

Monetizing the Multi-Dimensional Value of a Large Urban Park Through the Context-Adapted Social-Return-on-Investment Framework

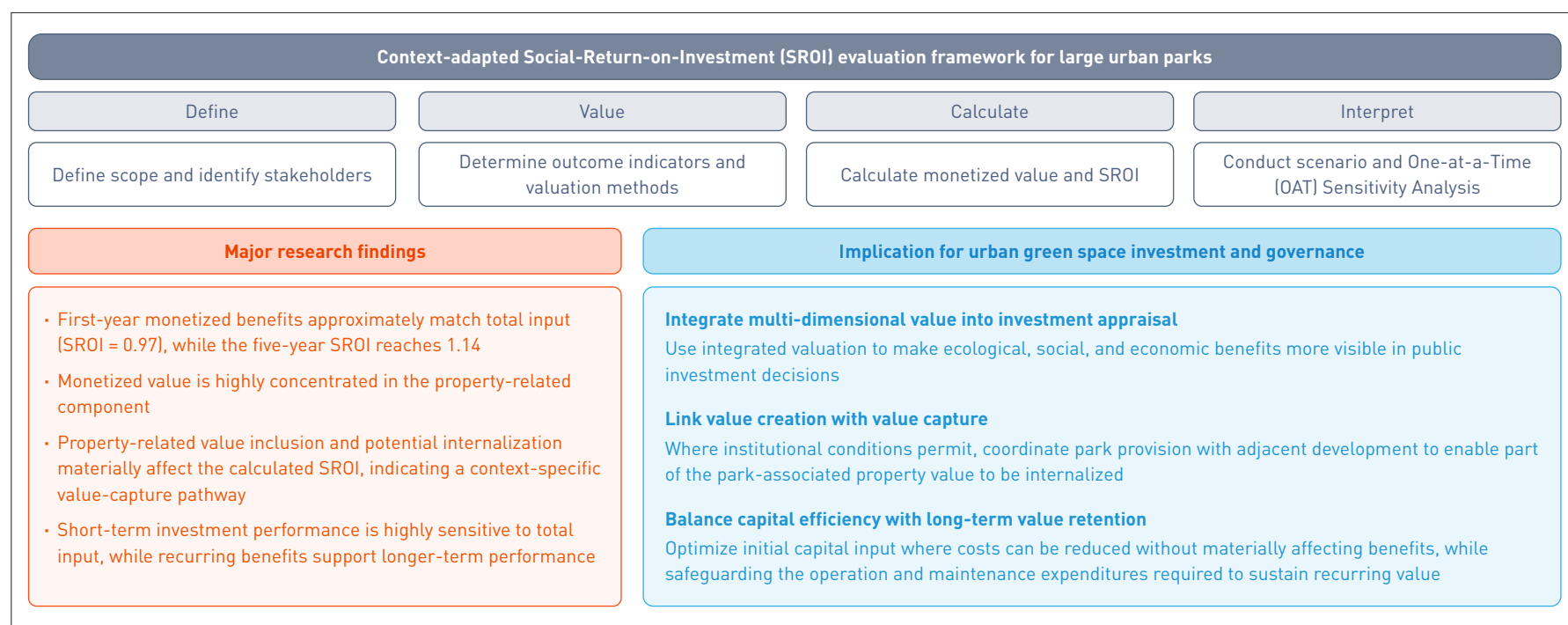
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GRAPHICAL ABSTRACT



ABSTRACT

Against the backdrop of China's "Park City" agenda and tightening municipal budgets, large urban parks face a persistent valuation and financing challenge because many of their ecological and social benefits and spatial externalities are not fully captured by conventional fiscal accounting or internalized by the entities responsible for park investment. This study proposed a context-adapted Social Return on Investment (SROI) framework that integrates selected ecological, social, direct economic, and

property-related outcomes within a unified monetary accounting system, and applied it in the case of Biyun Green Space in Shanghai. The findings reveal that: 1) Under the selected accounting assumptions, the park yields a first-year SROI of 0.97 and a five-year SROI of 1.14. This means every RMB 1 invested corresponds to approximately RMB 0.97 and RMB 1.14 in adjusted monetized value over one and five years, respectively. 2) The monetized value distribution is highly uneven with property-related

value accounting for 89.81% of the first-year total, followed by ecological value (5.87%), social value (2.21%), and direct economic value (2.11%). 3) Scenario analysis shows that the calculated SROI is strongly affected by the inclusion and potential internalization of property-related spatial externalities, indicating that coordinated park-property development may provide a context-specific value-capture pathway under particular institutional conditions. 4) One-at-a-Time Sensitivity Analysis shows that short-term investment performance is primarily constrained by total input, while longer-term performance increasingly depends on the accumulation of recurring ecological, social, and direct economic benefits, suggesting that capital efficiency is particularly important in the early investment stage, whereas sustaining recurring benefits becomes increasingly important over the longer evaluation horizon.

This study provides a context-specific empirical application of SROI for large urban park valuation. The findings highlight the need to balance early-stage capital efficiency with the long-term retention of recurring public benefits, while using context-appropriate mechanisms to internalize park-related spatial externalities.

KEYWORDS

Social Return on Investment (SROI); Large Urban Park; Comprehensive Value Assessment; Ecological Value; Social Value; Value Monetization

HIGHLIGHTS

- Adapts SROI to integrate ecological, social, and economic values of large urban parks
- Property-related value dominates the comprehensive value, while ecological and social benefits recur over time
- SROI is most sensitive to total input and property value, highlighting value-capture potential

1 Introduction

Rapid urbanization has fundamentally transformed the global spatial landscape, with projections indicating that nearly 70% of the world’s population will reside in urban areas by 2050^[1]. Within this

context, large urban parks have evolved beyond their traditional recreational functions to become essential components of urban green infrastructure that support ecological resilience, public health, and sustainable urban development^[2–4]. As multifunctional public assets, they generate diverse ecological, social, and economic benefits by restoring ecosystem functions, improving human well-being, and stimulating regional development^[5–6]. However, because these benefits largely exist as positive externalities that are not fully reflected in market transactions, the comprehensive value of urban parks is frequently underestimated in public investment and fiscal decision-making^[7–9]. In this study, the comprehensive value of urban parks refers to the combined ecological, social, and economic benefits generated by park provision. Ecological value comprises ecosystem-service benefits; social value reflects benefits to users’ health, well-being, education, and social interaction; and economic value includes both direct operational value and property-related spatial externalities.

Existing studies have developed a range of methods to quantify these three dimensions of urban green space value. Ecological valuation primarily focuses on regulating and supporting services, including water conservation, climate regulation, environmental purification, cooling, and biodiversity, using ecosystem-service valuation, ecological models, remote sensing, and related assessment tools^[10–13]. Recent studies further emphasize the need to connect urban green space typology, multifunctionality, spatial scale, and ecosystem-service assessment within more systematic frameworks^[14–16]. Social valuation generally measures recreation, health promotion, environmental education, and subjective well-being^[17–22] through methods such as the Contingent Valuation Method (CVM)^[17,19], social-media analysis^[23–24], and spatial social-value or GIS-based mapping^[25–26]. Economic valuation commonly examines operating benefits and the capitalization of green amenities into surrounding property values^[27–34], with hedonic pricing and spatial modeling widely used to estimate these effects. More recently, valuation studies have begun to move beyond single-method assessments: Tom Wild et al. examined multidimensional valuation of urban nature-based solutions across Latin American and European cities^[7], while Peter Odhengo et al. assessed urban green space value in Nairobi by combining user perception, willingness to pay, cost savings, and spatial accessibility^[35]. Recent advances in artificial intelligence have further expanded the assessment of perceived and cultural ecosystem services. Large language models (LLMs), combined with social-media data, have been used to classify cultural ecosystem services, identify public sentiment, and interpret large-scale unstructured visitor

narratives^[36–37]. However, these approaches primarily enhance the assessment of perceived and cultural ecosystem services rather than comprehensive investment appraisal.

Despite this methodological diversity and increasing analytical sophistication, two critical limitations persist across the existing literature. First, ecological, social, and economic values are still frequently assessed separately, or combined without being linked to a comprehensive investment-evaluation boundary^[7,14–16]. Second, construction costs, operational expenditures, and longer-term returns are not consistently incorporated together in green-infrastructure appraisal, though recent Social-Return-on-Investment (SROI) and Nature-based-Solution (NbS) studies have begun to address this gap^[38–40]. In practice, public investment decisions for urban park projects in China are commonly embedded within feasibility studies, construction approvals, and investment-estimate procedures, while comprehensive monetized benefit evaluations are not yet routinely connected to municipal budgetary or financing decisions^[41]. These limitations indicate the need for an investment-oriented valuation framework that can integrate ecological, social, and economic benefits with construction costs, operation and maintenance costs, and long-term returns within a unified accounting boundary. The SROI framework provides an approach for making broader non-market outcomes visible in investment appraisal^[42–43], which has been applied to public parks^[44–45], urban greenways^[46–47], and NbS interventions^[38,40].

While studies such as Christopher Tate et al.^[47] have broadened the scope of SROI, important methodological limitations remain in its systematic application to urban green infrastructure. Existing SROI applications have made substantial progress in monetizing social and economic outcomes, but ecological services are often represented by selected indicators rather than a systematic ecosystem-service accounting boundary^[39–40,47]. This is particularly limiting for large urban parks, whose ecological functions are broader than those typically captured in previous greenway SROI studies. Furthermore, internationally adopted valuation parameters, financial proxies, and institutional assumptions are largely derived from Western governance contexts, limiting their direct applicability to China's public investment, land management, and urban green space governance systems.

The consequences of these limitations are substantive rather than merely technical. Under fragmented valuation approaches, the investment performance of large urban parks can be systematically obscured: ecological, social, and economic returns are often assessed separately, while the mechanisms through which public green space investments generate and redistribute value remain

insufficiently examined. In China, this problem is particularly pressing. Under the ongoing implementation of the “Park City” agenda, expanding and maintaining urban green infrastructure require substantial capital and long-term management commitments^[48], while financing studies continue to identify barriers related to fragmented beneficiaries, uncertain revenue streams, and limited mechanisms for capturing non-market values^[9,49–52]. Without an integrated accounting framework that links multidimensional benefits to investment costs and financing mechanisms, large urban parks may continue to be treated mainly as expenditure items rather than long-term public assets^[50,52–53]. These pressures are also shaped by China's land-based urbanization and public green space development institutions, which influence how green space costs and adjacent development benefits are distributed^[48,54].

Against this background, this study argues that existing fragmented valuation approaches tend to obscure the investment performance and value-capture mechanisms of large urban parks, and that a context-adapted SROI framework can reveal how ecological, social, and economic returns are generated, distributed, and translated into financing implications under China's fiscal and institutional constraints. Rather than proposing a new valuation methodology, this study adapts the existing SROI framework by localizing valuation parameters, stakeholder identification, ecological accounting boundaries, and financing mechanisms to better reflect context-specific governance and market conditions. The framework is designed to be transferable to other contexts through the recalibration of locally relevant parameters and institutional assumptions. Shanghai Biyun Green Space is selected as an empirical case to examine the applicability in the Chinese urban green space context.

2 Methodology

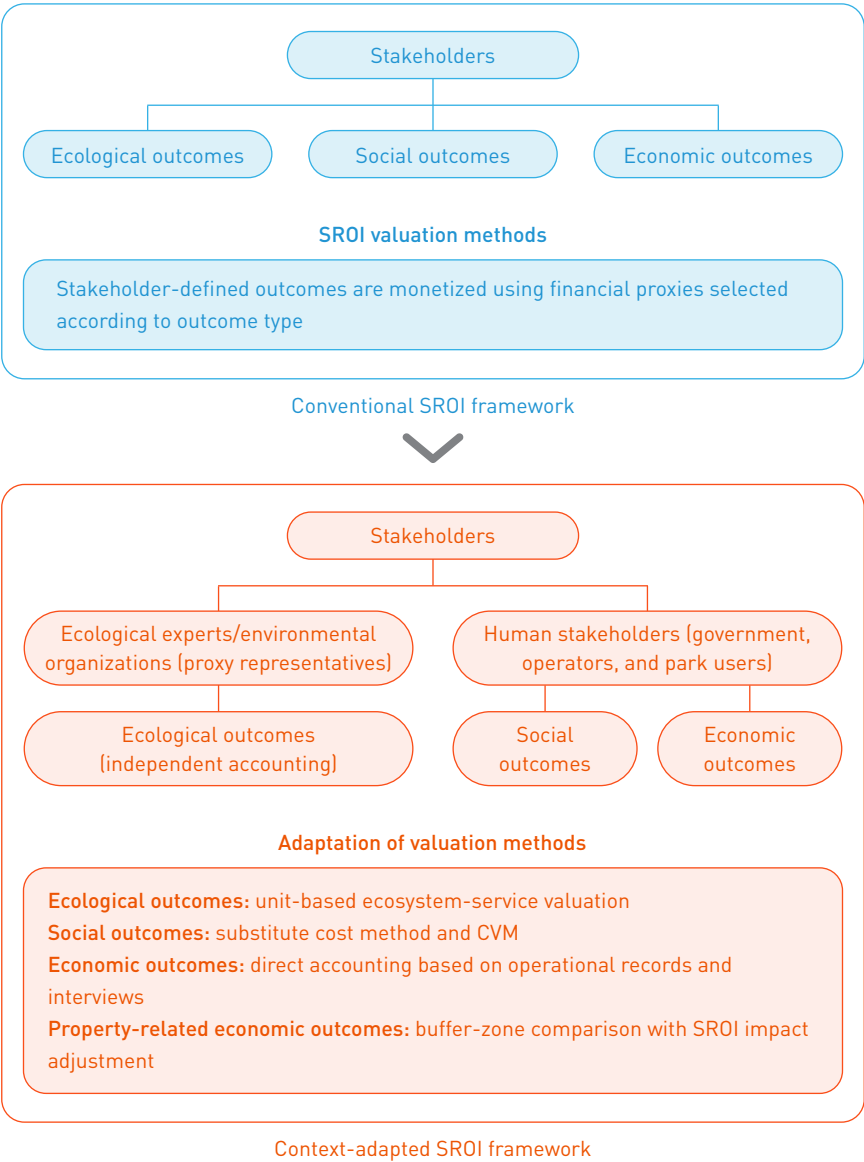
2.1 Adaptations of the SROI Framework

The conventional SROI framework is primarily stakeholder-driven and relies heavily on stakeholders' perceived outcomes and internationally used financial proxies. While this approach is useful for social-impact assessment, it has several limitations when applied to large urban parks. First, ecosystem services are often insufficiently represented because ecological outcomes do not have direct human stakeholders who can express preferences in the same way as residents, visitors, or operating entities. Second, international financial proxies may not be directly transferable to the Chinese valuation context, where ecological accounting

standards, public-service pricing, land development institutions, and real-estate market mechanisms differ substantially. Third, the conventional SROI framework pays limited attention to the spatial spillover effects of parks, particularly property-related externalities that are central to the financing and governance of large urban green spaces.

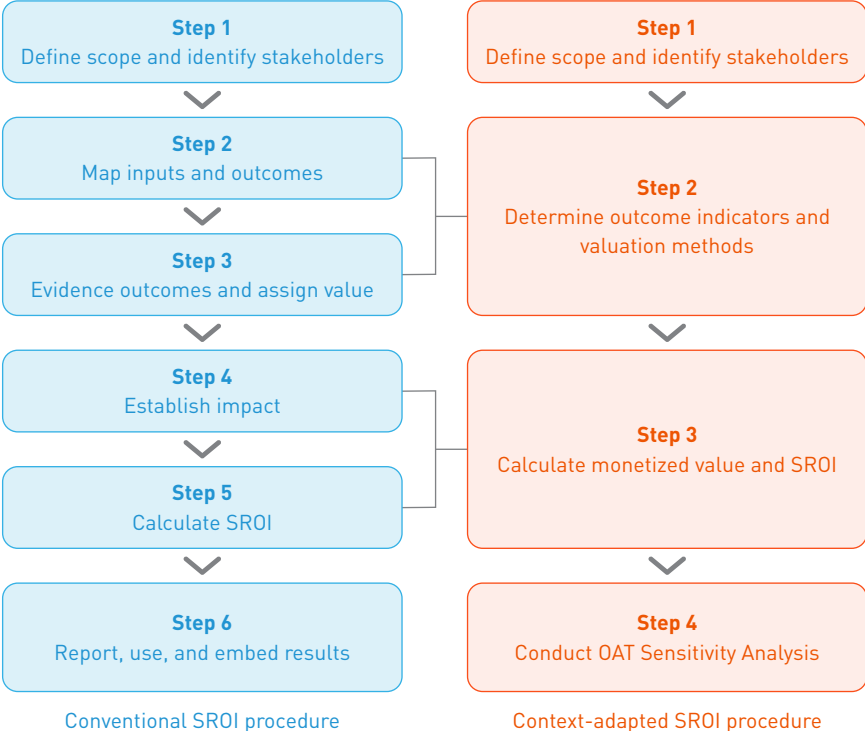
Drawing on conventional SROI methodology^[42–43], previous applications of SROI to urban parks and greenways^[44–47], and research on ecosystem-service and spatial-economic valuation^[10–16,27–34], this study adapts the SROI framework to the characteristics of large urban parks and to context-specific institutional and data conditions. The adaptation is reflected in three main respects (Fig. 1). First, in terms of evaluation

Fig. 1 Comparison of the conventional and the context-adapted SROI frameworks.



entities, ecological experts and environmental organizations are introduced as proxy representatives for ecosystem services, allowing ecological outcomes to be independently identified and accounted for rather than being subsumed under human stakeholder perceptions. Second, in terms of valuation methods, the framework replaces generic international financial proxies with locally applicable valuation approaches: ecological outcomes are estimated using a unit-based ecosystem-service valuation approach based on physical park data, locally applicable ecological parameters, official standards, and relevant literature; social outcomes are monetized through a combination of substitute cost and contingent valuation methods; direct economic outcomes are assessed through direct accounting based on operational records and interviews, while property-related economic value is estimated through buffer-zone comparison with SROI impact adjustment. Third, for empirical application to large urban parks, the analytical stages of conventional six-step SROI workflow^[43] were operationalized as a four-step workflow tailored to urban green space assessment: 1) defining the scope and stakeholders; 2) determining outcome indicators and valuation methods, 3) calculating monetized values and SROI, and 4) conducting One-at-a-Time (OAT) Sensitivity Analysis (Fig. 2). Reporting and interpretation of the results follow the broader SROI principles but

Fig. 2 Comparison of the conventional and context-adapted SROI workflow.



are not treated as a separate analytical step in this study.

The purpose of this adaptation is not to simplify SROI. This adapted framework retains the core logic of SROI—linking inputs, outcomes, monetized values, and investment returns—but modifies its operational structure to better match the ecological, social, economic, and institutional characteristics of the Chinese park-development context.

2.2 Workflow Elaboration

The context-adapted evaluation workflow is structured into four steps, as illustrated in Fig. 3.

Step 1: define scope and identify stakeholders. The scope of the analysis is delineated, and relevant stakeholders are identified through (face-to-face/telephone) interviews and (focus group/questionnaire) surveys. Stakeholders in green space projects are broadly classified into four categories: government departments, constructors/operators, the general public (e.g., nearby residents, communities, volunteers, tourists), and ecological experts or environmental NGOs.

Step 2: determine outcome indicators and valuation

methods. Drawing upon existing literature, the project benefits, measurement indicators, and valuation methods are synthesized in Table 1.

Step 3: calculate monetized values and SROI. To isolate the specific impacts associated with a given project, the initial estimated values are adjusted using four impact factors: deadweight, attribution, displacement, and drop-off^[43,55]. Deadweight refers to outcomes that would have occurred without the project; attribution refers to the share caused by other factors; displacement refers to benefits offset elsewhere; and drop-off reflects the decline of sustained outcomes over time. Ecological outcomes are treated as directly associated with the park's physical presence and are therefore not adjusted for deadweight or attribution. Social and property-related economic outcomes are adjusted where applicable. Deadweight factors were derived from official or authoritative third-party benchmarks where available, with conservative model assumptions used where no directly comparable benchmark existed; attribution factors were derived from questionnaire responses. For the science/environmental education outcome, a 25% annual drop-off rate was applied from

Fig. 3 Elaboration diagram of the context-adapted SROI workflow.

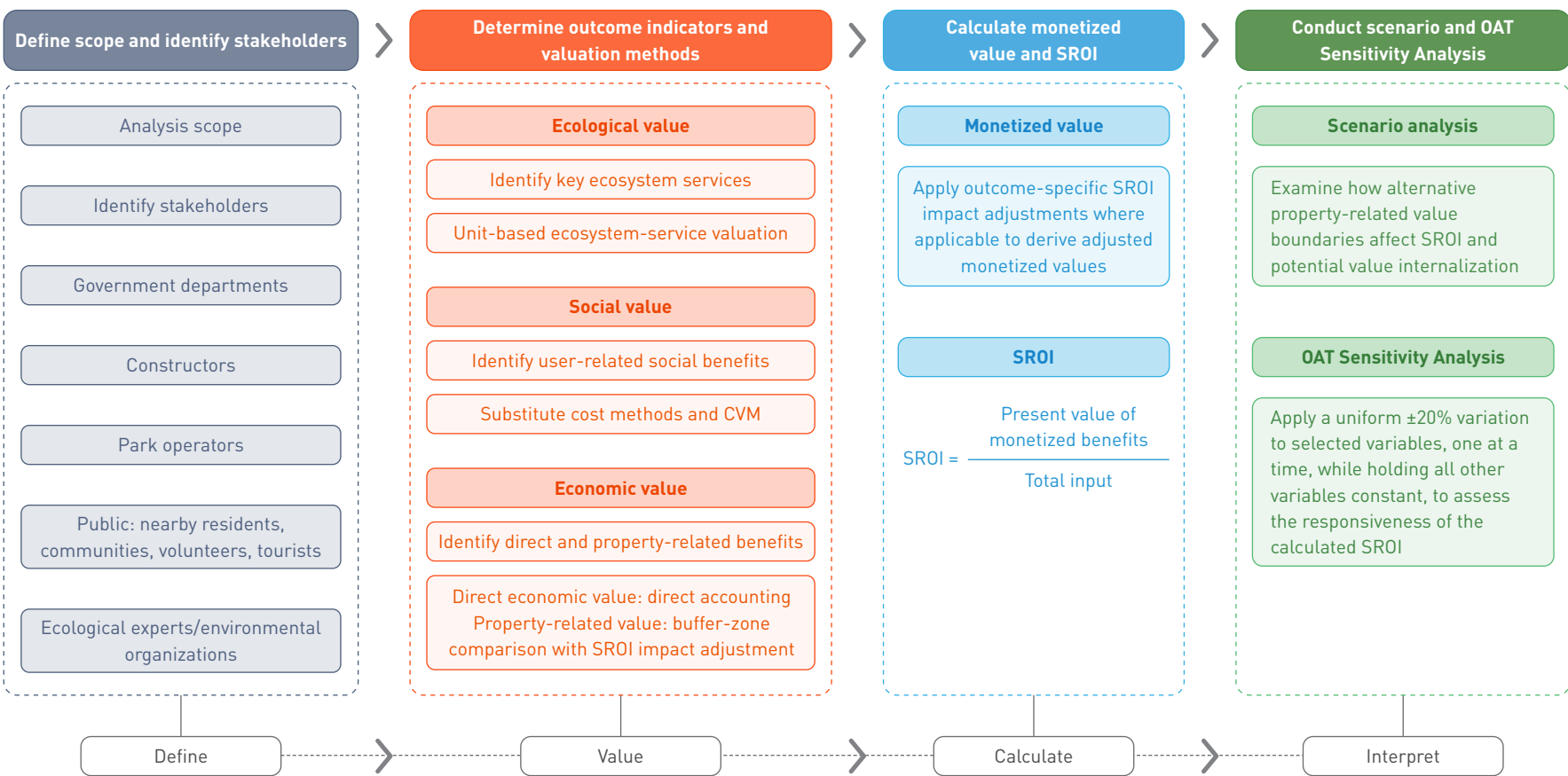


Table 1: Description of green space benefits and measurement indicators

Category		Stakeholder	Outcome	Indicators	Valuation method
Ecological value		Ecological experts	Ecosystem services provided	Water conservation, carbon sequestration and oxygen release, air purification, dust retention, noise reduction, temperature reduction, biodiversity	Unit-based ecosystem-service valuation (detailed in Supplementary Tables 5–6)
Social value	Nearby residents		Physical health benefits	Sports value	Substitute cost (gym fees)
			Mental relaxation	Mental health improvement	CVM
	Employees		Ecological knowledge acquisition and environmental awareness	Science/environmental education	Substitute cost (educational fees)
	Tourists		Enhanced social interaction	Social network expansion	CVM
			Parent-child interaction	Family harmony	CVM
			Improved daily convenience	Life satisfaction improvement	CVM
Economic value	Direct economic value	Government departments	Employment-related economic contribution	Social security contribution	Direct accounting
	Property-related economic value	Park operating entities	Revenue generation	Operating income	Direct accounting
		Nearby property owners	Improved residential quality	Property-related value	Buffer-zone comparison

the second year onward, consistent with previous park-based SROI applications of environmental learning and outdoor education outcomes^[45]. Consistent with Eq. 1, drop-off is applied from the second evaluation year onward through the term $(1 - D_r)^{n-1}$, rather than reducing the first-year value. This adjustment is used to avoid overestimating the persistence of this benefit.

The total value is aggregated by summing the adjusted ecological, social, and economic monetized values after applying the impact adjustments. The value of benefit “*i*” in year “*n*” is calculated by multiplying the monetized value of the financial proxy (unit equivalent) of benefit “*i*” by its quantity, while accounting for the impact factors. The formula is expressed as follows:

$$P_i = A_i \times N_i \times (1 - D) \times (1 - A) \times (1 - D_i) \times (1 - D_r)^{n-1}, \quad (1)$$

where P_i represents the value of benefit *i*; A_i is the monetized value of the financial proxy for benefit *i*; N_i is the quantity of the benefit;

D is the deadweight factor; A is the attribution factor; D_i is the displacement factor; D_r is the drop-off factor; and n denotes the year.

SROI calculations are typically conducted over a five-year horizon to capture longer-term investment outcomes. In this study, recurring ecological, social, and direct economic benefits were projected over their respective durations, while property-related value was treated as a one-off capitalized benefit in the first evaluation year. The present value (PV_i) of recurring benefit *i* is calculated as follows:

$$PV_i = \sum_{n=1}^5 \frac{P_i}{(1 + R)^{n-1}}, \quad (2)$$

where PV_i is the present value of the return for benefit *i*; P_i is the monetized value of benefit *i* in the relevant year; R is the discount

rate (set at 3% in this study); and n denotes the year. This rate is consistent with assumptions used in comparable NbS and urban green infrastructure appraisal studies^[38,47], calculated as follows:

$$SROI = \frac{\sum_{i=1}^j PV_i}{\sum_{i=1}^j C_i}, \quad (3)$$

where j is the total number of benefits; PV_i is the present value of the returns; and C_i represents the total inputs (costs).

Step 4: conduct scenario and OAT Sensitivity Analysis. The final step examines how changes in key assumptions affect the calculated SROI. Following common SROI practice, this study applies a uniform $\pm 20\%$ variation to each selected variable while holding the other variables constant. This approach provides a comparable basis for assessing which parameters the calculated SROI is most responsive to. However, because the same percentage range is applied across variables, the results may partly reflect differences in baseline monetary scale rather than the actual empirical uncertainty of each parameter. Therefore, the analysis should be interpreted as an exploratory test of model responsiveness rather than a statistically derived ranking of parameter uncertainty or importance. Variables that generate substantial changes in SROI under the tested assumptions were treated as parameters requiring closer attention in future green space investment planning, value-capture design, and data improvement.

2.3 Scenario Analysis of Property-Related Value Assumptions

Previous studies suggest that urban parks can generate external economic effects capitalized into nearby property values. In this study, property-related value was estimated within the defined buffer zones and adjusted using the SROI impact principles of deadweight and attribution to account for background market changes and non-park factors^[43]. Because the inclusion of such externalities in investment appraisal depends on the accounting and institutional boundary, scenario analysis was used to examine how alternative assumptions regarding property-related value affect the calculated SROI. Other ecological, social, direct economic benefits, and investment costs were held constant across the scenarios.

3 Study Area

The proposed SROI framework has been demonstrated through the case of the built-up area of the Biyun Green Space in Shanghai Pudong New Area. The project covers approximately 71 hm², including about 9 hm² of water bodies, 52 hm² of green space, and approximately 10 hm² of roads, plazas, and other paved areas.

Opened in 2022, it required an initial investment of approximately RMB 390 million. The park combines sports, recreation, waterfront, sponge wetland, and ecological education, making it suitable for assessing ecological, social, and economic outcomes under the SROI framework. The case is also institutionally relevant. The park was planned, invested in, constructed, and operated by a state-owned development enterprise^[56]. The surrounding area includes commercial, office, hospitality, and residential uses, as well as established high-end residential communities, providing the basis for buffer-zone property-premium analysis. This arrangement provides a specific context for examining whether park-associated property value can be partially internalized through an integrated park-property development model.

Empirical investigation confirms that seven residential communities are distributed within a 500-meter core buffer zone radiating from the park boundary, while another eight communities are located within the 500 to 2,000-meter peripheral buffer zone (Fig. 4). Regarding developer attributes, among the 15 sampled communities, two projects were developed by a state-owned enterprise (which concurrently serves as the construction and operating entity for the park), whereas the remaining 13 projects were undertaken by private developers.

Fig. 4 Spatial distribution of the 15 sampled residential communities.



4 Data Collection

4.1 Data Sources and Collection

This study used multiple data sources, including structured interviews, on-site questionnaire surveys, official and operational records, and housing-price data.

Structured interviews were conducted in February 2025 with representatives from the Shanghai Pudong New Area Greening Management Bureau, the project construction and operating entities, and ecological experts. The interviews provided information on park investment, construction costs, operation and maintenance, management arrangements, ecological outcomes, and direct economic activities. Data on operating income, parking income, venue use, and employment-related social security contributions were obtained from operational records, government information, and interviews.

Housing-price data were collected from major online real-estate platforms, including Lianjia and Fang.com. For residential communities within the buffer zones, average transaction prices over the most recent one or two years were used where available; otherwise, average housing prices were used as proxies. The estimated property-related value was further adjusted using SROI impact factors, including deadweight and attribution, to reduce over-attribution of housing-price differences to the park. Accordingly, the estimated property-related value should be interpreted as an accounting-based estimate under the specified assumptions rather than as a causal estimate of park-induced housing-price appreciation.

Social-value data were mainly obtained through an on-site visitor questionnaire survey conducted between February and March 2025. A systematic intercept sampling approach was used across different dates, time periods, and park-use locations, including major entrances, waterfront trails, activity nodes, and ecological education areas. The survey targeted adult visitors and nearby users with direct experience of the park. A total of 105 questionnaires were distributed and all were retained as valid responses.

To assess sample-size adequacy, Cochran's sample size formula was applied. Under a 95% confidence level, a 10% margin of error, and the maximum-variance assumption, the minimum required sample size for a large population ($N > 100,000$) is approximately 97. Therefore, the valid sample size of this study ($N = 105$) met the minimum sample-size requirement under this error threshold.

The questionnaire collected respondents' demographic

characteristics, park-use patterns, perceived benefits, attribution of benefits, and willingness to pay (WTP). To reduce hypothetical bias, the CVM section adopted a staged valuation process. Respondents were first asked to evaluate the park's influence on their daily life, the perceived loss if they could no longer use the park, and the relative importance of park-induced changes compared with other life-improvement factors. WTP per visit/use was then elicited using a matrix-style payment-card format with a hypothetical park-maintenance contribution as the payment vehicle.

Social value was then calculated by multiplying benefit-related person-visits by the corresponding per-visit unit value. For example, for sports value, 54 of the 105 respondents (51.43%) reported this benefit. Applying this recognition rate to the park's 269,828 annual person-visits yielded an estimated 138,773 benefit-related person-visits. Multiplying this figure by the unit value of RMB 66 per visit resulted in a pre-adjustment annual sports value of approximately RMB 9.16 million. Because the annual park-use volume was already expressed in person-visits, visit frequency was not multiplied again. To reduce potential overlap, social outcomes were treated as separate questionnaire categories, and environmental-awareness responses were not monetized as an additional standalone outcome beyond the science/environmental education category. The recognition rate, extrapolated benefit-related person-visits, and 95% confidence interval for each indicator are reported in Supplementary Table 3.

The on-site survey primarily captures the perceived value of active park users rather than representing a probability sample of all potential beneficiaries. Therefore, the WTP-based extrapolation should be interpreted as an exploratory estimate based on active-user perceptions.

4.2 Valuation Methods for Outcome Categories

The valuation approach was selected according to the characteristics and data availability of each outcome dimension.

Ecological services, including water conservation, carbon sequestration, air purification, cooling, and biodiversity, were monetized using a unit-based ecosystem-service valuation approach (detailed in Supplementary Tables 5–6). The selection of ecological service categories is consistent with recent urban green infrastructure and ecosystem service assessment literature^[10–16], while several local unit values and coefficients used in the detailed calculations draw on established Chinese ecological-service valuation sources^[57–60].

Social outcomes were valued using the substitute cost

method and CVM based primarily on the on-site questionnaire survey. Annual benefit-related person-visits were multiplied by the corresponding per-visit unit values, without an additional frequency multiplier (detailed in Supplementary Tables 2–3 and 7–10).

Direct economic outcomes were estimated from operational records and interviews with the park operator, covering employment-related social security contributions, building and venue leasing, commercial activities, and parking income. Because the park had not yet obtained a commercial operating license, income from ancillary buildings was estimated based on operator-provided information. Property-related economic value was estimated through a buffer-zone comparison and further adjusted for deadweight and attribution (detailed in Supplementary Tables 1 and 8–10).

5 Research Findings

5.1 Monetized Value of Categorized Outcomes

Under the selected accounting assumptions, the total adjusted monetized value of Biyun Green Space of the first evaluation year is approximately RMB 397.16 million (Table 2). Economic value accounts for the largest share of the monetized outcomes, representing 91.92% of the total adjusted value, mainly because of the property-related component. Ecological value accounts for 5.87% of the total monetized value, equivalent to RMB 23.32 million. Social value accounts for 2.21%, equivalent to RMB 8.77 million.

As stated above, the initial capital investment of the park was approximately RMB 390 million. After its opening, the park’s

Table 2: The monetized value of categorized outcomes of the first year

Category	Pre-adjustment value (RMB)	Final monetized value (RMB)	Proportion
Ecological value	23,316,500	23,316,500	5.87%
Social value	65,615,610	8,769,751	2.21%
Direct economic value	8,386,000	8,386,000	2.11%
Property-related economic value	7,670,714,904	356,688,243	89.81%
Total	—	397,160,494	100%

annual operation and maintenance cost was approximately RMB 17.82 million, based on an annual operator-reported unit cost of RMB 27/m². Accordingly, the first-year total input was RMB 407.82 million (RMB 390 million + RMB 17.82 million). For the five-year evaluation period, total input was RMB 479.10 million (RMB 390 million + RMB 17.82 million × 5). The first-year SROI is 0.97. Over the five-year evaluation period, the present value of total benefits is approximately RMB 546.03 million, while the total input is RMB 479.10 million, resulting in a SROI of 1.14. As detailed in Table 3, property-related value was treated as a one-off capitalized benefit in Year 1, whereas recurring ecological, social, and direct economic benefits were projected over their respective durations. Future benefits were discounted to the first evaluation year at a rate of 3%.

5.2 Scenario Analyses of Property-Related Value Capture Mechanisms

Property-related value represents a spatial externality whose inclusion in SROI depends on the accounting boundary and the extent to which such value can potentially be internalized by the entities involved in park development. To examine the influence of different value-inclusion boundaries on the calculated SROI, three scenarios were constructed based on the institutional and development characteristics of the case study.

1) Scenario 1 includes the adjusted property-related value associated with all sampled residential properties within the

Table 3: First-year and five-year SROI calculation (unit: RMB million)

Benefit category	Year 1	Year 2	Year 3	Year 4	Year 5
Ecological value	23.32	23.32	23.32	23.32	23.32
Social value	8.77	8.55	8.39	8.26	8.17
Direct economic value	8.39	8.39	8.39	8.39	8.39
Property-related value	356.69	0	0	0	0
Annual benefit before discounting	397.16	40.25	40.09	39.97	39.87
Discount factor	1.000	0.971	0.943	0.915	0.888
Present value of annual benefit	397.16	39.08	37.79	36.57	35.43

defined buffer zones, representing the broadest accounting boundary of park-associated property-related value.

2) Scenario 2 includes only the adjusted property-related value associated with the two residential projects developed by the state-owned entity responsible for the park’s construction and operation, amounting to approximately RMB 295.80 million. This scenario represents the portion of property-related value that may potentially be internalized within the same development structure.

3) Scenario 3 excludes property-related value and includes only ecological, social, and direct economic benefits.

Across the three scenarios, ecological, social, and direct economic benefits, as well as investment costs, were held constant. In Scenarios 1 and 2, property-related value was treated as a one-off capitalized benefit in the first year rather than as a recurring annual flow, while recurring benefits were projected over the five-year evaluation period according to their respective durations and discounted at 3% (Table 4).

Scenario 3 highlights the financing challenge of large urban parks when property-related value is excluded. The first-year SROI is 0.10, and the five-year SROI is 0.40, indicating that the recurring ecological, social, and direct operational value do not offset the total investment within the evaluated period under the tested assumptions.

By contrast, Scenario 1 produces the highest SROI because it includes the broader one-off capitalized property-related value associated with adjacent residential areas. Its first-year and five-year SROI values are 0.97 and 1.14, respectively. Scenario 2 yields a first-year SROI of 0.82 and a five-year SROI of 1.01, approaching

cost equivalence over the estimate horizon. The results suggest that, under the specific state-led institutional arrangement examined in this case, the inclusion and potential internalization of park-associated property-related value materially affects the calculated investment return. Such a mechanism should be interpreted as a context-specific value-capture pathway rather than a universally applicable financing solution.

5.3 Structural Responsiveness of SROI: OAT Sensitivity Analysis

An OAT Sensitivity Analysis was conducted to examine how the calculated first-year SROI and five-year SROI respond to changes in selected assumptions (Table 5). A uniform ±20% proportional variation was applied to each parameter to provide a comparable test of model responsiveness. Because this approach applies the same variation range to variables with different monetized values, the results should be interpreted as an exploratory sensitivity test rather than a statistically derived ranking of parameter uncertainty.

The results show that total input is the most responsive parameter in both evaluation periods, with a maximum relative change of 25.00%. Among the benefit-side parameters—including property-related, ecological, direct economic, and social values—property-related value has the greatest influence, with a maximum relative change of 17.96% in the first-year analysis and 13.06% in the five-year analysis. The corresponding first-year SROI ranged from 0.799 to 1.149 under the ±20% variation. This indicates that short-term SROI is particularly sensitive to total input and the magnitude of property-related value included in the accounting boundary.

Ecological value showed a smaller response in the first-year analysis, with a maximum relative change in SROI of 1.17%, increasing to 4.03% over the five-year evaluation period. The corresponding value for direct economic benefits increased from 0.42% to 1.45%, while individual social-value components remained comparatively less influential. These differences primarily reflect the relative monetized scale and temporal structure of the selected outcomes under the adopted valuation assumptions rather than their substantive importance.

6 Discussion

6.1 Context-specific Contribution of the Adapted SROI Framework

The empirical results support the central argument of this study: fragmented single-dimension valuation approaches may

Table 4: Comparative analysis of SROI under different scenarios

Scenario	Period	Total present value (RMB)	Total input (RMB)	SROI
Scenario 1: all adjusted property-related value	Year 1	397,160,494	407,820,000	0.97
	Year 1–5	546,031,627	479,100,000	1.14
Scenario 2: state-owned developer residential plots only	Year 1	336,269,131	407,820,000	0.82
	Year 1–5	485,140,264	479,100,000	1.01
Scenario 3: excluding property-related value	Year 1	40,472,251	407,820,000	0.10
	Year 1–5	189,343,384	479,100,000	0.40

Table 5: OAT Sensitivity Analysis of first-year and five-year SROI

Parameter		Monetized value (RMB)	First-year SROI (±20%)	First-year max relative change (%)	Five-year SROI (±20%)	Five-year max relative change (%)
Total input		407,820,000	0.812–1.217	25.00	0.950–1.425	25.00
Property-related value		356,688,243	1.149–0.799	17.96	1.289–0.991	13.06
Ecological value		23,316,500	0.985–0.962	1.17	1.186–1.094	4.03
Direct economic value		8,386,000	0.978–0.970	0.42	1.156–1.123	1.45
Social value	Life satisfaction improvement	2,907,282	0.975–0.972	0.15	1.145–1.134	0.50
	Sports value	2,472,935	0.975–0.973	0.12	1.145–1.135	0.43
	Mental health improvement	1,410,227	0.975–0.973	0.07	1.142–1.137	0.24
	Family harmony	849,821	0.974–0.973	0.04	1.141–1.138	0.15
	Science/environmental education value	875,344	0.974–0.973	0.04	1.141–1.139	0.09
	Social network expansion	254,143	0.974–0.974	0.01	1.140–1.139	0.04

underrepresent the comprehensive investment performance of large urban parks. Under the integrated SROI accounting framework, which jointly incorporates ecological, social, direct economic, and property-related values, the Biyun Green Space case generates a first-year SROI of 0.97 and a five-year SROI of 1.14 under selected accounting assumptions—this means every RMB 1 invested corresponds to approximately RMB 0.97 and RMB 1.14 in adjusted monetized value over one and five years, respectively. The first-year monetized benefits are close to the total input, while the five-year SROI modestly exceeds 1. Directly monetized ecological services account for 5.87% of the total adjusted value, while social value accounts for 2.21%. Although these shares are relatively modest, their inclusion extends the appraisal beyond directly recoverable economic returns and contributes to a more comprehensive representation of the park’s public value.

The adapted SROI framework therefore provides a structured way to integrate multiple value dimensions that are often evaluated separately. Through localized ecological accounting parameters, WTP-based social valuation, and scenario-based property-value analysis, it makes visible a broader investment return profile that may otherwise be overlooked in conventional public investment appraisal.

The main implication of this case is that integrated SROI can provide additional empirical evidence for reconsidering how large urban parks are positioned in public investment decisions—not merely as expenditure items, but as public assets capable of generating multiple forms of long-term value. In the context of China’s “Park City” agenda and tightening local government budgets, making these multidimensional returns more visible and quantifiable can strengthen the evidence base for green space financing and support more informed allocation of public resources.

6.2 Property-Related Value Capture and Institutional Boundaries

A key finding of this study is that property-related value forms a major component of the monetized outcomes. This is consistent with a growing body of hedonic and spatial evidence showing that urban green amenities can be capitalized into nearby housing values, though the magnitude and spatial extent vary across contexts^[27–34]. In the studied case, property-related value remains the largest economic component even after SROI impact adjustments. This finding suggests that the investment performance of large urban parks cannot be adequately assessed

through ecological or social valuation alone; the institutional mechanisms governing property-related value distribution are equally central to understanding the financial logic of park provision.

This finding also highlights a structural value-capture problem in urban green space provision. Large parks require substantial upfront public or quasi-public investment, while part of the economic benefit may be capitalized into surrounding property assets. If no mechanism exists to recover or internalize these external benefits, the provider of green infrastructure may bear the main construction and maintenance costs, while a significant share of the financial gains is realized by adjacent property owners or developers^[49–50,52–53].

The scenario analysis further clarifies the institutional significance of property-related value capture. When property-related value is excluded from the accounting boundary, the first-year and five-year SROI values fall to 0.10 and 0.40, respectively. Thus, the recurring ecological, social, and direct economic value included in this assessment do not offset the upfront and operating inputs within the five-year horizon. This indicates that the calculated investment return is strongly influenced by whether and how property-related spatial externalities are included and potentially internalized.

In the Biyun Green Space case, the involvement of a state-owned development entity in both park provision and adjacent residential development creates an institutional condition under which part of the park-associated property-related value can be internalized. This arrangement helps link value creation and value recovery within the same development framework. However, this model presupposes specific institutional conditions: a single public/quasi-public entity with simultaneous control over park investment and adjacent land development rights, a greenfield or newly planned development area, and a regulatory environment that permits cross-subsidization between infrastructure spending and residential development revenue^[48,53–54].

6.3 Cost Sensitivity and Life-Cycle Value Retention

The OAT Sensitivity Analysis (Table 5) identifies total input as the most responsive parameter in the SROI calculation. The first-year monetized benefits amount to RMB 397.16 million, compared with a total input of RMB 407.82 million, resulting in an SROI of 0.97. Under the accounting assumptions adopted in this study, the value-equivalence point at which SROI equals 1.0 corresponds to a total input of approximately RMB 397.16 million, or 2.61% below the observed first-year input. This indicates that a relatively small

reduction in total input could bring the first-year SROI to cost equivalence, highlighting the importance of capital efficiency in the early investment stage. This value-equivalence point should, however, be interpreted as a case-specific reference rather than an optimal or maximum investment threshold.

Over the five-year evaluation period, the SROI increases to 1.14 as recurring ecological, social, and direct economic benefits accumulate, whereas property-related value is treated as a one-off capitalized benefit in the first year. This temporal pattern suggests that cost optimization should not be understood as indiscriminate expenditure reduction. Expenditures that support ecological performance, public use, and long-term operation may be necessary to sustain recurring benefits over time. Previous urban park research similarly shows that low-input and value-engineering strategies can improve life-cycle cost efficiency while maintaining environmental and social objectives^[61]. Accordingly, the Biyun case suggests that investment management should balance early-stage capital efficiency with the retention of expenditures necessary to sustain long-term value.

6.4 Limitations and Prospects

Several limitations should be acknowledged. First, this study is based on a single case with a specific institutional arrangement, in which a state-owned development entity was involved in both park development and adjacent residential development. Future studies could further test the adapted SROI framework across park cases with different governance structures and development models.

Second, although the questionnaire sample met the minimum sample-size requirement, the social-value estimates were based on an on-site visitor survey and annual person-visit statistics, and therefore mainly reflect the perceived benefits of active park users. The person-visit approach avoids applying an additional visit-frequency multiplier, but the estimates remain sensitive to the proportion of respondents reporting each benefit and to the per-visit monetary proxies used to value these benefits. Although social outcomes were elicited as separate categories, some conceptual overlap among subjective benefits cannot be fully excluded. Future research could improve representativeness by expanding the sample, diversifying sample sources, and conducting longer-term surveys.

Third, property-related value was estimated through buffer-zone comparison and adjusted for deadweight and attribution. It should therefore be interpreted as a scenario-based estimate under the selected accounting assumptions rather than as a strict

causal estimate. Future studies could further incorporate individual residential transaction records, including actual transaction prices, transaction dates, housing characteristics, and location attributes, together with more rigorous spatial and statistical controls to better isolate park-associated property-price effects.

Finally, the monetized shares of ecological and social outcomes remain sensitive to the selected indicators, valuation proxies, and accounting boundaries. Future research could strengthen non-market valuation through dynamic ecological modeling, long-term monitoring, larger user samples, and broader ecosystem-service and well-being indicators.

7 Conclusions

This study makes three contributions to the existing literature. First, it develops a context-adapted SROI framework that extends conventional applications by incorporating localized valuation parameters, institutional settings, ecological accounting boundaries, and financing mechanisms, thereby improving the applicability of SROI to China's urban green-space governance. Second, it establishes a more comprehensive investment evaluation framework by integrating ecological, social, and economic benefits with construction and operation costs into a unified accounting system, addressing the fragmented nature of existing green space valuation approaches. Third, through an empirical application to a large urban park, the study identifies how different value dimensions contribute to investment performance and discusses the institutional conditions under which these returns may support sustainable financing and evidence-based public investment decisions. Together, these contributions provide both methodological refinement and practical evidence for improving the comprehensive valuation and long-term governance of large urban parks.

The main findings show that, under the selected accounting assumptions, the Biyun Green Space can generate a first-year SROI of 0.97 and a five-year SROI of 1.14. The results indicate that adjusted monetized benefits approximately match first-year input and exceed cumulative investment over the five-year evaluation horizon under the selected accounting assumptions. The findings also highlight the important role of property-related value in the overall SROI. Ecological, social, and direct economic value represent recurring public value but do not offset total investment within the five-year horizon when property-related value is excluded. In the Biyun case, the coordination of park development with adjacent residential development creates conditions for

partially internalizing one-off capitalized property-related benefits. This suggests that value-capture mechanisms may help alleviate financing pressures where similar institutional arrangements exist. Overall, integrated SROI assessment can make the multiple values of large urban parks more visible in public investment decisions. In the context of China's Park City agenda, this approach can support a more balanced understanding of large parks as long-term public assets rather than solely as fiscal expenditures.

ELECTRONIC SUPPLEMENTARY MATERIAL

Supplementary material is available in the online version of this article at <https://doi.org/10.15302/J-LAF-2026-0044>.

Competing interests | The authors declare that they have no competing interests.

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大型城市公园多维价值货币化评估——基于情境的社会投资回报率框架

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摘要

在中国“公园城市”建设持续推进和地方财政预算趋紧的背景下, 大型城市公园面临长期存在的价值识别与融资难题, 其生态、社会效益及空间外部性往往难以被传统财政核算充分识别, 也难以被公园投资主体有效内部化。本文以上海碧云绿地为研究案例, 引入符合中国情境的社会投资回报率(Social Return on Investment, SROI)框架, 将生态价值、社会价值、直接经济价值及房产相关经济价值纳入统一的货币化核算体系。研究结果表明: 1) 在本文设定的核算假设下, 碧云绿地首年SROI为0.97, 5年后评价期累计SROI为1.14, 即每投入1元, 在首年和5年评价期内累计分别对应约0.97元和1.14元的调整后货币化价值; 2) 各类货币化价值分布具有明显差异, 其中房产相关经济价值占首年货币化总价值的89.81%, 生态价值、社会价值和直接经济价值分别占5.87%、2.21%和2.11%; 3) 情景分析表明, 房产相关空间外部性的纳入及其潜在内部化程度会显著影响SROI结果, 在特定制度条件下, 公园-地产协同开发可能形成具有中国情境适应性的价值捕获路径; 4) 单因素(OAT)敏感性分析表明, 短期投资绩效主要受总投入规模影响, 而随着评价周期延长, 生态、社会 and 直接经济等持续性收益的累积对长期投资绩效的支撑作用逐渐显现, 表明项目早期应更加关注资本投

入效率, 而长期投资评价则需要重视持续性公共收益的维持。

本文为SROI框架在大型城市公园价值评估中的应用提供了中国情境化实证证据。研究表明, 大型城市公园投资决策需要统筹前期资本效率与长期持续性公共收益, 并结合具体制度条件探索房产相关空间外部性的价值内部化机制。

关键词

社会投资回报率(SROI); 大型城市公园; 综合价值评估; 生态价值; 社会价值; 价值货币化

文章亮点

- 基于中国情境拓展SROI, 综合评估大型城市公园的生态、社会和经济价值
- 大型城市公园的综合价值由房产相关价值占主导, 而生态和社会效益具有持续性
- SROI对总投入和房产相关价值最为敏感, 凸显价值捕获潜力