow and the digital tools employed at each stage. This visual representation serves as a guide, illustrating each phase of the research and highlighting the specific tools used at each step. By adopting this structured approach, our study contributes a transparent and methodical framework for data processing and analysis, which is invaluable in the realms of urban planning and information management.

By integrating these methodological approaches, our study provides a comprehensive and cohesive analysis that not only addresses the complex interplay between urban ecology and heritage conservation but also offers practical insights into the sustainable development of Macau's urban landscape.

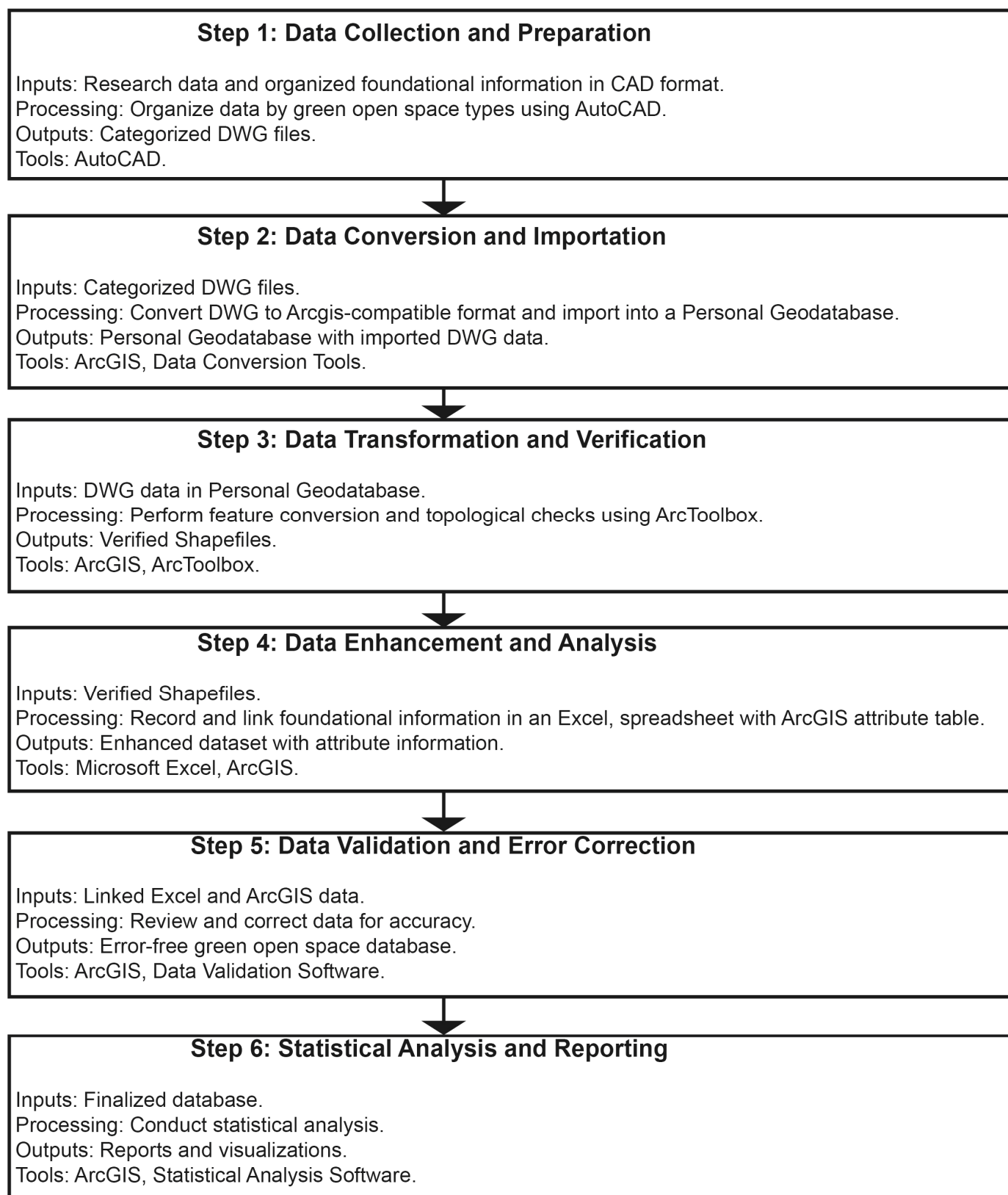


Figure 2. Step-by-Step methodology with digital tool (image source: drawn by the author).

2.3. Data Sources

The survey scope of this article covers the entire Macau Special Administrative Region (including the Macau Peninsula, outlying islands, new reclamation areas and the Hengqin

Macau University campus), with a total area of 33.9 square kilometers. The relevant data summary and analysis are mainly conducted on the urban built-up area, with an area of 31.8 square kilometers.

The contents of the basic data collected for the research work of this paper are mainly:

- (1) Urban Green Space Classification Standard (2015) by the Civic and Municipal Affairs Bureau of Macau [17];
- (2) 1:10,000 AutoCAD base map of the current state of urban green space in Macau (2020);
- (3) a 1:1000 AutoCAD map of the whole territory of Macau (October 2020);
- (4) Remote sensing image map of Macau (October 2020) with 0.6 m accuracy;

The research work adopts the method of comparing remote sensing image maps with AutoCAD maps combined with on-site surveys and utilizes AutoCAD and ArcGIS software to extract information, process images, and output the results of Macau's existing green spaces, water bodies, and other patches.

The novelty of our methodology lies in its integrated approach, combining advanced geographic information systems (GIS) with on-the-ground empirical research. This fusion of techniques allows for a more nuanced and accurate assessment of Macau's urban ecology and heritage-conservation spaces. Our study breaks new ground by providing a detailed spatial analysis that can inform future planning strategies, ensuring the sustainable development and enhancement of Macau's urban environment.

3. Results of the Macau Ecological Resources and Cultural Heritage Spatial Resources Survey

3.1. Historical Changes and Resources of Macau's Outlying Islands Ecological Reserves

In the *Macau City Master Plan (2020~2040)*, areas of natural resources with ecological value within the city limits are planned as ecological reserves, aiming to protect Macau's major mountains, water bodies, and wetlands and to safeguard biodiversity (Figure 3).

Zonas de Conservação Ecológica

Serão delimitadas as zonas naturais, com valor ecológico, como zonas de conservação ecológica, no sentido de salvaguardar as principais colinas, meios aquáticos e terras húmidas de Macau, assim como preservar a biodiversidade do Território, incluindo:



Figure 3. Main open space contents of Macau ecological reserves. (Image source: *Draft Urban Master Plan of the Macau Special Administrative Region (2020~2040)*).

It took hundreds of years for the Macau ecological reserve to develop its current green landscape. According to literature, the climatic conditions in the early years of Macau's

history were relatively harsh, with strong sea winds and heavy rainfall, especially during typhoons [18]. With the arrival of Jesuit priests (1563) and Franciscan friars in Macau, some people opened small nurseries around their houses or monasteries to plant medicinal herbs, which gave rise to a Jesuit nursery or Holy Spirit Nursery near the Fortaleza do Monte (Fortress of Our Lady of the Mount of St. Paul), as well as a nursery of Jesus on the eastern slope of the Colina da Penha (Penha Hill), facing the Nam Van (South Bay). Later on, numerous ships came and passed through Macau, bringing plants from India, Ceylon, Thailand, Timor, and other places to Macau. From the end of the 18th century to the beginning of the 19th century, the East India Company, headquartered in today's Jardim de Luís de Camões (Luís de Camões Park) in Macau, showed great interest in the flora of the East Asian region and invited botanists David Stornach and William Kerr to collect a large number of Asian species here in 1794 and 1803. The Jesuits then sent them to the Royal Botanic Gardens (Kew Garden) in London. The Jesuits also transformed the bleak, rocky hills of Green Island in Macau into an oasis of rare trees.

However, until the middle of the 19th century, Macau's territory was a barren landscape with little flat land and poor soil, with a thin layer of organic matter. The Duke of Arnosso recorded that in the 1880s, the Governor of Macau, Tomás da Rosa, ordered the planting of 60,000 trees [19], and on 9 May 1882, the Governor of the Municipal Councils of Taipa and Coloane, in his message no. 27 to the Ministers of Macau and Timor, wrote: "I am honored to submit to your Excellency that Official Letter no. 419, of the 4th of this month, proposes the planting of trees, which is the main subject of a letter from the Ministers of Macau and Timor, and that they have been given to you. I am pleased to inform you that the idea of planting trees, as proposed in the official letter no. 419 of the 4th of this month, has been gladly accepted by the Municipal Council, which is convinced that the project will be beneficial for the future sowing of trees and the cultivation of timber, and that the Municipal Council will start working on the project right away. In the village of Taipa, two sites have been selected, which are not large but have a deep layer of soil and are sheltered from the high winds coming from the north and the east. There are several suitable sites for nursery cultivation on Coloane Island, all of which are situated in the Seac Pai Van valley near the Templo de Tin Hau (Tin Hau Temple) and on the slopes of Ká Hó. In the village of Taipa, two sites have been selected that are small but deep and sheltered from the winds from the north and east. The Municipal Council has recently voted on the amount of money required for the purchase of tree species and saplings for cultivation" [20].

In October 1933, the Macau-Portuguese government established the Macau Department of Agriculture with the mission of protecting and improving the existing trees and parks in the colony, constructing and maintaining an arboretum, and establishing a botanical archive and an agricultural museum. In its terms of reference, it was responsible for the "emergency greening of Taipa, Coloane, and their annexes, which have not yet been opened up" and the "management of all parks", among other things. Unexpectedly, in 1936, the Macau Agricultural Department was abolished, and the management of green areas was returned to the Public Works Department of the Overseas Provinces until the mid-1960s, when it was transferred to the Municipal Council. After that, Macau launched the largest afforestation and greening project in its history on the islands of Taipa and Coloane, planting a large number of *Pinaceae*, *Acacia confusa* Merr., and *Trema tomentosa*. By 1996, the forested area of Macau's outlying islands had reached 412 hectares, most of which (362 hectares) were in Coloane. The forested areas of the outlying islands are characterized by dense vegetation and lush landscapes. According to the "Flora of Macau 2004", there are 1508 species of plants in Macau that have been surveyed and approved, showing the diversity of plant communities. As the Methodology Step 6 results shows in Table 1 and Figure 4. Nowadays, the open space resources of Macau's ecological reserves are mainly concentrated in the outlying islands of Macau, with a total area of about 5.76 km² (Table 1, Figure 4), which has become a valuable "urban green heart" and biodiversity-conservation area.

Table 1. Current status of open space background resources in Macau’s outlying islands ecological reserves.

Category Code	Open Space Category Name	Number of Plots	Area (m ²)
SG13	Country Parks	4	1,820,312
SG5	Scenic Woodland	16	3,475,190
SG6	Ecological Wetlands	8	344,289
SG7	Natural water bodies	3	120,101
Total		31	5,759,892

Source: authors’ compilation, survey data as of December 2022.

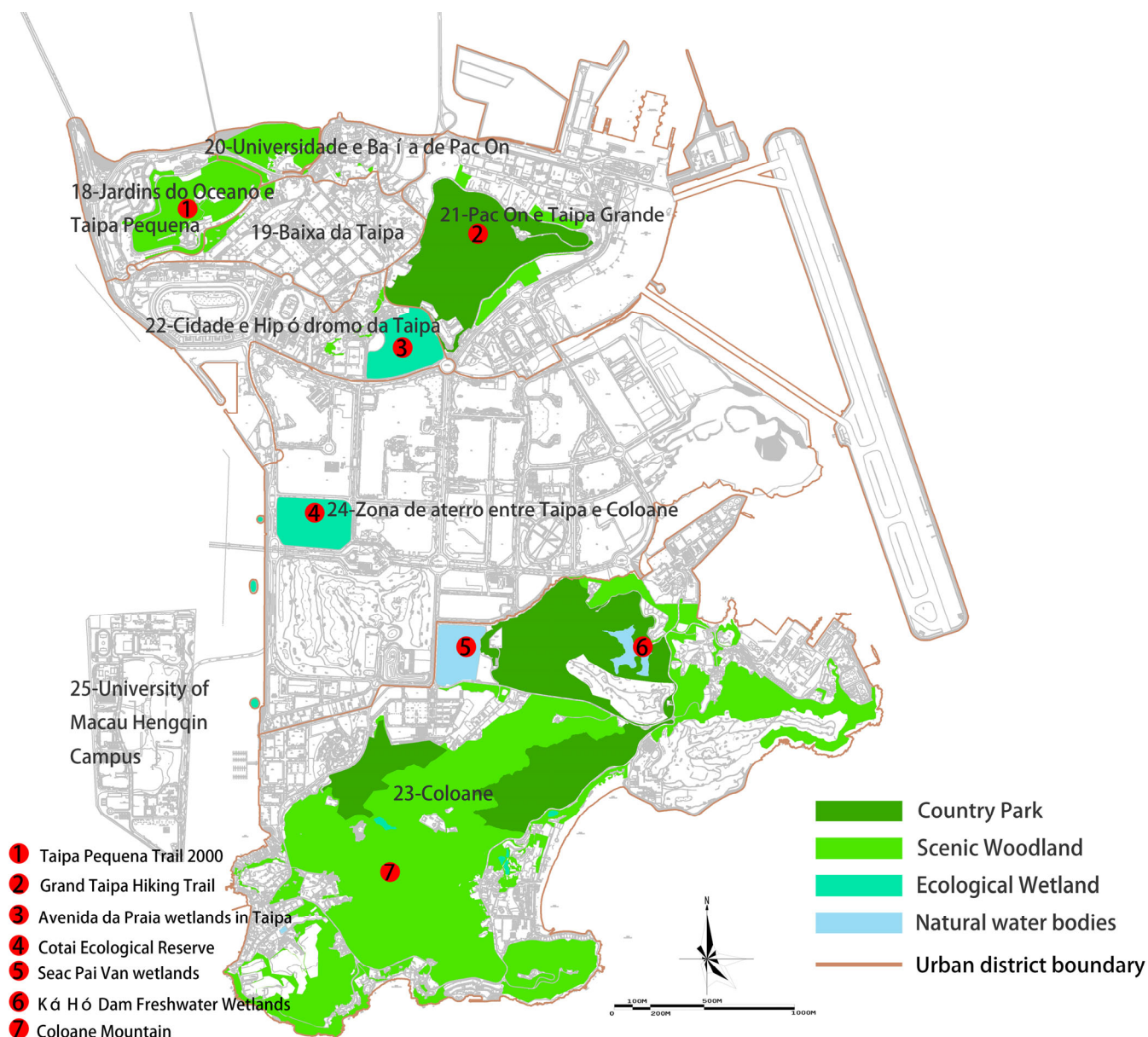


Figure 4. Distribution of major resources in Macau outlying islands ecological reserve (image source: drawn by the author).

3.2. Macau Cultural Heritage Spatial Resources

In Macau, cultural heritage in need of protection is defined by law as “assessed immovable property”. According to the Law 11/2013 of Macau on the Protection of Cultural

Heritage, “assessed immovable property” (built heritage) includes four categories: monuments, groups of buildings, buildings of architectural and artistic value, and venues [21]. Therefore, there are two main categories of open space resources in Macau’s cultural heritage: first, the eight Largo squares and streets in the World Heritage List, and second, the space of “venues” in the classified immovable properties (built heritage).

The first category is the space of the eight forecourt squares of Macau included in the World Heritage List, which consists of two sub-categories: firstly, the ancillary squares of historic buildings, which together with their adjacent buildings are included in the category of “monuments” in the “assessed immovable property”, such as Largo da Sé, etc. Secondly, they are included in the category of “group of buildings” under “assessed immovable properties”, such as the precincts of Largo do Senado, Largo de S. Domingos, Largo de Santo Agostinho, Largo do Lilau, and so on. Some other Largos, functionally, are mostly used as public open spaces, such as sitting-out areas, pedestrian streets, or civic squares (Table 2).

Table 2. Spatial overview of the eight Largo spaces in the Historic Centre of Macau on the World Heritage List.

Largo Name	Area m ²	Location	Legacy Features
Largo do Lilao	635	Largo do Lilao	One of the earliest settlement of Portuguese in Macau
Largo de Santo Agostinho	1638	Largo de Santo Agostinho	An important square in the Historic Centre of Macau
Largo do Senado	3700	Largo do Senado	Macau City Center Square, reflecting the city’s characteristics of mixed Chinese and Western cultures.
Largo do Pagode da Barra	4376	Largo do Pagode da Barra	Built in the first year of Hongzhi of Ming Dynasty (1488), the front square of Macau Temple
Largo da Sé	2246	Largo da Sé	Square in front of the Catholic Diocese of Macau
Largo do São Domingos	603	Largo do São Domingos	Western-style Plaza Space in the Historic Centre of Macau
Praça de Luís de Camões	1991	Praça de Luís de Camões	One of the earliest Portuguese residential area in Macau
Largo da Companhia de Jesus	517	Ruínas da Antiga Catedral de São Paulo	Remembering the Jesuits who came to Macau to establish St. Paul’s College

Source: statistical collation by author.

The second category is “place-type” urban open space with cultural heritage value, i.e., defined by the Law of Macau on the Protection of Cultural Heritage as “human creations or joint creations of mankind and nature with significant cultural value, including places with archaeological value”. As the Methodology Step 6 results shows in Figures 5–7 and Table 3, it includes green space in parks, green space in streets, green space in courtyards, scenic woodlands, and open space for transportation. The green blocks in the figure represent the legally protected “place-type” urban open spaces, and their categorization attributes are shown in Table 3.

被評定的不動產及緩衝區分佈圖
 Delimitação gráfica dos imóveis classificados e respectivas zonas de protecção

此圖根據第1/2017號、第31/2018號、第33/2018號、第31/2019號以及第37/2021號行政法規所載之被評定的不動產及緩衝區範圍製作。
 Conforme com as delimitações gráficas dos imóveis classificados e respectivas zonas de protecção nos Regulamentos Administrativos Nº 1/2017, 31/2018, 33/2018, 31/2019 e 37/2021.



Figure 5. Distribution of classified immovable property (built heritage) and buffer zones in Macau Peninsula, 2021. The traditional Chinese in the picture is what is displayed in the official source file of Macau, and the corresponding English has been annotated below. (source: Cultural Affairs Bureau of the Government of the Macau Special Administrative Region).

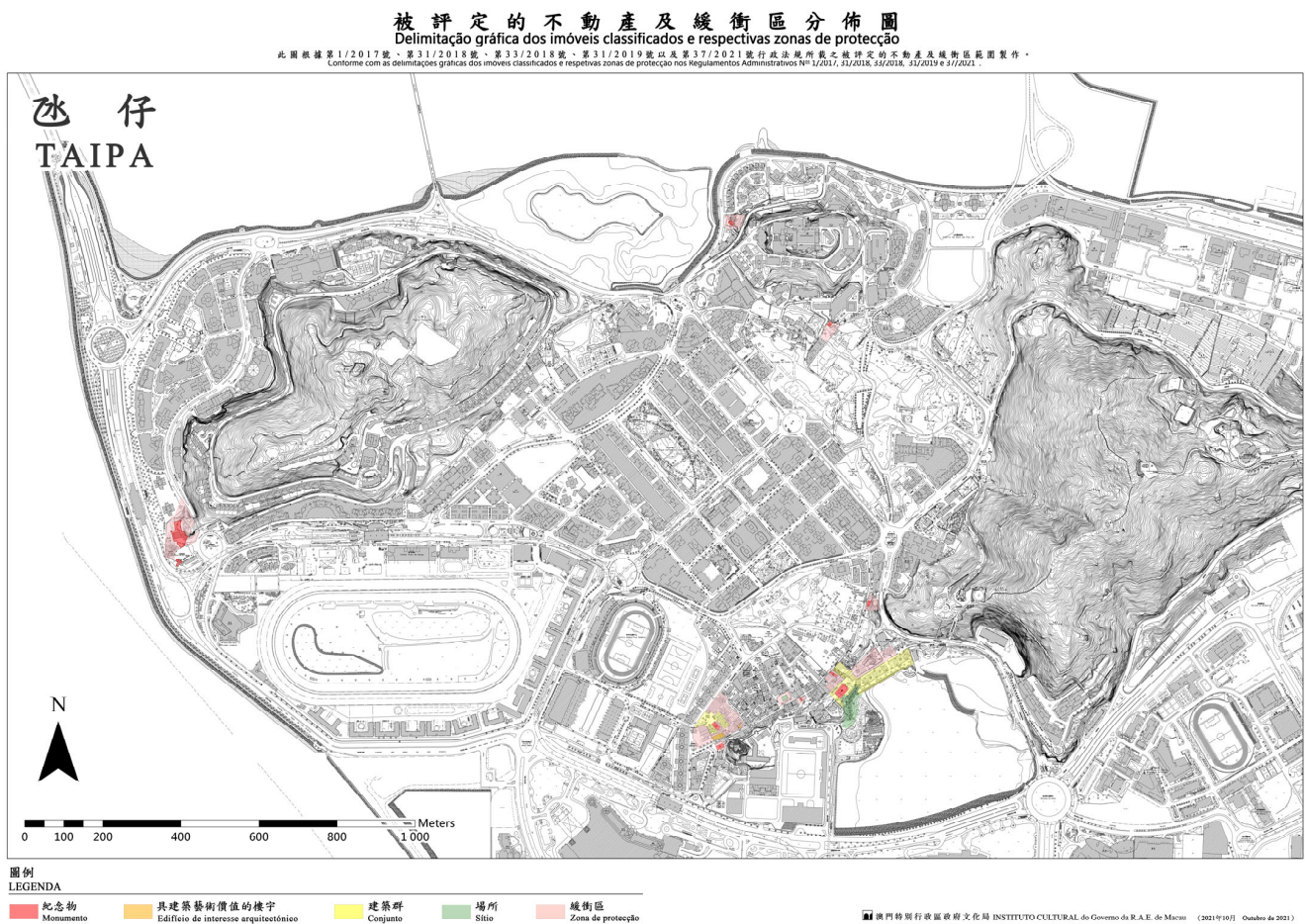


Figure 6. Distribution of classified real estate (built heritage) and buffer zones on Taipa Island, Macau, 2021. The traditional Chinese in the picture is what is displayed in the official source file of Macau, and the corresponding English has been annotated below. (source: Cultural Affairs Bureau of the Government of the Macau Special Administrative Region).

In addition to the 33 urban open spaces listed above, which are protected as “assessed immovable property”, there are also some “selected cultural heritage-type open spaces” resources in Macau, such as the Jardim da Cruz located next to the Avenida da Praia na on the Taipa Island of Macau, the Aldeia cultural A-Ma in Coloane, and the Vila de Nossa Senhora in Coloane, all of which are of high cultural heritage value. This kind of open space has the key elements for cultural heritage assessment, such as historical tradition and folklore characteristics, and is eligible to be selected as a cultural heritage resource to be added to the list of “assessed immovable assets” of Macau in the future (Figure 8).

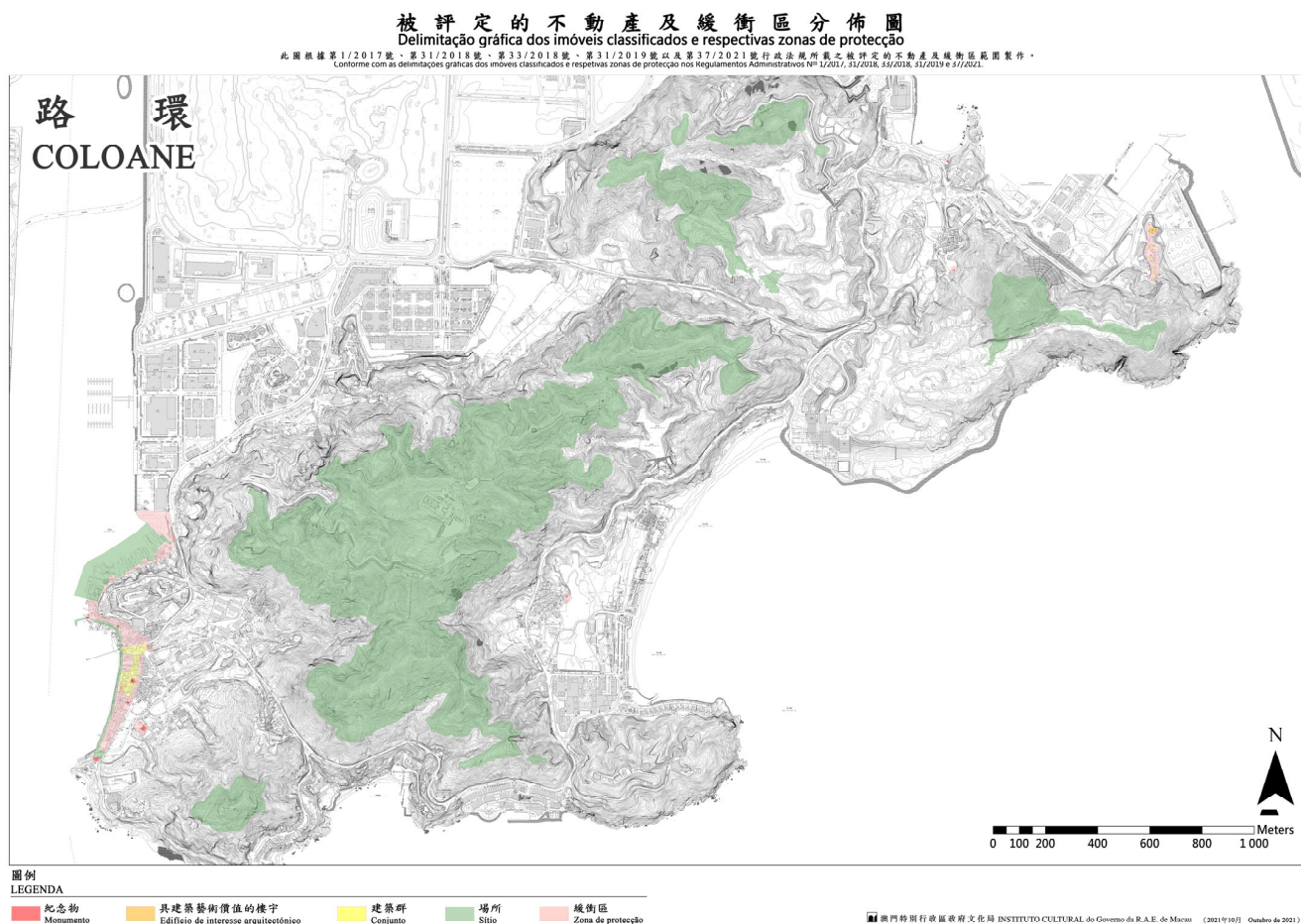


Figure 7. Distribution of assessed immovable property (built heritage) and buffer zones in Coloane Island, Macau, 2021. The traditional Chinese in the picture is what is displayed in the official source file of Macau, and the corresponding English has been annotated below. (source: Cultural Affairs Bureau of the Government of the Macau Special Administrative Region).

Table 3. Overview of Macau’s cultural heritage open spaces in urban areas.

Place Name	Area (m ²)	Location	Legacy Features
Praça do Tap Seac	12,655	Avenida do Conselheiro Ferreira de Almeida	First located outside the old city walls of Macau
Barra Hill	37,599	Southwest tip of Macau Peninsula	Macau Peninsula second highest hill
Penha Hill	22,356	Southern Macau Peninsula	Macau Peninsula third highland
Guia Hill	95,556	Macau Peninsula East	Horizontally shaped like a yodel, the highest hill in the Macau Peninsula
Má Káu Séak Hill	9372	Northeast Macau Peninsula	There is Mong-Há Fort on the mountain, and the ruins of the fort and bunkers are still preserved.
Mong Ha Hill	23,438	Northern Macau Peninsula	On the hill, there are still ruins of a cannon platform and a bunker.
Ilha Verde Hill	44,742	Northwestern Macau Peninsula	There are still the ruins of a monastery on the mountain.
Jardim de Lou Lim Iok	12,362	Between Estrada de Adolfo Loureiro and Avenida de Horta e Costa	Macau’s only famous garden with the style of Suzhou’s garden.

Table 3. Cont.

Place Name	Area (m ²)	Location	Legacy Features
Jardim de Luís de Camões	23,015	Jardim de Luís de Camões	One of Macau's World Heritage-listed venues, with a history dating back to 1849.
Jardim Municipal da Montanha Russa	9572	Between Mong Ha Hill and Ma Kau Shek Hill	Built in the 19th century, the park reflects the style of classical gardens of the Romanesque period.
Jardim de S. Francisco	6191	Avenida da Praia Grande	Macau's first city park
Jardim da Vitória	1910	Avenida de Sidónio Pais	The garden was established to commemorate the victory over the Dutch invasion in June 1622
Jardim de Vasco da Gama	4248	Rua de Ferreira do Amaral	In Memory of Vasco, the Portuguese Navigator
Ponte Governador Nobre de Carvalho Harbourfront	104,138	Ponte Governador Nobre de Carvalho	Includes European-style buildings and one of the most scenic bays in Southeast Asia.
Rua Central-Rua de S. Lourenço-Rua do Padre António-Rua da Barra-Calçada da Barra-	10,093	Rua Central-Rua de S. Lourenço-Calçada da Barra	The center street of "Christchurch".
Praça de Ponte e Horta	2433	Southwestern Macau Peninsula	In Memory of the Governor of Macau, Ponte e Horta
Cemitério dos Parsees	1165	Estrada dos Parsees	Tomb of a Hindu who practiced the Persian religion.
Parque Municipal Dr. Sun Yat-Sen	52,660	Between Ilha Verde and Tamagnini Barbosa	A bronze statue of Dr. Sun Yat-sen was erected in the park.
Cemitério S. Miguel Arcanjo	16,885	Estrada do Cemitério	Planned cemeteries in Macau in the 19th century
Former site of Rua do Tarrafeiro Market	249	Travessa das Galinholas and Travessa do Alpendre	Ruins of early public markets in Macau
Jardim do Carmo	3513	Rua da Restauração	It is built on the mountain facing the sea, starting from the Kama Church at the top and ending at the Residence Museum at the bottom.
Feira Do Carmo	72	Rua Direita Carlos Eugénio	As the only remaining early public market in Macau, it has been preserved in its original form and location.
Waterfront from Coloane Pier to Largo Tam Kong Miu	7123	Southwestern part of Coloane Island	Numerous scenic spots along the route, including Rua de S. Francisco Church, Coloane Library, Coloane Children's Park and Tam Kong Miu, etc.
Areas at or above 80 m above sea level on Coloane Island	1,278,610	Coloane	There are eight walking trails on the mountain with a total length of 25,310 m. There are more than 2,000 species of trees, shrubs and herbs along the trails.
Lai Chi Vun Shipyard Area	21,849	Estrada de Lai Chi Vun	Shipbuilding craftsmanship in the mid-to-late 20th century, the life cycle of Lai Chi Bowen Village formed by the shipbuilding industry, the village morphology and the landscape cycle of the whole area

Source: compiled by the author based on the information of the Macau Cultural Affairs Bureau's assessed immovable properties (built heritage).



Figure 8. Distribution of World Heritage Sites in the Historic Centre of Macau (Label A–H connect with Table 2). (Image source: drawn by the author).

4. Macau’s Urban Ecology and Sustainable Utilization: Recommendations for Planning Strategies Based on Analysis and Results

As a carrier of natural resources such as mountains, forests, lakes, and seas, the green open space in Macau’s outlying islands ecological reserve should aim to protect the natural landscape and waters as much as possible, restrict the use of the land in the reserve for constructive development in order to obtain good ecological and environmental benefits, and constitute a “green lung of the city” and a place for the preservation of biodiversity. To achieve this objective, the relevant urban areas have to be planned to restrict the development and utilization of land within the protected areas. For example,

(1) How can we maximize the protection of natural landscapes and waters in Macau's outlying islands ecological reserve? (2) What specific measures should we take to safeguard these critical natural resources? (3) What strategies are needed to ensure that the ecological reserve provides the ecological services required by the city and protects biodiversity?

In order to achieve this goal, the relevant urban planning strategy should start with land use planning and management to protect mountainous forests and vegetation areas, ecological water bodies, and natural shorelines, and to ensure the integrality of the existing wetlands, water bodies, and coastlines. At the same time, it is necessary to integrate the open space of the mountains, water bodies, and green spaces of Macau's outlying islands and to connect the green spaces and water nodes through the "green network", forming an organically interconnected blue-green network and communicating the landscape connection between surface waters and green spaces, so as to realize the structural layout proposed by Macau's urban master plan: The structural layout proposed in the *Macau City Master Plan* is to realize the "Green Axis", linking up the significant natural spaces such as the major hills, green areas, and waterfront wetlands in Coloane, enhancing the ecological fabric of the city. The specific planning strategy should cover the following contents:

4.1. Recommendations for Planning Strategies: Enhance Ecological Conservation of Mountains, Forests and Wetlands, and Strictly Control Excessive Construction

As Macau continues to reclaim land, its land area continues to increase, the area of ecological landscape and green space on Macau's outlying islands decreased between 2010 and 2020. The reasons for this are mainly due to the expansion of the surrounding urban construction land, which has reduced the scale of some scenic woodlands and ecological wetlands, as well as the uncontrolled expansion of housing by local residents and the establishment of functional areas for barbecue, hiking, cycling, and other service facilities by individual organizations in the scenic woodlands. To a certain extent, these behaviors have affected the fundamental quality of Macau's ecological environment and adversely affected the residents' leisure life, urban landscape, and biodiversity. Therefore, in order to protect the quality of the ecological environment of the Macau SAR and the long-term well-being of its citizens, it is necessary to emphasize strengthening the ecological conservation of mountains, forests, and wetlands in urban planning and management and to strictly control excessive construction.

Take the ecological pond in the western section of Wetland in Avenida da Praia, Taipa, for example. With an area of about 28 ha, it is the only remaining native mangrove wetland in the city of Macau. It is inhabited by many wild egrets, and the white egrets swirl and fly over the lake surface, creating a unique ecological landscape. The wetland was designated as an ecological reserve by the Macau SAR Government in 2001 because of the presence of the world's endangered black-faced spoonbill (Figure 9). However, the construction of large-scale gaming structures such as the Venetian casino building in the vicinity of the wetland has affected the habitat and feeding of the birds. The construction of an automated pedestrian walkway on the western side of the wetland, although convenient for tourists, interferes with the lives of egrets and birds.

From the perspective of urban planning and management, as the valuable "green heart" of Macau's urban area, Macau's outlying islands' mountainous forests and wetlands should be properly protected and enriched to enhance the quality of vegetation and improve the diversity of ecological communities and landscapes. In particular, in order to protect Macau's wild bird habitats, the protection of the natural habitats of the Mangrove Beach Wetland along the waterfront of the Estrada do Istmo and the ecological pond in the western section of the wetland in Avenida da Praia should be further strengthened so as to attract more wintering migratory and migratory birds to forage and roost in these habitats. In particular, studies should be conducted on the use of berry species to optimize the existing forest stands so as to increase the food supply for birds and improve their living environment.



Figure 9. Macau’s ecological pond in western section of wetland in Avenida da Praia surrounded by urban buildings. The green part in the right picture is the location of the open space green area. (Image source: photographed by the author.)

4.2. Recommendations for Planning Strategies: Make Full Use of Established Countryside Walking Trails and Improve Supporting Facilities

The Macau outlying islands ecological reserve provides Macau residents with valuable space for sports, leisure, and science education in a near-natural environment in a highly urbanized area. So far, the municipal authorities have developed 13 walking trails in the green areas of the mountains and the coastline of the ecological reserve, with a total length of 33,560 km, creating good conditions for Macau residents to enjoy nature (Table 4).

Table 4. Analysis of the current status of the countryside walking trails in Macau outlying islands ecological reserve.

No.	Name	Location	Length (m)	Scenic Features	One-Way Walking Time (min)
1	Circuito da Barragem de Ká Hó	Parque Natural da Barragem de Ká Hó	1550	The rest of the route is flat and spacious, except for the starting point which is uphill. Along the way, one can enjoy bird-watching and flower-watching, as well as seeing historical sites such as Hakka literature and Qing Dynasty ancient tombs. The trail connects with the Northeast Walking Trail of the Loop via a spur trail.	≈30
2	Circuito de Manutenção de Coloane	Estrada do Alto de Coloane	1225	It is the first health trail in the Coloane district, with nine fitness stations along the route, free use of sports equipment and two intersections with the Coloane Walking Trail.	≈25
3	Trilho da Taipa Pequena 2000	Parque Natural da Taipa Grande	4000	The first section of the trail is a 600 m-long eco-roaming trail with a gentle slope. The middle section is a stone fitness trail that leads to the highest point in Taipa (158.2 m above sea level), or a 1200 m bird-watching trail that heads southeast to enjoy the flight of egrets and the beautiful view of Taipa Island.	≈90

Table 4. Cont.

No.	Name	Location	Length (m)	Scenic Features	One-Way Walking Time (min)
4	Trilho da Taipa Pequena 2000	Trilho da Taipa	2300	It is a 2.5 m wide walking trail that loops around the entire hill of Trilho da Taipa, with 5 fitness stations, children's play area and sitting area. Along the trail, you can enjoy the view of Macau Peninsula, Taipa and Hengqin Island in Zhuhai.	≈50
5	Trilho de Coloane	Estrada do Alto de Coloane	8100	The trail is set on a hillside at an average elevation of 100 m and circles around the central plateau of the Loop, offering beautiful views of the Loop and a variety of plants and birds along the way. It is the longest hiking trail in Macau.	≈150
6	Rede de Trilhos do Nordeste de Coloane	Located on the hill to the east of Seac Pai Van	4290	The Walking Trail, with an average elevation of 55 m above sea level, is a nature education trail with 10 stations. Among them are the Acacia Forest Trail and the Golf Trail, which offers views of the golf course, Ká Hó Village and Ká Hó Reservoir.	≈90
7	Circuito da Barragem de Hac Sá	Parque Natural da Barragem de Hac Sá	2650	Located high on the hillside, the trail encircles the reservoir and offers views of the Hac Sá Reservoir and the beautiful ocean view of Praia de Hac Sá. The trail is connected to the Coloane Walking Trail.	≈55
8	Circuito de Manutenção da Barragem de Hac Sá	Parque Natural da Barragem de Hac Sá	1505	Along the route, there are 9 fitness stations with gentle surfaces. Visitors can use the fitness stations to do simple exercises or jogging while enjoying the view of Hac Sá Reservoir.	≈30
9	Trilho do Morro de Hac Sá	Southwest of Coloane Trilho do Morro de Hac Sá	2150	It is a circular walking trail, which is divided into three sections, namely the Rock-watching Trail, the Sea-watching Trail and the Red Leaf Trail. It is the only open space amongst the walking trails in Macau where you can get close to the mountains and the sea at the same time and touch the nature.	≈45
10	Trilho do Altinho de Ká Hó	Parque de Merendas do Altinho de Ká Hó	1490	The trail starts from a 280 m-long staircase with a drop of up to 50 m. After reaching an elevation of 100 m, the trail circles around the Central Hill, enjoying stunning views of the reservoir and golf course, and has branch trails leading to the Coloane Walking Trail and the Parque Natural da Barragem de Hac Sá.	≈30
11	Trilho do Parque de Seac Pai Van	Parque de Seac Pai Van	1680	The trail has a number of branch trails, one of which is a 935 m long nature education trail with 24 interpretive stations.	≈40
12	Caminho Antigo de Seac Mín Pun de Coloane	Hác Sá	1500	It is the most historic and oldest road in Coloane. It crosses the east and west valleys and has a tortuous path.	≈35
13	Trilho à Beira-Mar de Long Chao Kok de Hac Sá	Praia de Hac Sá	1120	Located at the southernmost tip of Macau, it extends from Praia de Hac Sá Villa Compound to the west to Chuk Wan Beach Villa Compound. The landforms along the route maintain the coastal characteristics with rich vegetation species, such as small-leaved sea golden sand, pigweed, and fallen roots.	≈25
	total		33,560		

Source: authors' tabulation based on records of the Macau Municipal Affairs Bureau and data from on-site surveys.

At present, there are still problems with insufficient supporting facilities for the established walking trails in the Macau ecological reserve. For example, some remote walking trails (Figure 10) do not have full coverage of mobile communication network signals, and there is insufficient parking space at the entrances, causing certain difficulties for the public to use the trails. In this regard, there is a need for planning and coordination, prioritizing the construction of essential infrastructure such as fire and rescue roads, mobile communications and sanitary latrines, etc., and improving the service reception capacity of existing country walking trails as well as opening up new trails in an appropriate manner.



Figure 10. Macau's Rocha da Garra do Dragão Coastal Walking Trail Winding through the Mountains and the Sea (image source: photographed by the author).

4.3. Recommendations for Planning Strategies: Make Full Use of Established Countryside Walking Trails and Improve Supporting Facilities Establishing Country Parks and Scenic Woodlands as Nature Education Bases for the Public

There are four existing country parks on Macau's outlying islands that are very popular among Macau residents, namely Parque Natural da Taipa Grande, Trilho da Taipa Grande, Parque Natural da Barragem de Hac Sá, and Parque de Merendas da Barragem de Ká Hó, with an area of 1.82 million m². Together with the surrounding scenic woodlands, the total area is about 5.3 million m², which constitutes the main part of Macau's outlying islands' ecological protection and open space. Among them, the Parque Natural da Barragem de Hac Sá is located in the forested area in the southeast of the Central Hill of Coloane Island, which is developed from the original Parque Natural da Barragem de Ká Hó and Water Park together with the surrounding supporting facilities. Near the dam of the reservoir, there is a skate park, a plant maze, a play area, barbecue, picnic and camping sites, a family trail, and a health trail with pleasant scenery. The trails and aquatic plant areas in the park serve as a base for ecological conservation and science education. The Parque Natural da Barragem de Ká Hó is located to the northeast of Coloane Island, with the Parque Natural da Barragem de Ká Hó and its surrounding scenic woodland as the main landscape. The park has established facilities such as the Coloane North-East Hiking Trail Network, the Ká Hó Reservoir Lakeside Trail, the Ká Hó Freshwater Wetland, the dam mural (Figure 11), a barbecue area, a picnic area, and toilets. The Parque Natural da Barragem de Ká Hó Experience Camp in the park is available for schools and organizations to apply for to experience nature education and camping.



Figure 11. Parque Natural da Barragem de Ká Hó main entrance view. The traditional Chinese in the picture is the place name. (image source: photographed by the author).

Looking to the future, Macau's country parks and scenic woodlands on the outlying islands should further optimize their construction contents through planning (Figure 12), such as the lack of effective management of green heritage spaces to enable the scientific construction of a nature education base that is "close to nature and people-oriented", protect land resources with valuable ecological value and safeguard biodiversity, and provide the public with a more natural and ecological open space environment full of scientific knowledge.



Figure 12. Village environment in the scenic woodland of Ká Hó mountain is in urgent need of planning control and optimization (image source: photographed by the author).

5. Discussion: Evidence on the Conservation and Utilization of Cultural Heritage Open Space

5.1. Cultural Routes in World Heritage Landscapes

Cultural routes are a way of presenting World Heritage properties in order to allow foreign visitors to learn about the cultural characteristics of the properties through the guidance of cultural routes. The International Committee on Cultural Monuments and Historic Sites (ICOMOS) defines “World Heritage Cultural Routes” as follows: Cultural routes generally refer to the linking of multiple heritage sites by means of a thematic story in order to achieve multicultural exchange and understanding. The background of the thematic story can be religious, cultural, or ethnic. A cultural landscape is a place of historical, aesthetic, ethnographic, or anthropological value formed by the interaction between human beings and the natural environment over a long period of time.

Specifically for Macau, this kind of “cultural route” mainly refers to the 22 heritage buildings, 8 largos, and the linear space formed by the connection of the early Portuguese streets in the Historic Center of Macau [22,23], which are listed in the World Heritage List, as shown in Figure 13. In Figure 13, the blue line on the left is the Cultural Route of the Historic Center of Macau, linking the Chinese and Western religious elements, the cultural background, the Portuguese and Chinese living quarters, and other characteristics of the area along the route. The blue line on the right is the area for the protection of the cultural heritage of the Guia Lighthouse, located at the top of the Guia Hill, the highest peak of the Macau Peninsula, and the sanctuary of the Igreja de Nossa Senhora da Guia. From an aesthetic point of view, the Shrine of Igreja de Nossa Senhora da Guia is a perfect combination of Chinese and Western artistic painting techniques, which is reflected in the colorful frescoes on the vaults and walls of the building. The Guia Lighthouse is the first modern lighthouse on the coast of China. It is of outstanding historical value, with a scenic vista overlooking the entire Macau Peninsula, witnessing the historical changes of Macau over the past 500 years of the fusion of Chinese and Western cultures.

For Macau’s World Heritage landscape and cultural routes, the cultural heritage open space planning strategy of “prioritizing preservation and restoring the old as the new” should be adopted, covering four specific aspects: (1) Carefully protect the overall landscape of Macau’s historic city center so that the open space in the street area and the historic architectural landscape can maintain their characteristics in the long term and reflect each other. (2) The overall landscape and environmental style of the World Heritage Area should be uniform and continuous. Important nodes in the historic district should highlight the main landscape features and construct a rhythmic sequence of appreciation spaces. (3) The green landscape environment around the historical buildings and the Largo space should be harmonized with the unique style of Macau’s streets and lanes. (4) Make use of building recesses, corners, open spaces between buildings, sitting-out areas, sidewalks, parking spaces, etc. in the historic streets to increase greening as much as possible. To actively promote the implementation of three-dimensional greening on the walls and facades of buildings along the streets, so as to improve the landscape of heritage and cultural routes.

5.2. Distinctive Heritage Precincts

The characteristic heritage streets in the Historic Centre of Macau are a popular tourist destination for both Chinese and foreign tourists, including the pedestrian streets of the Historic Centre starting from the Largo do Senado and ending at the Calçada de S. Francisco Xavier. It combines heritage attractions with pedestrian alleys, linking up the space of the heritage area in a “point-line-plane” manner. The pedestrianized streets and lanes include the following: Largo do Senado—Travessa de S. Domingos—Largo da Sé—Travessa da Sé—Largo de S. Domingos—Rua de S. Domingos/Travessa do Soriano—Rua da Palha—Rua de S. Paulo—Largo da Companhia de Jesus—Rua da Ressurreição—Travessa da Paixão—Calçada de S. Francisco Xavier (Figure 14). They can be categorized into two types: (1) the

square-type streets represented by the Largo do Senado; and (2) the pedestrian alleyways represented by Travessa da Paixão (Figure 15).

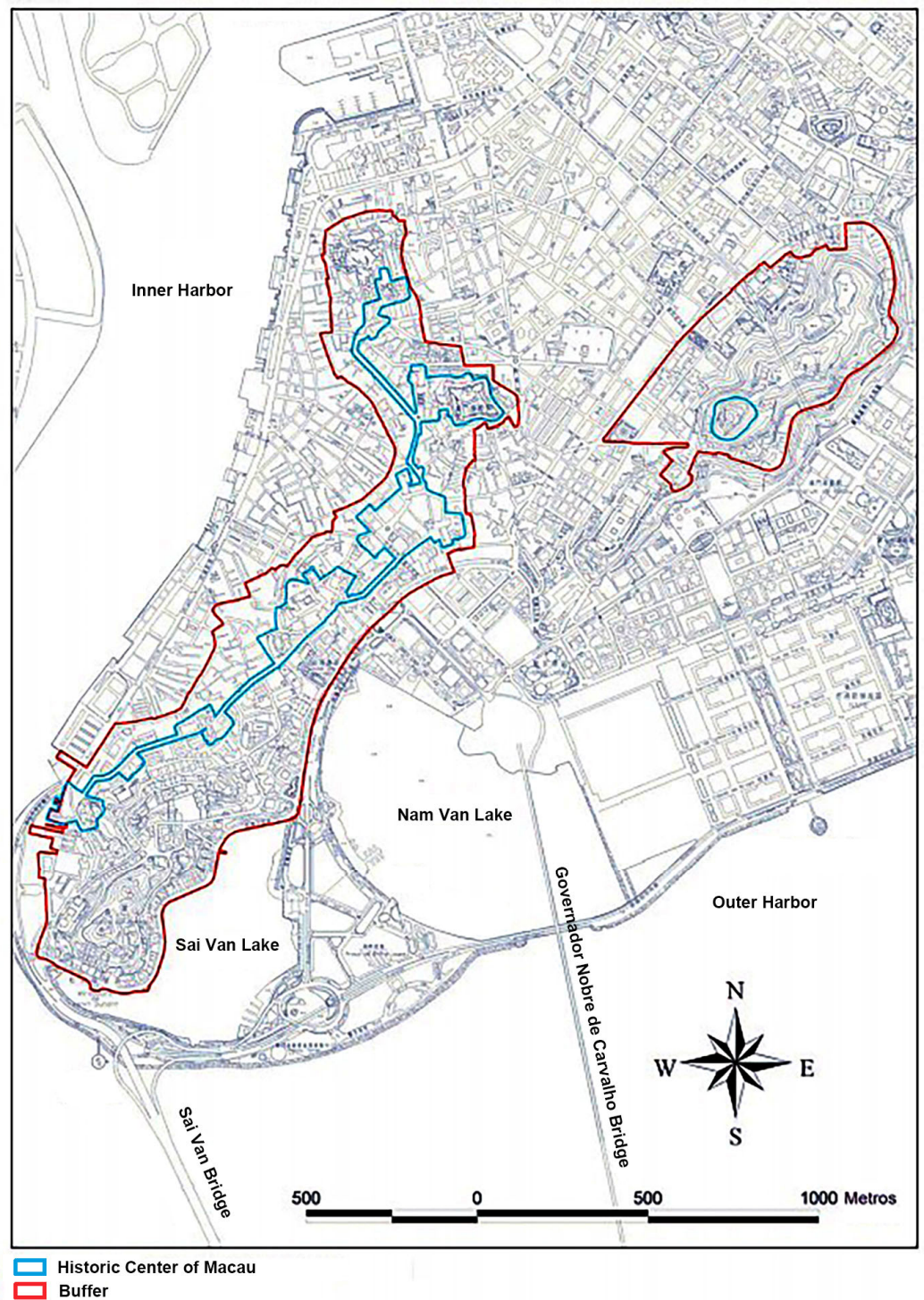


Figure 13. Scope of the World Heritage Cultural Routes in the Historic Centre of Macau. The traditional Chinese in the picture is the place name. (image source: Imprensa Oficial—Government Printing Bureau, 2013).

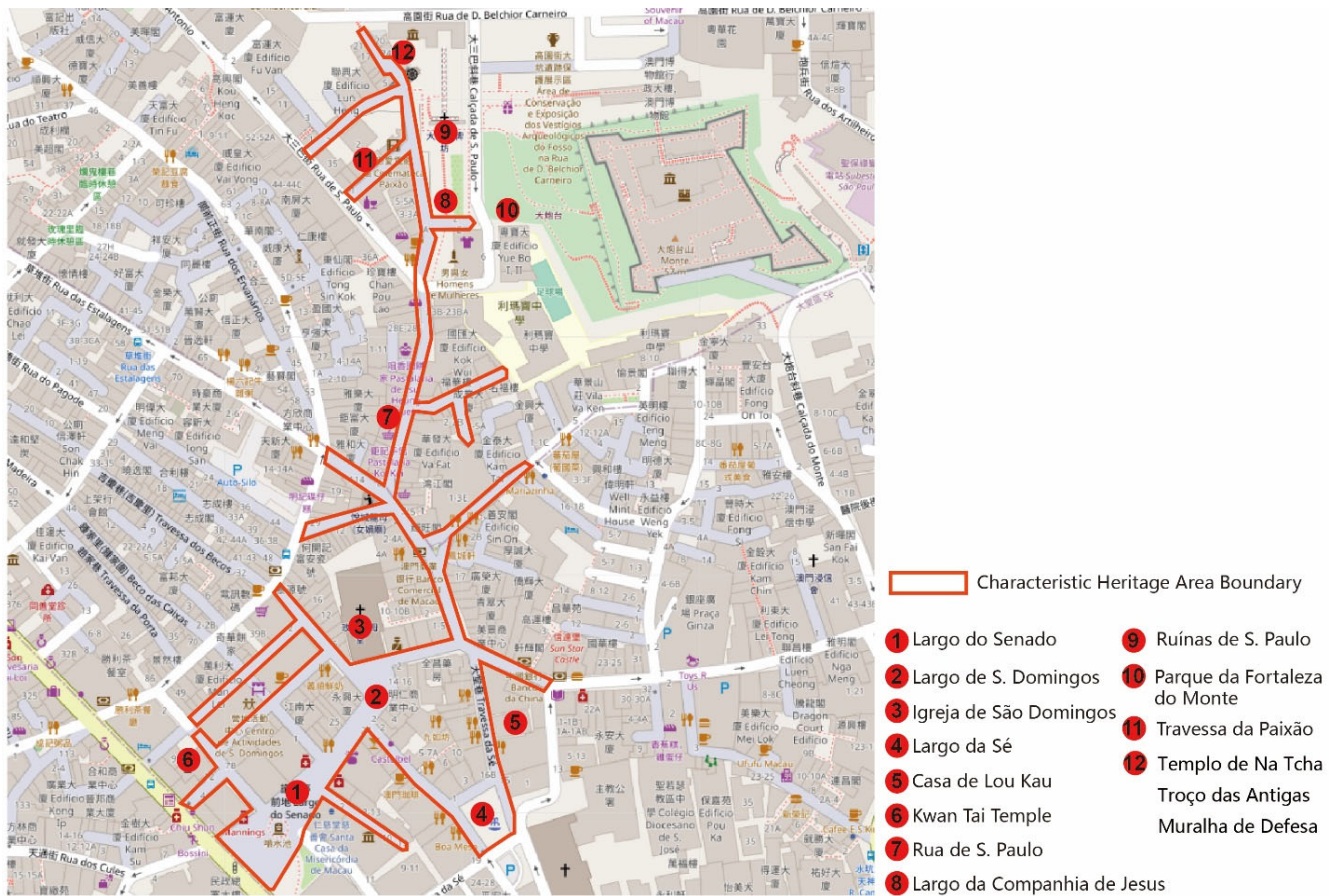


Figure 14. Characteristic heritage areas in the Historic Centre of Macau. The traditional Chinese in the picture is the place name. (image source: drawn by the author).

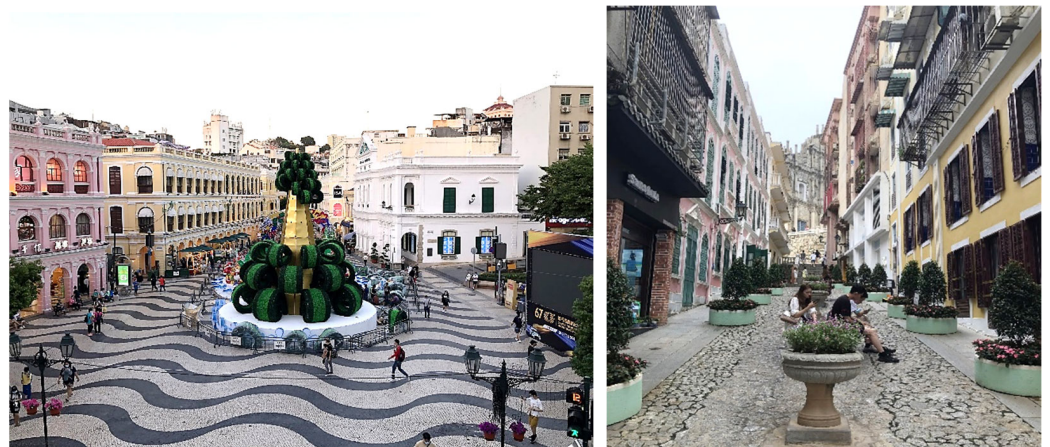


Figure 15. The Largo do Senado (left) and Travessa da Paixão (right) on the Macau Peninsula (image source: photographed by the author).

Macau’s distinctive heritage districts include the following historical and cultural assets: Largo do Senado, Largo de S. Domingos, Igreja de São Domingos, Largo da Sé, Casa de Lou Kau, Kwan Tai Temple, Rua de São Paulo, Largo da Companhia de Jesus, Ruínas de São Paulo, Parque da Fortaleza do Monte, Travessa da Paixão, Templo de Na Tcha, and ruins of the old city walls (Figures 14–16).



Figure 16. Illustration of the World Heritage Characteristic Neighborhoods of the Macau Peninsula (image source: drawn by the author).

In addition to the “Historic Centre of Macau”, which has been inscribed on the World Heritage List, Macau’s distinctive heritage districts also include other historic districts, such as Taipa’s Rua da Cunha and Coloane’s Largo do Presidente António Ramalho Eanes. The planning strategy for the preservation and inheritance of open space should include three aspects: (1) Conform to the international trend of changes in the way of conservation of historic districts and pay attention to the conservation of the areas surrounding the historic monuments; that is, from the conservation of tangible heritage such as historic buildings, heritage units, and streets and lanes of the old city to the conservation of the overall atmosphere, including the surrounding landscape environment. As stated in the Venice Charter [24], “the essentials of a historic monument include not only a single building but also an urban or rural environment in which a unique civilization, a meaningful development, or a historical event can be identified. The protection of monuments involves the protection of the environment on a certain scale. Where a traditional setting exists, it must be preserved, and no new construction, demolition, or alteration that results in a change of subject matter or color relationships is permitted”. (2) The inheritance of distinctive heritage districts is different from the conservation of cultural relics by heritage units, which requires the maintenance and utilization of their reasonable functions so that they can become an indispensable part of Macau’s urban life. For an international tourist center city like Macau, it is necessary to cultivate the characteristic heritage districts as much as possible to become landmark tourist attractions and popular tourist industry activity gathering places [25–27]. (3) The spatial form and landscape image of distinctive

heritage districts should be maintained on the basis of the traditional style through planning, coordination, and market guidance, combined with the application of new technologies and materials, and constantly adapted to the aesthetic needs of contemporary people, so as to make them both “still elegant” and “always new” (Figures 17 and 18).



Figure 17. The Travessa da Misericórdia, a characteristic heritage area of the Macau Peninsula (image source: photographed by the author).



Figure 18. Rua da Cunha, Macau’s outlying island heritage district. The traditional Chinese in the picture is the name of the place and the sign of the store. (image source: photographed by the author).

6. Conclusions

The paper has provided a comprehensive analysis of the spatial planning strategies for urban ecology and heritage conservation in Macau, an ultra-high-density city facing unique challenges. We have investigated the distribution of cultural heritage-type open

space resources and proposed planning strategies for key conservation and utilization targets. Our findings highlight the importance of integrating ecological conservation with urban planning to enhance the quality of life for Macau's residents and contribute to the discourse on sustainable urban development.

In line with the suggestions provided earlier, we have emphasized the need for a unified urban development framework that considers historical sites, cultural landmarks, and natural ecosystems simultaneously. The creation of a "green network" connecting various green spaces and cultural heritage areas in the city not only provides habitats for wildlife but also offers leisure and educational spaces for citizens. Macau's ecological reserve resources are mainly concentrated in the outlying islands, with a total area of about 5.76 km², which is a valuable "green heart of the city" and biodiversity-protection area. The green open space in the area should mainly protect the natural green areas and natural waters as much as possible and restrict the constructive development and utilization of the land in the area from the planning, so as to constitute the "green lung of the city" and the biodiversity-conservation area, in order to obtain good ecological and environmental benefits. The planning strategy for the sustainable use of the ecological reserve should start with land use planning and management, so as to protect the ecological area of the wetland, the water body, and the natural shoreline as a whole. At the same time, by combining the open space of mountains, water bodies, and green areas on the outlying islands, we should connect various types of green areas and water nodes through a "green network", so as to build a blue-green spatial network that is organically connected and to communicate the landscape connection between surface water bodies and green spaces, so as to realize the linkage of the "green toughness axes". This will realize a structural layout that connects natural spaces such as major mountains, green areas, and waterfront wetlands with a "green network". Specific strategies include: (1) strengthening ecological conservation of mountains, forests, and wetlands and strictly controlling excessive construction; (2) making full use of the established countryside walking trails and improving the supporting facilities; and (3) To establish national parks and scenic forests as hubs for public nature education. On the other hand, the conservation of cultural heritage and ecological green spaces align in Macau could be present as: (1) Integrate cultural heritage protection and ecological green space planning into a unified urban development framework. This means considering the value of historical sites, cultural landmarks and natural ecosystems simultaneously in urban planning and decision-making; (2) By creating a "green network" to connect various green spaces and cultural heritage areas in the city. Such a network can be a physical green space, park, walking path, or a visual corridor or ecological corridor, which not only provides habitats for wildlife, but also provides leisure and education space for citizens.

Macau is a world-renowned historical and cultural city. In 2005, UNESCO inscribed the Historic Center of Macau on the World Heritage List. There are two main types of open space resources in Macau's cultural heritage: first, the eight Largos listed in the World Heritage List, and second, the "place-type" urban open space with cultural heritage value, including some selected cultural heritage open space resources.

- (1) The World Cultural Heritage landscape and cultural routes, including the 22 heritage buildings, 8 largos, and the linear spaces connected by the early Portuguese streets in the "Historic Centre of Macau", should adopt the planning strategy of "prioritizing preservation and restoring the old as the old" for the cultural heritage open space resources. Open space planning strategy: carefully protect the overall landscape of the Historic Center of Macau so that the open space of the district and the historical architectural landscape can maintain their characteristics in the long term and reflect each other. Important nodes of the Historic District should highlight the main landscape characteristics and construct a rhythmic sequence of appreciation spaces; the green landscape environment around the historical buildings and Largo space should be built and repaired in harmony with the unique style of Macau's streets and lanes; and the implementation of three-dimensional greening along the walls and facades

of the buildings along the streets should be actively promoted so as to improve the scenery of the world heritage cultural routes.

- (2) Characteristic heritage districts, including the pedestrian streets of the historical districts on the Macau Peninsula starting from the Largo do Senado and ending at the Calçada de S. Francisco Xavier, as well as the open space resources of the outlying islands' historical districts, Rua do Cunha and Largo do Presidente António Ramalho Eanes, etc. They can be broadly categorized into two types: square-type streets, represented by the Largo do Senado, and pedestrian alleyways, represented by the Travessa da Paixão. Characteristic heritage area protection and inheritance of the appropriate way through the planning of pedestrian streets and lanes linked to heritage attractions, cultural heritage space, convenient for citizens and tourists to use. The main planning strategies are: (a) Follow the international trend of changes in the protection of historic districts, from the protection of a single historic building to heritage units, old city streets, and other tangible heritage, extended to include the surrounding landscape environment, including the protection of the overall atmosphere of the district. (b) Maintain and give full play to the reasonable use function of the characteristic heritage street area as far as possible, so that it becomes an indispensable part of Macau's urban life, and cultivate it into a landmark tourist attraction and a popular gathering place for tourism industry activities. (c) The spatial form and landscape image of the distinctive heritage street area should be maintained on the basis of the traditional style through planning, coordination, and market guidance, combined with the application of new technologies and materials, and constantly close to the aesthetic needs of contemporary people, so as to make it not only "still elegant", but also "always looking new".

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