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Resilience Value and Recovery: The Symbiotic Relationship between Classical Gardens of Suzhou and the Historic Urban Water System

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Abstract

The World Heritage property Classical Gardens of Suzhou (CGS) comprises water-focused cultural landscapes closely integrated with the historic urban water system (HUWS) of the ancient city of Suzhou in China. Historically, the gardens and the water system developed together, influencing and complementing one another in a symbiotic relationship. In response to the combined pressures of climate change and rapid urbanization, the resilience value – that is, the inherent capacity to adapt to and withstand environmental stresses – embedded in this relationship offers critical insights for urban planners, ecologists and cultural heritage agencies working to improve the flood and ecological resilience of gardens and ancient cities. This article surveys relevant scholarship and draws on field visits and interviews. It focuses on the resilience value of the symbiotic relationship that developed between the gardens and the urban water system and reviews key policies and practices since the 1950s. It summarizes efforts that have helped revive the symbiotic relationship and proposes strategies to further promote the recovery of this relationship by drawing on its embedded resilience value to enhance the resilience of both the gardens and the city of Suzhou.

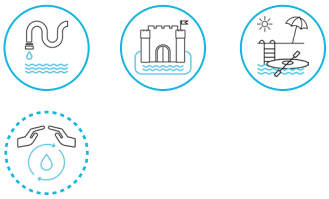
Policy Recommendations

- Treat CGS and HUWS as a single organism and comprehensively restore their symbiotic relationship.
- Ensure the connectivity of gardens, rivers, lakes and wetlands, and strengthen the exchange of ecological materials and the functions of risk transmission between CGS and HUWS. Enhance the restoration and, when necessary, rebuild historic waterways, reconnect isolated waterways to improve long-term water system connectivity, and restore the ecological systems of gardens and urban water bodies.

KEYWORDS

UNESCO World Heritage
Classical Gardens of Suzhou
historic urban water system
symbiotic relationship
resilience value

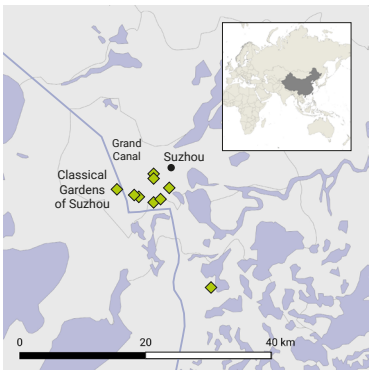
WATER ICONS



CLIMATE



Cfa: Humid subtropical climate



< Fig. 1 Pond in the eastern garden of Couple's Retreat Garden, Suzhou (Source: Yapeng Ou, 2025).

Introduction: Classical Gardens of Suzhou and Historic Urban Water System

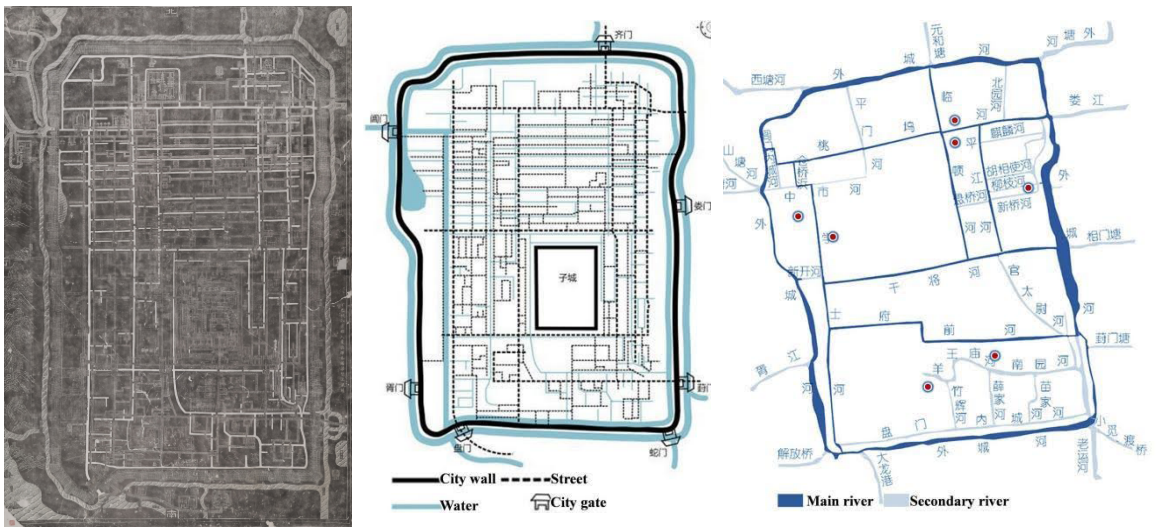
Classical Gardens of Suzhou, added to the World Heritage List in 1997, comprises "complex landscapes of pavilions, terraces, towers, rocks, hills, streams, and pools" created with "great subtlety and skill in a small area, re-creating natural beauty and harmonizing natural and human aesthetics" (ICOMOS 1997). Renowned for being "artificial yet comparable to a natural wonder," the gardens mark the pinnacle of Chinese classical "mountain and water gardens." Today, nine gardens[1] are included in the UNESCO World Heritage property. Mimicking the natural world, the gardens incorporate natural elements like water, rocks, plants and cultural elements such as buildings of aesthetic, literary and poetic significance (fig. 1). Together, they reflect the unique design philosophy of Eastern classical gardens, which revolves around the core principles of "emulating Heaven and Earth" and "water management and landscaping." They embody the concept of a living environment centered around "mountains and waters" and "unity of Heaven and Humanity" (Zong 1981). Historically, the gardens' formation and development were closely related to the highly developed water system in the ancient city of Suzhou (Wu 1991; Zheng and Li 2009). The city follows the design and construction concept of water–city integration, with a spatial pattern shaped by excavated canals (Wu 1991; Yu 1986). Since the Song Dynasty (AD 960–1279), Suzhou has been one of the Chinese cities with the largest and most comprehensive urban water networks and densest waterways.

Throughout history, this well-developed urban water system established the foundation for water landscaping in CGS (fig. 2). As a result, CGS co-evolved with HUWS. Overall, through the coordinated construction of urban water networks and gardens, Suzhou has achieved city–water harmony, city–landscape integration, and resilient development based on the connectivity of its water system. The inherent symbiotic relationship between CGS and HUWS, along with its associated resilience value, provides a fundamental basis for coordinated protection of the gardens and HUWS in the face of climate change. They also provide a model of water system planning for flood resilience (Zhu 2018).

However, since the early 1900s, modern urban construction has undermined the symbiotic relationship and co-evolution between CGS and HUWS. Amid urban economic growth and rapid population increase, waterways were filled in to create roads and housing throughout the Ming and Qing dynasties (AD 1368–1912). The density of waterways has continued to decrease (fig. 3), with a reduction from 5.8 kilometers per square kilometer in the Song Dynasty to 2.5 kilometers per square kilometer in the 1990s (Wu 1991).

Since large-scale urban construction started in the 1950s, this problem has progressively worsened. For various reasons, most of the water sources in CGS were disconnected from the external urban water system (Chen et al. 2014; Wu et al. 2012). Meanwhile, large-scale infrastructure construction has disrupted groundwater connectivity, while overextraction has caused a significant decline in its volume and level (Wu et al. 2012). This has led to the disconnection of both internal and external water sources, including underground and surface water sources of CGS. The water bodies in the gardens face

1. The nine gardens are the Humble Administrator's Garden, Lingering Garden, Net Master's Garden, Mountain Villa with Embracing Beauty, Canglang Pavilion, Lion Grove Garden, Garden of Cultivation, Couple's Retreat Garden, and Retreat and Reflection Garden.



^ Fig. 2 From left: a) Pingjiang Prefecture Map Stele (平江府图碑) from AD 1229 showing temples, bridges, rivers and city walls of Pingjiang (Suzhou) during the Southern Song Dynasty (Source: Suzhou Museum of Inscribed Stone Tablets); b) Plan of Pingjiang in the Song Dynasty (AD 960–1276) (Source: redrawn based on Hanchu Yin, 2021); c) Suzhou's current urban water system with seven classical gardens within the city wall inscribed as World Heritage (Source: redrawn based on Sha Shi, 2017).

difficulties not only in obtaining water from the urban water system, but also in discharging (rain)water outward. In addition, their small size and poor self-purification ability have compromised their ecological stability, leading to varying degrees of eutrophication. This has affected the expression and presentation of garden landscape aesthetics (Chen et al. 2014; Wu et al. 2012) and weakened the gardens' flood and ecological resilience, as evidenced by the severe inundation of Canglang Pavilion following a heavy storm in 2024. Considering the growing climate crisis, restoring the symbiotic relationship between CGS and the urban water system is essential for the sustainability of CGS.

Academic and other authorities have long overlooked this symbiotic relationship, let alone its embedded resilience value. Existing research predominantly focuses on the heritage value of CGS and their conservation. At the same time, the limited studies addressing Suzhou's HUWS remain confined to isolated examinations of its structural morphology, construction techniques, landscape aesthetics and historical evolution. Meanwhile, within cultural heritage conservation practice, there is a notable absence of integrated approaches that coordinate the conservation of CGS and HUWS. To fill this dual gap, this research aims to reveal the resilience value embedded in the symbiotic relationship that once existed between CGS and HUWS and propose strategies to restore it. To this end, we first examine the nature and resilience value of the symbiotic relationship between CGS and HUWS. We then review the policies and practices of CGS and HUWS since the 1950s and identify shortcomings. Finally, we summarize the efforts made so far that have been conducive to restoring the symbiotic relationship between CGS and HUWS. On this basis, we propose strategies to promote the relationship's recovery by leveraging the embedded resilience value in response to the urgent need to enhance the resilience of both gardens and city.

Our research employs a qualitative methodology that first entailed a review of journal articles, monographs and government documents concerning CGS and HUWS of Suzhou. We then visited representative gardens, including Canglang Pavilion and Couple's Retreat Garden, as well as historic districts of Pingjiang, Humble Administrator's Garden and Changmen Gate to investigate current water body conditions, connectivity between CGS and HUWS and water ecological restoration practices. During field visits, interviews were conducted with elderly and long-term residents to gather information on changes in HUWS, community-water relationships and neighborhood flooding. Finally, we interviewed a senior planner and water conservancy engineer, who provided an expert perspective on the evolution of HUWS, restoration practices and ongoing planning initiatives.

The Symbiotic Relationship between Classical Gardens and the Historic Urban Water System and Its Resilience Value

Connotation of the symbiotic relationship

The gardens in the World Heritage property not only embody traditional Chinese gardening art but also form a comprehensive water cultural landscape closely integrated with Suzhou's unique urban water system. Historically, the two have been closely connected and have influenced and complemented one another, forming the "bloodline" of Suzhou (Lv 2017). First, CGS's water system and Suzhou's water system shared the same source, forming the urban water environment. The water sources of CGS fell into two categories: 1) direct water intake from the urban water system, and 2) water intake from wells drilled at the bottom of ponds (Wu et al. 2012; Zheng and Li 2009; Zhu 2018).[2] In both cases, garden water bodies were connected with urban surface water or urban groundwater. This is due to the site selection characteristics of CGS, which emphasize the presence of water bodies and water systems within or around the site, as well as proximity to or connection with waterways (Xu and Ma 2021).

Second, CGS and HUWS were not merely physically connected but formed a co-evolving system, reflecting a symbiotic relationship shaped by mutual adaptation (Zheng and Li 2009). Specifically, the overall layout, building placement and vegetation arrangement of the garden were not determined solely by the preferences of the garden owner. Instead, they developed in response to the urban water system, evolving alongside its historical transformation (Zheng and Li 2009). On one hand, CGS benefited from being connected to HUWS, which offered favorable conditions for water-focused garden design and landscaping. This also influenced the location and distribution of gardens, as their development and decline closely followed changes in the urban water networks (Lv 2017). Meanwhile, different water environments (e.g., canal morphology, water flow direction) also stimulated the development of various garden water landscaping methods and aesthetic pursuits. On the other hand, the construction of the gardens also changed the distribution of urban waterways. For example, in Suzhou's urban fringe, where gardens are concentrated, waterways became sporadic (Zheng and Li 2009).

Finally, the integrated construction of CGS and HUWS as a holistic system has not only enhanced aesthetic and ecological functions but

2. According to Zheng and Li (2009), 60–70 per cent of the water sources of CGS come from the urban waterways diverted from the Grand Canal, 30–40 per cent from groundwater, and only a few from underground springs (Zheng and Li 2009).



^ Fig. 3 Evolution of Suzhou's historic urban water system from AD 1229 to AD 1797 (Source: Hanchu Yin, 2021).



^ Fig. 4 Scheme of the connection between the water system of the Couple's Retreat Garden and the urban water system (Source: Google Maps; photos by Yapeng Ou, 2025).

also strengthened the resilience of both the gardens and the city. Territorial, urban and garden water systems together form a "primary-secondary-branch" network (Zhu 2018), ensuring that both gardens and the city could play a long-term role in ecological and flood resilience.

Resilience value of the symbiotic relationship

Owing to the integrated construction and complementary relationship between CGS and the city, they have become a "resilient ensemble" capable of coping with external pressures such as

extreme weather and habitat disturbances. This is one of the reasons why Suzhou, despite being surrounded by numerous water bodies outside the city and low and flat internal terrain, has seldom suffered from floods in its history (Yu and Liu 2018). CGS and the urban water system have undergone thousands of years of adaptive co-evolution, forming a relatively stable overall structure that has sustained a multifunctional system capable of regulating microclimates and water ecology and of avoiding water disasters.

Historically, the stable operation of this system enabled CGS and the city to not only cope with natural disasters such as floods and droughts but also to respond flexibly to the needs of urban development, creating a highly adaptive and livable environment. First, thanks to the connected waterways, clean water flowed continuously into the city, reducing pollution (Wu 1991). This not only purified the urban water environment but also provided a reliable water source for the gardens. Second, ponds and channels in the gardens were connected to the urban water system (fig. 4), forming a comprehensive drainage and water storage system that could regulate runoff, alleviate floods, and enhance the overall disaster resistance of the city. Additionally, the symbiotic relationship between CGS and the urban water system helped regulate the microclimate and provided diverse habitats, thereby maintaining biodiversity.

Protection of Classical Gardens and Historic Urban Water System

Stage of protecting garden architecture while neglecting the urban water system

Beginning in the 1950s, municipal and CGS management authorities began to overlook the symbiotic relationship between CGS and the urban water system. Until the 1990s, although the gardens were protected, the urban water system and water environment suffered continual damage. In 1952, the Suzhou Garden Management Office was established and arranged for folk craftsmen from Xiangshan to restore the gardens. The period from 1953 to 1957 saw the first wave of garden restoration. In 1979, fourteen gardens were restored, marking a new wave of restoration (Xia 2021). These early efforts to conserve the gardens mainly focused on maintaining individual buildings and garden elements, emphasizing the stability of the structures and preserving the building style. They prioritized well-known gardens due to financial limitations and a "monument-centric" historic preservation ideology. Regarding the protection of garden water systems, given their limited connection to external water sources that saw declining water quality due to pollution, measures were widely implemented to disconnect the gardens from the urban water system. This was seen as necessary to prevent pollution from outside sources and to keep the water bodies within the gardens manageable (Chen et al. 2014). In sharp contrast, since the 1950s, as many as 23 waterways have been filled in, totaling 16.32 km (Shi et al. 2017), and domestic and industrial sewage have been discharged directly into these waterways. The integrity of the urban water system was damaged, and the water's ecological environment continued to deteriorate. From the 1970s to the late 1990s, the urban water system experienced problems such as water pollution, stagnation, continuous shrinking of waterway length and an increase in silted sections and dead-end waterways (Zhou and Ruan 1998).

Prioritizing the protection of the gardens over that of the urban water system has resulted in a loss of the resilience value of their symbiotic relationship. This isolated individual protection

method obscured the importance of the relationship between the gardens and HUWS, weakening their organic connectivity. For instance, the loss of waterway connectivity reduced the city's capacity to regulate floods and microclimates, thereby exacerbating its vulnerability to extreme weather events, such as heatwaves and sudden rainstorms (Wu 1991). With the gradual destruction of Suzhou's HUWS, characterized by the loss of waterways and deteriorating water ecology, as well as the replacement of waterways with drainage pipe networks, its regulation and storage capacity have decreased, leading to frequent inundation during typhoon seasons (Yu and Liu 2018).

By the late 1990s, the fragmented approach had already proven ineffective, prompting a paradigm shift toward integrated water system planning that recognized the interdependence of heritage preservation and ecological resilience.

Stage of highlighting the garden water body management and historic urban water system protection

Since the late 1990s, the protection of urban water systems has emerged as a new focus of urban heritage conservation. At this stage, the municipality introduced a series of regulations, measures and plans aimed at strengthening the protection of the HUWS. The "Regulations on the Protection of Urban Rivers in Suzhou City" (1996) stipulates that urban waterways must be protected, with priority given to their historical features. Following CGS's designation as a UNESCO World Heritage property in 1997, the city prioritized water system protection and restoration as a cornerstone of its heritage management strategy. In particular, HUWS protection has become a crucial lever for promoting the preservation of historical and cultural heritage (Jin 2024). The *Suzhou Urban Water Environment Governance Plan* (2007–2020) mandates reconnecting existing dead-end waterways to create a continuous network of flowing urban waterways. Additionally, *Protection Measures for Historical and Cultural Cities and Towns in Suzhou City* (2003) emphasizes the importance of maintaining the integrity and connectivity of the water system, as well as restoring the main waterways in key neighborhoods. With the advancement of protection concepts and the strengthening of an enabling environment, comprehensively implemented measures include water system restoration, urban water diversion projects, sewage treatment, waterway dredging and flood control facility construction.

During this stage, the water quality, safety and connectivity of the HUWS were improved, and many dead-end waterways were reconnected. The first historic waterway reconstruction project, the Mid-Zhangjia Alley Waterway reconstruction,[3] was implemented and completed in 2020 (fig. 5), which has to some extent improved the connectivity of the urban water system. The layout of the backbone waterway system, namely, three horizontal and three vertical primary waterways within the ancient city of Suzhou and one surrounding moat system (as shown in fig. 2), has been protected. However, concurrently, some large-scale infrastructure construction and renovation projects have also damaged the integrity of the urban water system. With the renovation of Ganjiang Road, the connection between Ganjiang Waterway and the backbone water system has been interrupted (Qiu 2009).

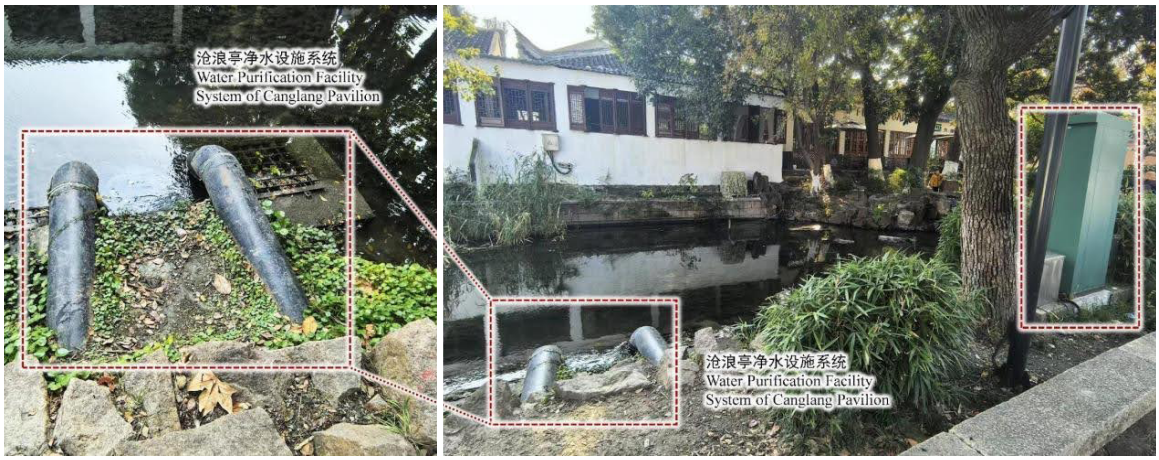
3. It took the municipality of Suzhou 15 years to reconstruct this 607-meter-long waterway at a cost of over 20 million RMB (about US$2.74 million) (Jin 2024).



^ Fig. 5 Comparison of Mid-Zhangjia Alley Waterway before (top) and after reconstruction (bottom) (Source: Black-and-white photos were taken in 2020 by Jinshuai Zhang of the Suzhou National Resources and Planning Bureau; color photos by Yapeng Ou, 2025).

Meanwhile, CGS protection has also been strengthened, especially following their nomination and listing as a World Heritage Property. A framework has been established for protecting the intrinsic value of key heritage elements, including historic buildings, plants, water bodies and rockeries. It has now become widely accepted that water bodies are a fundamental part of the gardens. However, with the destruction of HUWS during the period of rapid urbanization, the accumulation of non-point source pollution and the overall decline in the quality of the urban water environment, the pressure of water management in the process of garden protection has become increasingly severe (Chen et al. 2014). Since the 1990s, a widespread problem of deteriorating water quality and aquatic ecology has been observed in gardens, resulting in turbid water bodies and adverse landscape effects. Therefore, the significant new progress in garden protection at this stage is the strengthened management of garden water bodies. The *Regulations on the Protection and Management of Suzhou Gardens* (1996) not only requires that the original layout of gardens should not be changed to maintain the original appearance of rockeries and water bodies but also puts forward a new requirement for water protection, stipulating "no discharge, infiltration of sewage, or dumping of solid waste into gardens."

To improve the water quality of CGS and HUWS, a "nature-based and engineering-supported" approach has been increasingly adopted since the first decade of the twenty-first century. CGS water body treatment generally adopts in situ ecological restoration methods to enhance the self-purification ability of garden water bodies and to optimize the landscape aesthetic. Common measures include adding biofilm self-purification devices and microbial agents to the water body, introducing aquatic animals and plants,



^ Fig. 6 Water purification facility system of Canglang Pavilion, composed of an artificial water circulation system and a distribution box (Source: Yapeng Ou, 2025).

installing artificial water circulation systems (fig. 6), and dredging sediment (Chen et al. 2014; Wu et al. 2012). Alternatively, underground infiltration treatment systems (such as those in Humble Administrator's Garden) or sand filters (such as those in the Garden of Cultivation) were constructed next to the ponds or outside the gardens to purify the water. While these practices have improved the water landscapes to a certain extent, they also have several drawbacks, including high management costs and long-term energy consumption, which contradict the low-carbon and green concepts (Chen et al. 2014).

Regarding HUWS water quality management, a helpful example is the Pingjiang Waterway, which in recent years has become well-known for its clear and clean water; it also combines nature-based solutions with engineering technology (fig. 7). First, ongoing efforts have been made to dredge the waterways. Since 2018, large-scale dredging has been carried out on the Pingjiang Waterway and its surrounding waterways, restoring natural water flow (China Environment Network 2023). Second, its self-purification ability has been enhanced by restoring the aquatic ecosystem. Aquatic plants with strong adsorption capacity have been planted in all nine waterways within the Pingjiang Historic District (*Jiangsu News* 2024). Furthermore, an underground water purification plant was built to extract and purify water from the nearby moat and then inject the purified water into the waterways and gardens within the district. Finally, water quality has been improved through water diversion. The efficient regulation of seven sluices within the district has achieved precise management of water bodies. These measures, since 2018, have improved water quality and ecology. However, persistent challenges remain, such as gaps between policy and local enforcement.

However, despite the progress made in the water body governance of CGS and HUWS in recent years, little attention has been paid to restoring their symbiotic relationship. The problem of isolated management remains due to institutional silos, lack of awareness and technical challenges. Still, there have been calls from society and academia to recover this relationship (e.g., by restoring the hydrological connectivity between CGS and HUWS). Therefore, adopting an integrated approach to protecting both is essential.



^ Fig. 7 The current state of water bodies following the introduction of aquatic plants and dredging in Pingjiang Historic District (Source: Yapeng Ou, 2025).

Existing Practices Conducive to Recovering the Symbiosis between Classical Gardens and Historic Urban Water System

CGS generally suffer from various ecological problems involving water, including small water bodies, low environmental capacity, disconnection from groundwater and surface water sources, weak self-purification ability and malfunctioning aquatic ecosystems (Wu et al. 2012). Integrated city water management and planning on a larger scale is imperative to solve this problem. In 1982, Suzhou was listed in the first batch of Chinese Historical and Cultural Cities. Based on this protection system, in August 2012, the municipality of Suzhou took the innovative step of establishing a National Historical and Cultural City Protection Area (hereafter, Protection Area) (Jiangnan Forum 2018), currently the only management mechanism in China that fully links protection and management. A specialized joint management office for CGS and HUWS has been established in the Protected Area, breaking down institutional silos between authorities responsible for garden management, water conservancy, environmental protection and urban planning. This has promoted inter-departmental information sharing, collaborative decision-making and concerted action (Fan 2023).

Regarding protective planning, Suzhou focuses on the water network between gardens and optimizes their layout based on urban development needs and ecological protection goals. The aim is to ensure that the water system can provide a stable water supply and ecological support for the gardens, which can be integrated into the urban water ecosystem, thereby enhancing the overall ecological resilience of the city (Suzhou Natural Resources and Planning Bureau 2013). The *Suzhou Historical and Cultural City Protection Plan* (2013–2030) emphasizes the protection of the "double chessboard layout of waterways and roads." It also emphasizes specific protection requirements and long-term development goals for the ecological, cultural and landscape aspects of CGS and the urban water

system, clarifying their connectivity and ecological needs. Under the guidance of the planning system, the ancient city of Suzhou implemented a waterway dredging project, completing the dredging of 26 waterways by 2020, with Phase 2 involving the dredging of 30 additional waterways. The River Management Authority aimed to universally improve the transparency of the 56 waterways in the historic districts by approximately one meter through a series of integrated water management measures (Suzhou Water Authority 2020).

Conclusion: Transmitting the Resilience Value of the Symbiotic Relationship to Promote Its Recovery

CGS and Suzhou's HUWS have coexisted in a symbiotic and resilient relationship, adapting together to external pressures such as extreme weather and habitat disruption. In the context of the ongoing climate crisis and growing environmental pressure, this resilience value provides a fundamental focus for the overall protection and preservation of CGS and the ancient city of Suzhou, facilitating climate adaptation. However, since the early 1900s, this symbiotic relationship between CGS and HUWS has been undermined due to modern urban construction. This, in turn, has led to the loss of its embedded resilience value, which is especially needed at a time of climate change.

Fortunately, since the early twenty-first century, preservation priorities for CGS and HUWS have evolved from an architecture-centric approach that marginalized water heritage to a "pro-water paradigm" emphasizing garden water landscape stewardship and the protection of historic waterways and the associated cultural heritage. To improve the water quality of CGS and HUWS, a "nature-based and engineering-supported" approach has been adopted. Some of the existing practices have also leveled the ground for the recovery of the symbiotic relationship between CGS and HUWS. For example, an integrated management mechanism and protection plan have been established. This has to some extent promoted a shift from individual garden protection to integrated city–garden protection. However, even though CGS and HUWS are concurrently managed, they still suffer from a conventional "isolated management" pattern, and their symbiotic relationship remains fractured. With the climate crisis, while building on the existing "good practices" of coordinated water management and heritage protection, it is crucial to promote the recovery of the symbiotic relationship between CGS and HUWS. This can be accomplished by active and effective transmission of the resilience value inherent in that relationship, which is also an important criterion for assessing whether the latter has been effectively restored. The water management and heritage protection of CGS and Suzhou's HUWS needs to be made even more synchronized, while continuing to enhance their hydrological connectivity. In the long run, this will enable both to provide multiple ecosystem services such as landscape beautification, climate regulation, biodiversity conservation and flood regulation.

Based on the protective measures mentioned above, to maintain the resilience of the symbiotic relationship between CGS and HUWS, it is necessary to regard CGS and HUWS as an organism and restore their symbiotic relationship holistically. It is also important to ensure the connectivity of gardens, rivers, lakes and wetlands, and to strengthen the ecological material exchange and the functions of risk distribution and reduction between CGS and HUWS. Additionally, efforts should be made to strengthen the restoration and reconstruction

of historic waterways and to continue to reconnect dead-end waterways to improve water system connectivity and restore the ecological systems of gardens and urban water bodies.

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