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Integration of Socio-Ecological Systems in Urban Forest Agroecosystem Management for Sustainable Tourism

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Abstract: Urban agroecosystem management faces pressures from urbanization, environmental degradation, and weak integration policies, resulting in a decline in the quality of ecosystem services. Sectoral approaches have not been able to systematically integrate ecological and social dimensions. This study aims to formulate a conceptual model for urban agroecosystem management based on the Socio-Ecological Systems (SES) framework as an integrative approach to sustainability. The method used is a systematic literature review of international publications in the last five years related to ecosystem services, green infrastructure, peri-urban agroecology, and collaborative governance. A total of 100 scientific articles were obtained through the search process, and after going through the screening process, a total of 15 articles were obtained as the main material for the scientific literature process in this study. The analysis shows that vegetation and biodiversity are ecological ecosystems that produce regulatory, provisioning, and cultural ecosystem services. These benefits contribute to improving environmental quality and community well-being. Adaptive governance, community participation, and ecosystem-based integration policies significantly influence the ecosystem system, creating positive feedback mechanisms. The developed conceptual model emphasizes the interconnectedness of biophysical and social components in building resilient and sustainable urban agroecosystems. This study proposes a new conceptual model based on socio-ecological systems that integrates biophysical, social, and tourism dimensions in urban forest agroecosystems by placing tourism experience as the main mediating variable in shaping the desire feedback mechanism.

Keywords: Adaptive Governance; Ecosystem Services; Socio-Ecological Systems; Urban Agroecosystems; Sustainability.

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Introduction

The acceleration of global urbanization is putting significant pressure on the management of urban green spaces, particularly as competition for land between physical development and environmental conservation efforts intensifies. World Bank data shows that currently more than 55% of the global population (approximately 4.4 billion people) lives in urban areas, and this figure is projected to increase to nearly 70% by 2050 (World Bank, 2023). As a result of this massive expansion, the UN-Habitat World Cities Report reveals a worrying trend: the world has witnessed a consistent decline in green spaces in urban areas globally over the past 30 years (UN-Habitat, 2022). Green spaces and urban forests play a crucial role in providing ecosystem services, including regulating the microclimate, providing habitat for

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biodiversity, and mitigating the urban heat island effect. All of these functions are essential elements in achieving sustainable urban development (Qu et al., 2025). In urban contexts, agroecosystems such as courtyards and green spaces contribute to food security and community well-being (Lal, 2020; Orsini et al., 2013). Therefore, the World Bank emphasizes the importance of reserving green open land before urban development occurs, especially in developing countries that are facing the pressure of rapid urbanization in order to prevent unhealthy density (overcrowding) and maintain the ecological function of the city.

Ecological balance and meeting the socio-economic needs of communities depend heavily on the integration of vegetation functions with management systems that consider the reciprocal interactions between humans and the environment from an agroecosystem perspective. Urban forests are no longer simply conservation areas, but rather adaptively managed ecological-productive systems. Urban green open spaces have significant potential as nature-based tourism destinations, which are gaining increasing popularity post-pandemic, going beyond their ecological functions. Areas such as urban forests offer recreational experiences that combine ecosystem services with social and cultural values, thus stimulating local economic growth while improving community well-being (Zhang et al., 2025; Ijatuyi et al., 2025; Chen & Cheung, 2025). However, nature tourism development must be based on sustainability principles to avoid triggering environmental degradation or social conflict.

Literature findings reinforce the integration of social and ecological dimensions by showing that visitor perceptions of biophysical elements such as biodiversity levels and landscape quality are positively correlated with tourist satisfaction and support for conservation efforts (Ardiansyah et al., 2026; Zhang et al., 2025). This indicates that the success of sustainable tourism is determined not only by biophysical conditions but also by the capacity of governance to manage socio-ecological interactions responsively. The Social-Ecological Systems (SES) approach offers a comprehensive analytical framework for examining the interactions between biophysical components—such as vegetation structure, species diversity, and ecosystem services—and social components, including user perceptions, community participation, and institutional governance (Hasanah et al., 2026). By combining these two dimensions, adaptive and sustainable management strategies can be formulated (Ardiansyah et al., 2026). In this context, ecosystem services are not solely viewed as ecological benefits, but also as socio-economic constructs shaped by values, preferences, and institutions. The integration of biophysical and social dimensions through this framework enables the optimal achievement of ecosystem services (Zhou & Liu, 2024; Lade et al., 2020).

Elinor Ostrom's Social-Ecological Systems (SES) framework is fully reflected through the interconnectedness of its four main components, which interact dynamically with each other. The Resource Units and Resource Systems components are represented by tangible biophysical elements such as vegetation structure, species diversity, landscape quality, and ecosystem services, which form the ecological foundation of tourism. These ecological components interact directly with the Actors, which in this context are visitors and local communities, who bring social dimensions in the form of values, preferences, perceptions, levels of satisfaction, and their commitment to conservation efforts. To ensure that this interaction between humans and nature does not damage the ecosystem, a Governance Systems component is required, consisting of institutional governance, institutions, and responsive community participation. Through the integration of all these components, ecosystem services are no longer viewed merely as passive ecological benefits, but rather as an adaptive socio-economic construct, where the success of achieving sustainable tourism and optimizing ecosystem services depends heavily on how effectively the governance system is able to align the needs of actors with the carrying capacity of available resource units.

There is still a tendency in various studies to separate the analysis of urban agroecosystem management from social dynamics such as tourist preferences, community participation, and local economic impacts. Several studies have identified variations in tourism demand and the importance of adaptive management strategies to visitor preferences (Ijatuyi et al., 2025; Russo & Cirella, 2025; Zhang et al., 2025), but these findings have not been explicitly integrated into SES-based agroecosystem management models. This research aims to formulate a sustainable agroecosystem management approach in urban forests serving as tourist destinations, emphasizing the integration of socio-ecological elements. This approach is designed to maintain the quality of ecosystem services while supporting environmentally friendly tourism activities. Conceptually, this study is expected to contribute to the development of literature on green open space management and ecosystem service-based governance policies in the context of urban sustainability (Fauzia et al., 2024; Qu et al., 2025). This research presents a new approach to developing an integrative model of urban forest agroecosystems, grounded in a socio-ecological systems (SES) perspective.

This approach simultaneously connects biophysical, social, and tourism function components

within a unified conceptual framework. Unlike previous studies that tend to separate ecological and social aspects, this study integrates causal relationships from vegetation to adaptive governance through ecosystem services and tourism experiences. Tourism experiences are positioned as a connecting variable that mediates the relationship between ecosystem quality and actor participation. The result is a positive feedback model capable of explaining the mechanisms of agroecosystem sustainability more comprehensively.

Method

This study employed a Systematic Literature Review (SLR) approach, guided by the PRISMA 2020 guidelines, to ensure transparency, consistency, and replicability in the literature selection process (Page et al., 2021). The PRISMA 2020 process, consisting of four stages: identification, screening, eligibility, and inclusion, was followed throughout the research process. All articles retrieved from databases during the identification stage were exported and processed through reference management software, where duplicates were removed. Second, title, abstract, and keyword screening were performed. Full-text review was based on substantive relevance, methodological quality, and research objectives. A total of 100 articles sourced from Scopus, Web of Science, and Google Scholar were screened according to the PRISMA stages, resulting in 15 primary articles as study material in this study.

We extracted data from nine selected articles by reviewing key information as well as author(s), year of publication, and research location, type of urban agroecosystems, types of ecosystem services examined, SES dimensions and their implications for sustainable tourism development. Next, a thematic analysis was conducted to describe patterns, research gaps, and interactions between urban agroecosystems, ecosystem services, and tourism sustainability.

The data selection and extraction process was undertaken systematically according to protocols established at the start of the study. This enhanced the validity of the findings. The findings from the literature were then summarized narratively and conceptually in a variety of ways to demonstrate a higher-level understanding of how urban agroecosystems, as components of socio-ecological systems, can contribute to human well-being through the sustained delivery of ecosystem services and sustainable tourism development.

A literature search was conducted in reputable international databases, such as Scopus, Web of Science, and Google Scholar, using a combination of keywords: "urban agroecosystem," "urban forest," "ecosystem services," "social-ecological system," and "sustainable tourism." Inclusion criteria included: 1. Indexed international journal articles; 2. Published within the last five years (2020–2025); 3. Relevant to the themes of agroecosystems, ecosystem services, and SES. Exclusion criteria included: 1. Non-peer-reviewed articles; 2. Studies not focused on the urban context; 3. Articles with low methodological quality. Some references from before 2020 are still used as a conceptual basis.

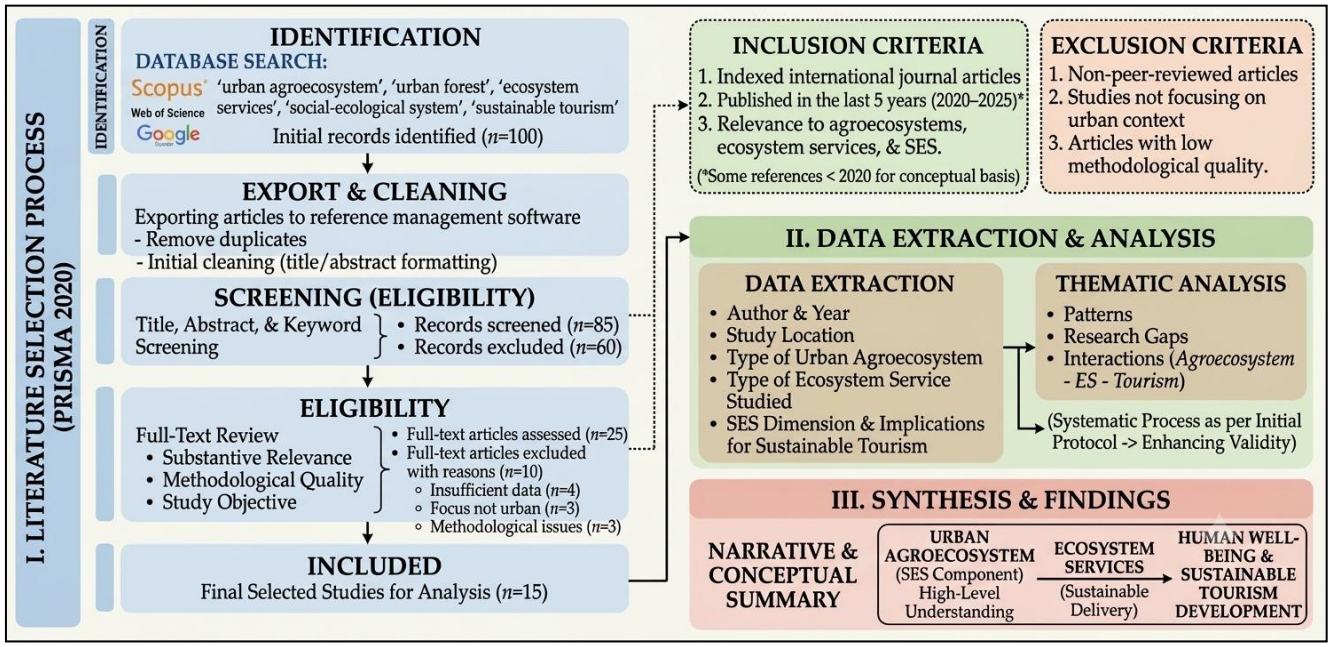

Figure 1. Research Flowchart

Result and Discussion

Literature Synthesis on Agroecosystems and Socio-Ecological Integration

A literature review reveals that urban forest agroecosystems are complex and dynamic systems born from the intensive interaction of biophysical and social aspects. To understand the sustainable functioning of these systems, the integration of biophysical components—such as vegetation and biodiversity—and social elements such as institutional governance is fundamental (Lade et al., 2020; Qu et al., 2025). These reciprocal relationships are generally explained through a Socio-Ecological Systems (SES) approach (Tsai et al., 2023; Wu & Liu, 2024).

However, there is significant disagreement among researchers regarding the causal dynamics within these systems. On the one hand, several studies argue that ecological (biophysical) changes predominantly dictate the behavior and social adaptation of surrounding communities (Díaz-Pinzón et al., 2024). Conversely, findings by Zhou & Liu (2024) demonstrate contradictory results, where policy interventions and institutional (social) governance often fail to mitigate environmental degradation due to local resistance. Moreover, while Wu & Liu (2024) are optimistic that the SES approach is able to portray these reciprocal relationships in a balanced manner, Tsai et al. (2023) criticize that the conventional SES model tends to simplify the complexities in the field and often ignores the conflicts of interest between policy stakeholders that hinder the adaptation of the system.

The relevance of the Socio-Ecological Systems (SES) framework lies in its ability to more fully unravel the complexity of urban agroecosystems. Armson et al. (2022), Calzolari et al. (2020), Ijatuyi et al. (2025), and Zhang et al. (2025) emphasize that vegetation is a key component of urban forest agroecosystems, supporting biodiversity while providing a variety of ecosystem services. Its regulatory function includes controlling air quality and temperature, its provisioning function includes crop yields, and its cultural function encompasses recreational and aesthetic values. These three functions simultaneously promote improvements in environmental quality and the well-being of urban residents. However, a review of various studies indicates that the majority of research still often separates the ecological dimension from the social aspect.

The limited number of studies that directly integrate these two aspects within a single analytical framework necessitates a more comprehensive strategy. The SES approach is considered capable of addressing this gap by connecting various dimensions in an integrated manner (Lade et al., 2020; Morris et al., 2024; Tsai et al., 2023; Wu & Liu, 2024).

Identification of Socio-Ecological System (SES) Components

Identification of SES components aims to understand the structure and dynamics of agroecosystems as a whole. Based on literature synthesis, there are three main interacting components: social actors, biophysical resources, and socio-ecological interactions (Díaz-Pinzón et al., 2024; Tsai et al., 2023; Wu & Liu, 2024; Zhou & Liu, 2024).

Social Actors

Social actors in urban forest agroecosystems include local governments, local communities, tourists, academics, and non-governmental organizations. The government plays a role in policy development and green space management, while communities act as users and managers at the local scale (Díaz-Pinzón et al., 2024; Sharpley, 2020; Tsai et al., 2023; Wu & Liu, 2024). Tourists benefit from ecosystem services, while academics and NGOs provide knowledge and policy guidance.

Within the SES framework, social actors function not only as resource users but also as drivers of change through active participation in management and decision-making. This participation is key to creating adaptive governance that is responsive to environmental and social changes (Ijatuyi et al., 2025; Romagosa, 2020; Tsai et al., 2023; Wu & Liu, 2024).

However, interactions between actors in urban forest agroecosystems are often characterized by complex, conflicting interests. Local governments tend to focus on formal regulations and macro-targets of urban aesthetics, which are sometimes at odds with the practical needs of local communities who rely on these spaces for their daily economic or social needs. On the other hand, pressure from the tourism sector can trigger excessive commercialization, which risks degrading the ecological function of urban forests if left unchecked. This is where academics and non-governmental organizations (NGOs) play a crucial role as knowledge brokers, translating grassroots needs into scientifically based recommendations to ensure equitable and sustainable policies (Ijatuyi et al., 2025; Sharpley, 2020).

Ultimately, the successful integration of all these actors within the SES framework depends heavily on the social capital possessed by the community. When communication channels between actors are transparent and inclusive, this collaboration can generate local innovations that strengthen urban forests' resilience to the pressures of massive urbanization. Responsive adaptive governance will not be created automatically, but must be maintained through a balanced division of roles, where local communities are no longer positioned as passive objects receiving policies, but rather as

strategic partners in maintaining the long-term stability of urban ecosystems (Díaz-Pinzón et al., 2024; Wu & Liu, 2024).

Biophysical Resources

Biophysical resources encompass all ecological elements that support agroecosystem function, such as soil, vegetation, and biodiversity. Soil serves as the primary medium for water production and storage, while vegetation regulates the microclimate and provides habitat (Armson et al., 2022; Calzolari et al., 2020; Lal, 2020; Orsini et al., 2020). Biodiversity, particularly fauna such as arthropods, contributes to maintaining ecosystem balance.

The availability and quality of these biophysical resources significantly determine the system's capacity to provide ecosystem services sustainably. Deterioration in biophysical quality will directly impact ecosystem function and the benefits received by communities (Fauzia et al., 2024; Lade et al., 2020; Qu et al., 2025; Zhang et al., 2025).

Despite these crucial roles, biophysical resources currently face massive anthropogenic pressures due to unsustainable agricultural intensification and land conversion. Practices such as the excessive use of synthetic chemicals and monoculture can accelerate soil degradation, erode local biodiversity, and disrupt the natural hydrological cycle. When this biophysical stability is disrupted, agroecosystems lose their resilience to extreme climate change, which in turn triggers food insecurity and decreases the economic well-being of farmers.

Therefore, the implementation of holistic, conservation-based landscape management strategies is urgent and cannot be postponed. Approaches such as agroforestry, regenerative agriculture, and Integrated Pest Management (IPM) can be effective solutions for restoring and maintaining soil quality and faunal biodiversity. Through the integration of appropriate policies and active community participation, the restoration of these biophysical functions not only ensures the sustainability of agricultural production but also strengthens the long-term provision of ecosystem services for future generations.

Socio-Ecological Interactions

Interactions between social and biophysical components occur through the use of ecosystem services, tourism activities, and environmental management practices. These interactions are reciprocal, with ecological conditions influencing human experiences and perceptions, while human activities influence ecosystem quality (Ijatuyi et al., 2025; Tsai et al., 2023; Wu & Liu, 2024; Zhou & Liu, 2024).

Collaboration between actors in the form of community participation, environmental education programs, and community-based governance is a crucial factor in strengthening socio-ecological relationships. This collaborative approach has been shown to increase the effectiveness of ecosystem management while strengthening socio-ecological resilience (Chen, 2025; Díaz-Pinzón et al., 2024; Wu & Liu, 2024).

On the other hand, imbalances in these socio-ecological interactions are often triggered by uncontrolled anthropogenic pressures, such as massive land conversion and overexploitation of natural resources. When human activities exceed the environmental carrying capacity, ecosystem quality degradation occurs, directly reducing the utility value and environmental services available to communities. These negative impacts not only threaten the sustainability of biodiversity but also create new vulnerabilities for local communities whose economic and social livelihoods depend closely on the ecological stability of the area.

Therefore, integrating science-based policies with local wisdom is crucial in formulating sustainable adaptation strategies. Efforts to restore harmonious socio-ecological relationships require an adaptive regulatory framework, combining regular monitoring of biophysical conditions with strengthening community social capacity. Through this synergy, environmental challenges such as climate change and habitat degradation can be effectively mitigated, while ensuring that the welfare benefits from ecosystem services are distributed equitably and sustainably to future generations.

The Role of Agroecosystems in Supporting Sustainable Tourism

Urban forest agroecosystems hold great potential as sustainable, nature-based tourism destinations. Vegetation diversity and heterogeneous landscape structures enhance the visual quality and comfort of the environment, providing a positive tourism experience for visitors (Armson et al., 2022; Ijatuyi et al., 2025; Qu et al., 2025; Zhang et al., 2025).

Beyond aesthetics, agroecosystems also possess significant educational value. The diverse flora and fauna can be utilized as a medium for environmental education, which in turn increases public ecological awareness (Chen, 2025; Fauzia et al., 2024; Lal, 2020; Orsini et al., 2020). This demonstrates that agroecosystem-based tourism is not solely oriented toward recreation, but also toward conservation and education.

Within the SES framework, positive tourism experiences will lead to increased visitor satisfaction, which in turn contributes to increased support for

environmental conservation efforts (Romagosa, 2020; Sharpley, 2020 Tsai et al., 2023; Wu & Liu, 2024). This support can be realized through participation in reforestation activities, environmental maintenance, and policy advocacy. Thus, agroecosystems act as a link between ecological functions and socio-economic benefits in the context of sustainable tourism (Chen, 2025; Ijatuyi et al., 2025; Zhang et al., 2025).

Conceptual Model of Sustainable Agroecosystem Management

Based on a literature synthesis, a conceptual model was developed that describes the causal relationships between components in a socio-ecological system. The model consists of a series of processes.

Vegetation → Biodiversity → Ecosystem Services → Landscape Quality → Tourism Experience → Actor Participation → Adaptive Governance → System Sustainability (Lade et al., 2020; Tsai et al., 2023; Wu & Liu, 2024; Zhang et al., 2025).

This model suggests that improving vegetation quality will strengthen biodiversity, which in turn increases the capacity to provide ecosystem services. These ecosystem services contribute to landscape quality and the tourism experience perceived by visitors (Armson et al., 2022; Calzolari et al., 2020; Ijatuyi et al., 2025; Qu et al., 2025).

Positive tourism experiences will influence community perceptions and attitudes, thus encouraging active participation in environmental management. This participation, in turn, strengthens adaptive governance, which is key to maintaining the long-term sustainability of the system (Díaz-Pinzón et al., 2024; Tsai et al., 2023; Wu & Liu, 2024). The relationships between components in this model are dynamic and form a positive feedback loop, allowing the system to adapt to environmental and social changes (Chen, 2025; Lade et al., 2020; Sharpley, 2020; Zhou & Liu, 2024). Furthermore, this positive feedback cycle creates a multiplier effect that strengthens the resilience of the overall socio-ecological system. When adaptive governance is successfully implemented through flexible and collaborative regulations, it directly impacts the protection and restoration of vegetation at the site level (Lade et al., 2020; Wu & Liu, 2024). Successful governance in maintaining natural capital ensures that the causal cycle does not end as a linear process, but rather a regenerative loop that continuously enhances the system's adaptive capacity to external disturbances such as climate change or anthropogenic pressures (Zhou & Liu, 2024; Chen, 2025). Thus, system sustainability is no longer a static target, but rather a dynamic process maintained by harmonious interactions between humans and their environment.

However, the effectiveness of this conceptual model in practice depends heavily on the synchronization between local actors' perceptions and implemented governance policies. Barriers to actor participation—whether due to conflicting interests or a lack of incentives for communities—can disrupt this chain of causality, potentially turning positive feedback into system degradation (Sharpley, 2020; Tsai et al., 2023). Therefore, integrating ecological monitoring (such as vegetation quality and biodiversity) with social evaluation (such as tourism experience and actor satisfaction) is crucial in formulating responsive adaptive governance strategies (Zhang et al., 2025). Through this holistic approach, the developed socio-ecological model can serve as a practical guide for policymakers in designing sustainable tourism landscapes.

Based on literature synthesis and conceptual analysis, a sustainable agroecosystem management model within the Socio-Ecological Systems framework is presented in Figure 2.

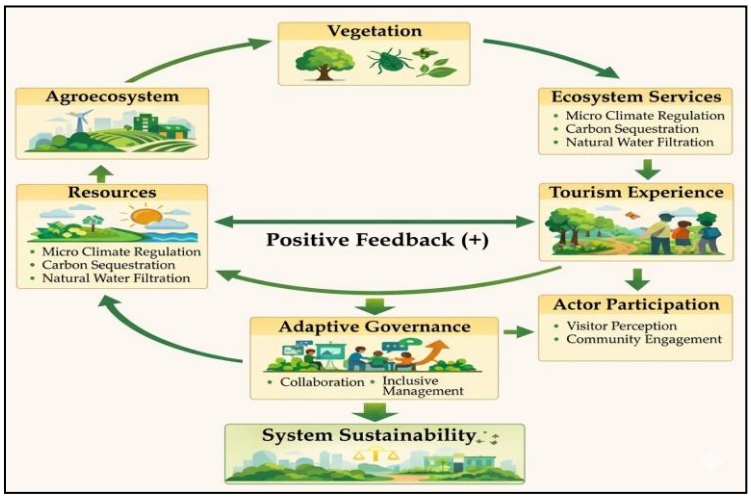

Figure 2. Conceptual Model of Urban Agroecosystem Socio-Ecological System

Theoretical and Practical Implications

Theoretically, this study confirms that urban agroecosystems are complex systems that cannot be understood in isolation. The SES approach provides an integrative framework capable of comprehensively explaining the interrelationships between ecological and social dimensions (Lade et al., 2020; Tsai et al., 2023; Wu & Liu, 2024; Zhou & Liu, 2024).

Practically, the results of this study provide several important implications for urban green space management, namely: (1) the need to increase vegetation diversification to strengthen ecosystem services; (2) the importance of community participation in collaborative management; and (3) the integration of conservation strategies and sustainable tourism development (Armson et al., 2022; Chen, 2025; Ijatuyi et al., 2025). This approach is expected to form the basis for formulating policies and strategies for managing urban agroecosystems that are more adaptive, inclusive, and sustainable (Tsai et al., 2023; Qu et al., 2025; Wu & Liu, 2024; Zhang et al., 2025).

These findings indicate that most previous research has not explicitly positioned tourism experience as a mediating variable in socio-ecological systems. Previous studies tend to focus on the relationship between ecosystem services and social benefits without elaborating on the feedback mechanisms linking actor behavior to system sustainability. Therefore, the model proposed in this study provides a conceptual contribution by explaining the dynamic pathways linking biophysical quality to adaptive governance through tourism experience as the key link.

Conclusion

The integration of Socio-Ecological Systems (SES) in urban forest agroecosystem management demonstrates that system sustainability is determined by the dynamic interactions between biophysical and social components. Vegetation and biodiversity serve as the foundation for providing ecosystem services, while actor participation and adaptive governance are key factors in maintaining the system's sustainability. The resulting conceptual model emphasizes the causal and feedback relationships between ecosystem quality, tourism experiences, and governance mechanisms. In an urban context, this approach enables the transformation of urban forests into multifunctional systems that simultaneously integrate ecological, social, and economic functions. However, the model developed in this study is still macro-conceptual and uses a cross-sectional approach. Therefore, it does not empirically and quantitatively test the fluctuations in these interrelationships or capture the dynamics of long-term landscape change longitudinally.

Thus, the SES approach can still serve as a strategic framework for planning and managing more resilient, adaptive, and sustainable urban agroecosystems. In the context of Mataram City, optimizing the function of the Pagutan Green Open Space (RTH) as a multifunctional agro-ecosystem has the potential to become a prototype for green space management based on ecosystem services and sustainable tourism. Although the specific research focus on Pagutan RTH requires adjustments if these findings are generalized to other regions with different socio-cultural characteristics, this conceptual model still has strong potential to serve as a basis for developing evidence-based policy. Ultimately, the limitations of space and time in this study actually open up opportunities for future research to quantify system indicators for more comprehensive urban green space management.

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