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Review

Transforming Research on Recreational Ecosystem Services into Applications and Governance

Zhifang Wang [1], Yuqing Jian [1,*], Zhibin Huang [1], Salman Qureshi [2], Kexin Cheng [1], Zhuhui Bai [1] and Qingwen Zhang [1]

[1] College of Architecture and Landscape Architecture, Peking University, Beijing 100871, China
[2] Institute of Geography, Humboldt University of Berlin, Rudower Chaussee 16, 12489 Berlin, Germany
* Correspondence: jyq0824@stu.pku.edu.cn; Tel.: +86-18578602426

Abstract: The science-practice gap has recently been discussed as a critical challenge restricting sustainable growth and development in all facets of our society, including explorations of Recreation Ecosystem Services (RES). To better explore how well the scientific study of RES and its application are connected, this paper aims to synthesize empirical evidence based on an in-depth and systematic literature review. We found that studies of RES have not effectively transformed into the decision-making and long-term planning of our cities. From 2005 to 2020, only 13% of studies referred to specific applications, and about 40% of papers mentioned no applications or practical implications for their research. However, RES research has many potential applications, which can be categorised into six main aspects. In terms of non-spatial improvement: Improved monetary benefits (40%), non-monetary benefits (30%); in terms of spatial improvement: space with high recreational potential or degradation (7%), the relation between supply and demand (7%); and Cross-service governance (16%). After combining the results of various studies, we developed a framework starting from applicable problems and their solutions, which can incorporate the outcomes of RES research while systematically narrowing down the research questions and methods. The framework offers a starting point for further research that can modify and improve in bridging science-practice gaps in RES studies.

Keywords: ecosystem services; cultural ecosystem services; urban ecology; science-practice gap; ecosystem governance; landscape practice

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1. Introduction

The science-practice gap, or synonymously the science-policy gap, has recently been viewed as limiting the sustainable growth and development of society, in terms of the transformation of knowledge from science into practice and governance. Scholars worldwide working in multiple disciplines have sought to address this gap, aiming to improve governance and social well-being [1–4]. Thus, the issue of transforming scientific theories and research into applications and governance is a timely topic that requires attention.

Ecosystem services (ES), "the benefits that people obtain from ecosystems", are increasingly acknowledged as valuable in contemporary planning and governance [5]. However, the application of relevant research were believed to be still superficial and fragmented [6,7]. ES considers the ecological and socio-economic attributes that link natural and human systems and contribute to the overall enhancement of human well-being [8]. Many scholars have demonstrated the advantages of the ES approach in planning, design, and other practices with include its (1) spatially explicit relationships between landscape structure and ES functions, supplies, and values [9], (2) inclusion of stakeholders [10], and (3) comprehensible results [11]. However, only a few studies have explored the applications of ES, and most involve theoretical rather than practice-based procedures [7].

The application of recreational ecosystem services (RES) deserves particular attention as recreation is both a component of cultural ecosystem services (CES) and a carrier of personal experiences of ES [12]. The Millennium Ecosystem Assessment Synthesis Reports (MA) suggested that RES can be regarded as the recreational pleasures that people derive from natural or man-made ecosystems and that involve the contribution of the natural environment to the recreational opportunities and experiences enjoyed by society [13]. Recreation services can provide direct and indirect benefits, such as ecological conservation, human health, social and cultural education, and economic value in the marketplace [14–16]. Recreational activities in outdoor green spaces can be restorative and improved well-being [17]. Recreation services can also provide economic benefits to communities and businesses [18]. Since the definition of ES was initiated in the MA 2005 [13], RES have received increasing attention from scholars in various disciplines such as ecology, economics, urban planning, geography, and social sciences [19,20]. However, an significant knowledge gap remains between RES research and its application. RES have been implemented and applied in some areas, such as the travel cost method for value recreation in the European Union [21] and public participation GIS methods for guiding a planning exercise [22,23]. Nevertheless, knowledge of how RES research can inform applications and governance remain limited.

In this study, we conduct a literature review to synthesise the empirical evidence, with the aim of identifying the relationship between the scientific study of RES and its application. Three key research questions are specifically addressed in the review process: How much RES research can serve the application and governance? How well does the RES research connect to application and governance? What can RES research be applied to? This study's ultimate goal is to develop an innovative application framework for RES to provide new approaches to transforming studies into applications and governance. In this paper, the applicability of RES is discussed broadly to include both practice (planning, design, maintenance, and construction of landscape or land uses) and governance (the various processes of negotiation involving the collective interests of stakeholders). Challenges and opportunities of RES research in applications will also be discussed. The overall goal of this study is to identify the science-practice gaps concerning RES and suggest an agenda for the effective transformation of RES research into application and governance. Our assessment of the useful insights into the links between RES and applications can inform evidence-based decision-making and practice-oriented research of RES. This can then help to fulfill the direct need for a better recreational environment and enhance the well-being of residents.

2. Materials and Methods

2.1. Data Collection

The existing literature and its information were obtained from the Web of Science database, which reflects the development of the scientific frontier (www.webofscience.com). The words 'recreational ecosystem services', 'recreational services', 'recreation services', or 'recreation values' were used as keywords and searched on Topic Search, including all the years since MA (2005 to 2020). The document types (English-language publications only) selected in the database were 'REVIEW' and 'ARTICLES'. A total of 1149 published studies were initially identified. Among them, the 'REVIEW' informed us about research progress and the 'ARTICLES' informed us about research analysis.

The literature records were then exported to EndNote Desktop for selection in the second stage. The selection process included eliminating the duplicates in terms of studies, the literature sources, and authors in other academic fields. Then, another manual selection was carried out according to the title, keywords, and abstract. Many that were identified according to the search terms were found to be not specifically related to RES (primarily because some keywords were sporadically identified in the papers by the search engine). There were the following questionable problems in search results: (1) recreation activities are not that same as recreation services; (2) the literature was not downloadable; (3) the

research object was not RES (and the term was only used to support an aspect of the discussion); and (4) the research objective was not focused specifically on RES. Thus, a total of 122 pieces of literature (120 articles and 2 reviews) were ultimately identified after our thorough and rigorous systematic screening review process. Figure 1 illustrates the systematic selection, and a deduction approach used to select research studies that for further in-depth review.

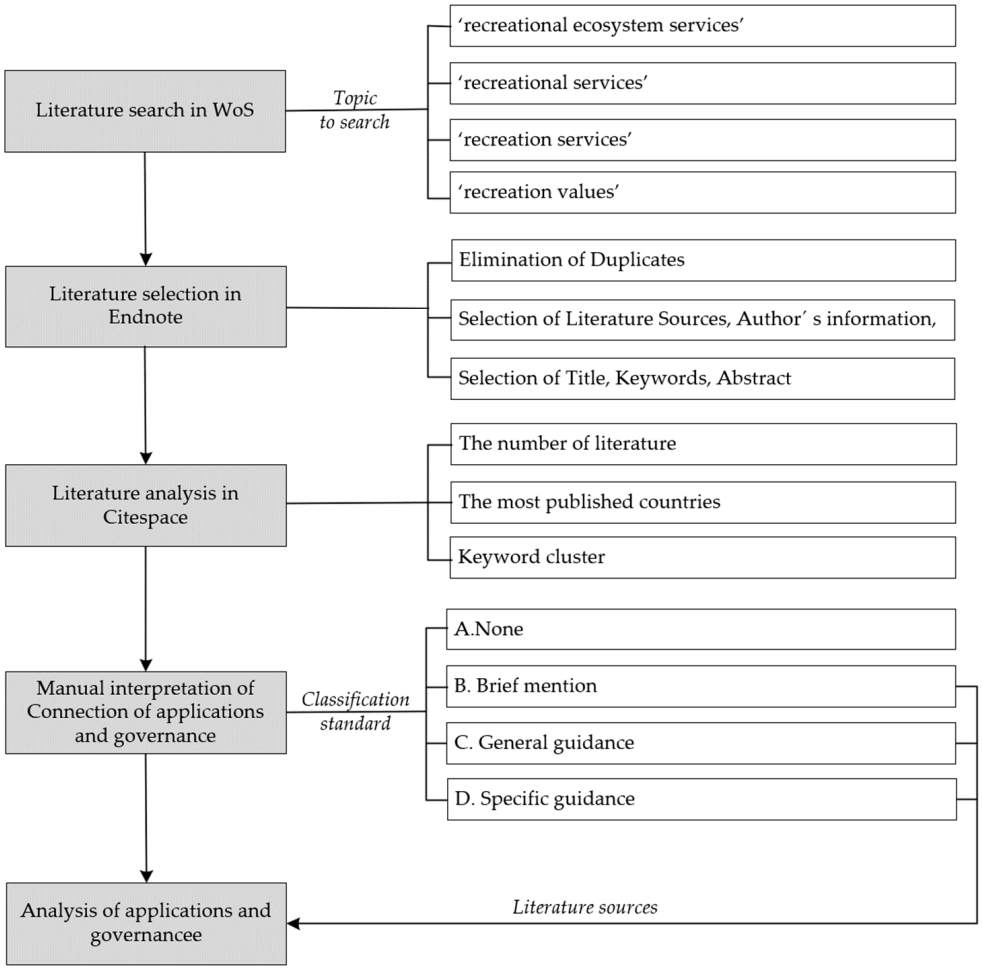

Figure 1. Flowchart of research methodology.

2.2. Assess the Connections to Applications and Governance

The research team read 120 abstracts to determine whether the studies addressed applications and governance focusing RES. Forty-six studies were removed because they do not refer to the applications and governance. This helped to standardise the extent of the connection between applications and governance; the research team referenced Rachelle K. Gould's method [24] and identified four connections (None, Brief mention, General guidance, Specific guidance) (Table 1). We then jointly discussed every piece of study, extracted each statement that supports the connection to applications and governance, and refined our definitions for clarity and consistency. This whole exercise of reading and discussion among colleagues allowed us to collectively understand and thus accurately gauge the connections of studies to applications and governance issues.

A Multilayer Pie Chart was created to illustrate the concept of levels. An inclusion relationship between different levels (https://help.fanruan.com/, accessed on 1 November 2022). This was useful for linking service types and detailed applications to reveal the RES research framework related to applications and governance. The chart was generated using Microsoft Office Excel.

Table 1. Connection to practical application.

Connection	Definition	e.g.,
None	Does not reference applications and governance	/
Brief mention	References practical application, but only tangentially; does not develop or substantiate claims of relevance to applications and governance	helps the decision-making about their improvement a lot; should incorporate recreational value as an effective indicator of cultural services; planners focus not only on physical landscape and expert-based approaches but also on social landscape, etc.
General guidance	Discusses research applications and relevance to governance with more attention to universal findings than to those in any specific context	Enhancing the quality of accommodation facilities; more and better communication actions; the promotion of and education about green areas to residents; etc.
Specific guidance	Makes substantial reference to applications and governance in a specific case, with attention to how the research findings may affect particular decision processes concerning applications and governance	support passive recreation activities such as sitting and reading areas with benches and shades; closing these areas to vehicle traffic and relying more heavily upon existing accessible public transit systems; address this unique pattern requires interventions such as continuous educational or awareness campaigns programs, etc.

2.3. Bibliometric Analysis

A bibliometric analysis of the number of published studies, countries of publication, and keywords was conducted using the Citespace software, which is widely used for bibliometric analyses (https://citespace.podia.com/, accessed on 1 November 2022) [25]. It creates networked infographics on a particular subject, which enabled us to better understand and interpret research trends. In addition to identifying the number of papers and the most published countries, summarizing the general core content of literature was primary aim in our study. Analysing the Keyword cluster indicated the popular topics in RES research. The research keywords analysis began by identifying the 25 most cited or frequently occurring items, followed by generating a hotspot network in Citespace.

3. Results

3.1. Increased Coverage of Ecosystems and Places but Limited Applications

Research on RES began in 2005 since the MA (Figure 2). After that, several studies were inculcated to create a synthesized understanding, and the research grew rapidly before peaking in 2018. In terms of the most published countries (Figure 2), the United States had the largest research output. European countries with significant RES demand such as Italy, England, Germany, and Spain, comprised ~27% of the total literature. Research into RES can be applied to a whole area with different habitat types. The study areas of interest, as shown in Figure 3, mainly include rivers and lakes (19%), urban areas (18%), nature reserves (17%), coastal (16%), others (13%), forests (7%), wetland (7%), and rural area (3%). Among them, "other" mainly refers to mountains, sites, etc.

Table 2 gives the number of studies and their degree of connection to practical application. Approximately 38% of the studies did not support any applications and governance. They are mainly concerned with theory or methodology and proposed new assessment methods for measuring RES value or investigating its formation and transformation mechanisms. Nearly 26% of the studies briefly mentioned the practice areas their findings were relevant to, but none provided specific details. In addition, 23% were able to describe where it should be applied but not how. Only 13% of the studies were classified as Specific guidance. These discussed in detail how their findings related to applications and governance,

or indicated specific measures of goals such as meeting recreation needs, increasing RES value, or avoiding negative impacts.

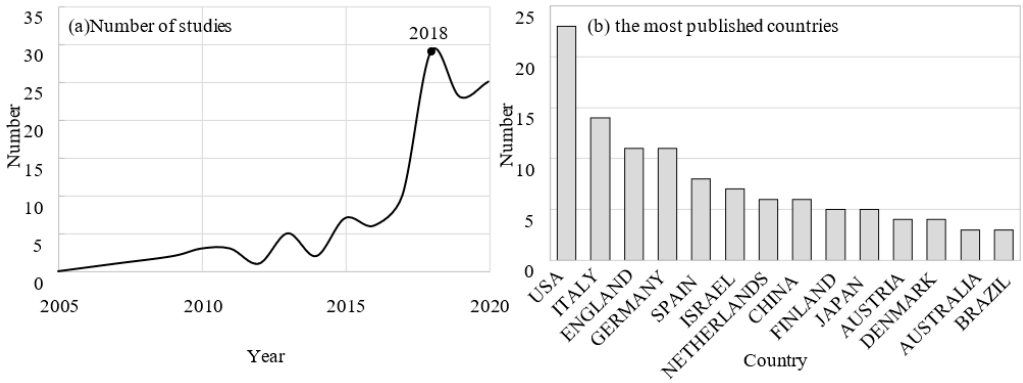

Figure 2. The trend of studies and the most published countries on RES research from 2005 to 2020.

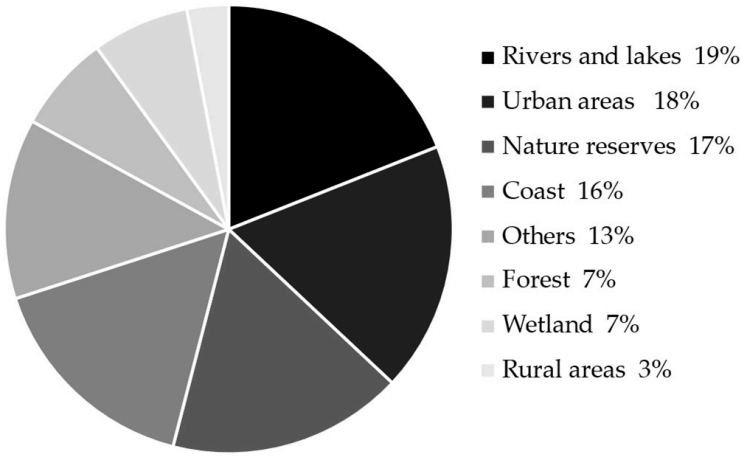

Figure 3. Habitat types and their proportion in RES research.

Table 2. Connections to applications and governance, in term of number of studies and proportion of total.

Connection	Number	Proportion
None	46	38%
Brief mention	31	26%
General guidance	28	23%
Specific guidance	15	13%

3.2. Applications of RES research

Of the 122 selected papers, 74 addressed RES applications and governance with various connections. Further these, we identified three main aspects of RES application: (1) non-spatial improvement; (2) spatial improvement; and (3) cross-service governances (70%, 14%, and 16%, respectively) (Figure 4). Each of these aspects was supported by details of the applications (Table 3). Non-spatial improvement was the most common aspect and consisted of monetary and non-monetary benefits. Most of the research in Spatial improvement was included in the application directions of Space of High recreational potential or degraded and the Relation between supply and demand. Cross-Service governance refers to the trade-off between RES and other ES and the coordination of interests between various groups.

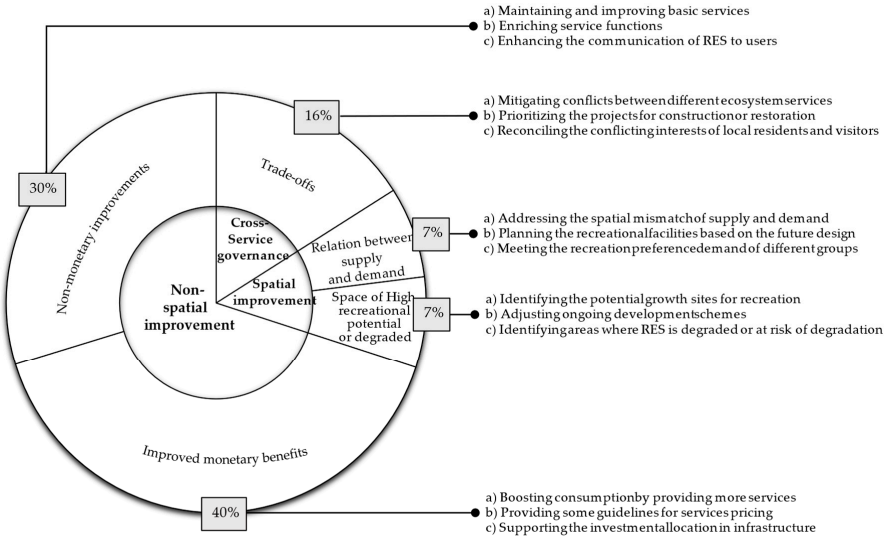

Figure 4. Multilayer pie chart of application and governance in RES.

Table 3. Application of RES research.

Service Types	Applications		Detailed Applications	Ref:
Only RES	No-spatial improvement	Improved monetary benefits	(a) Boosting consumption by providing more services (b) Providing instruction for pricing services (c) Supporting investment allocation through infrastructure	[26–30]
		Non-monetary improvements	(a) Maintaining and improving basic services (b) Enriching service functions (c) Enhancing the communication of RES to users	[31–35]
	Spatial improvement	Space with high recreational potential or degradation	(a) Identifying the potential sites for recreation (b) Adjusting ongoing development schemes (c) Identifying areas where RES is degraded or at risk of degradation	[36–40]
		Relation between supply and demand	(a) Addressing the spatial mismatch of supply and demand (b) Planning recreational facilities based on future design (c) Considering the recreation preference of different groups	[41–46]
With other services	Cross-service governance	Trade-off	(a) Mitigating conflicts between different ecosystem services (b) Prioritizing projects involving construction or restoration (c) Reconciling the conflicting interests of local residents and visitors	[32,33,47–49]

3.2.1. Non-Spatial Improvement

Knowing the direct monetary benefits and service quality information of RES helps to identify the challenges imposed on professionals, administrators, and managers when attempting to improve the non-spatial services they offered. Incentives and other monetary benefits can provide better packages.

- Improved monetary benefits

RES are often considered to be an important revenue stream, and can have a significant influence on sector decisions and subsequently on local development planning [50]. RES can realise the transformation into a green economy, and thus is increasingly important

to the government [51]. While municipality expenditure is allocated to promoting RES in developed cities [52,53], the city authorities in most developing countries face a tight budget, due to other priorities [54]. We identified three specific RES applications and governances that provide monetary benefits. First, providing additional services can boost consumption. A study of Italian nature reserves, for example, suggested that providing more and better information on attractions and improving recreational facilities can increase economic benefits by attracting more visitors to stay overnight [29]; Second, guidelines for service pricing can be provided. Pricing is a technically difficult and politically sensitive areas that recreation directors must make decisions about [27]. If users find pricing difficult to accept, t various strategies can be applied to enhance their perceptions of RES. The price increase can also be defined as a corresponding increase in costed or that there is insufficient revenue to cover costs through tax subsidies [30]. Visitor values can also be linked to funding for the purchase of RES flows through the trust (an online donation mechanism) [26]. In this way, resistance to pricing decisions from affected users can then be minimised. Third, investment can be allocated to infrastructure. Some studies of RES have identified differences in the marginal willingness to pay for various types of parks among urban residents in developing countries. This finding can help governments planning RES facilities in different locations to generate higher revenues [27]. TESSA research models are also used to assess the monetary value impact of specific government measures (e.g., land use changes) on RES [28].

- Non-monetary improvements

Improvement in RES quality is closely related to the study of user preferences, as this knowledge can guide a region in developing reasonable management and improvement plans for its current recreation infrastructure [27]. The variability in users' landscape preferences in terms of recreation purposes (e.g., picnicking, hiking, etc.) can guide the vegetation management and infrastructure construction in parks, based on different functional orientations. Thus, the knowledge of user preferences can inform the improvement of services. Enrichment RES, such as providing wildlife viewing opportunities within traditional fishing activities, conservation education during fishing, and farming combined with horse riding, can make trips more attractive [30,31,34]. Specifically, the novel RES, which combines traditional production with recreational activity such as grazing areas and bridleways with a visually attractive open landscape that is educational and entertaining, offers entry points for applications and governance.

However, not all outreach RES is positive. Expanding the services to provide RES that meet the needs of the users will increase the costs they face or affect the recreational experience. Authorities should focus on maintaining and improving basic services rather than developing special services [55]. For example, to satisfy their visitors, the management should consider all sites rather than just the most popular, as visitor preferences may vary greatly [56].

Some studies also indicate that better communication is required to bring RES improvements to the attention of users, as their perception will be affected if they are not fully aware of such improvements [57]. The actions involve combining and improving several items related to the facilities where service is provided and improved-. These can include the availability of maps, informational brochures, explanatory videos, clear layout, and center lighting in information rooms, along with interpretive guides that have sufficient knowledge to provide accurate information [58].

3.2.2. Spatial Improvement

The understanding of the spatial conditions of RES is important for a variety of purposes, including risk communication, service delivery, planning, and policy, while providing citizens with RES that optimally responds to their needs.

- Space with high recreational potential or degradation

Recreation potential reflects the ability of an ecosystem to provide maximum recreational services to humans. A spatial assessment of recreation potential can inform decision-making such as land use planning and regional recreation management [36]. Studies at a sufficiently large spatial scale were able to identify the potential growth sites for recreation [37], and RES has been proven to be heterogeneous in spatial distribution and associated with specific Spaces. For example, water recreation activities distributed along oceans, lakes, rivers, and other water bodies have developed rapidly. The economic benefit of RES varies in a gradient from urban, suburban, and rural areas [38]. Studies of recreation potential studies can also help to identify priority areas for recreation infrastructure and enable on-site management planning such as the design of footpath routes or signage to create viewing areas [59]. The adaptation of ongoing development schemes can also represent the application and governance of recreational spaces with high potential. For example, a study of East Kazakhstan examined the proposal to build highways to connect several high-attraction recreation facilities to form a regional recreation system and expand the regional recreation area [60].

RES represent a natural solution to environmental challenges associated with extreme weather conditions [61]. However, ecosystems are often degraded or are at risk of degradation in RES areas under the influence of human use and the threat of natural disasters [39]. Spatial identification and intervention in areas at risk of degradation are key to achieving sustainable development [62]. In addition to increased monitoring, the specific application involves identifying areas where RES is degraded or at risk of degradation under the influence of visitor use to guide decision-making on concerns that managers should focus on-for instance, overuse and increasing use (safety concerns, ecological degradation, cultural resource degradation, trail degradation), overflights (soundscape degradation) [40].

- Relation between Supply and Demand

The spatial configuration of RES supply and demand determines the quality and degree of human well-being achieved by RES [26]. Studies of supply-demand relations can help policymakers to set spatial development goals and develop programmes according to supply-demand matching. By mapping or spatially overlaying the hot-cold spots of RES supply and demand, the mismatch between supply and demand can be identified [41]. For example, a study of small towns in Southeast Asia found that rural areas have less supply of recreational facilities than urban areas; however, drawing on the construction of urban recreational facilities, green areas, and agricultural land transformed into parks and agritourism improved the local recreation facilities [42].

The combined quantitative results concerning supply and demand can inform the planning of the scale and pattern distribution of recreational facilities, based on the future RES supply-demand scenarios [27]. Recreation-related indicators, such as naturalness, accessibility, and cultural resources, can inform GIS and mapping methods. These can be used to quantify the objective supply of RES and to identify the future RES resources needs accordingly [43]. Similarly, the demand for RES can be modeled by individual characteristics (e.g., age, income, education level, region, etc.), recreational intention (e.g., visit frequency), population density, and other indicators for future scenario prediction [29,44]. Some studies have attempt to combine the results of supply and demand to make planning recommendations. For example, some have suggested that potential national parks should be built near densely populated areas but not near other national parks, or more small parks should be built within protected areas rather than a smaller number of large parks [45].

Research into the demand of different groups can guide the planning and specific space design so as to meet the recreation preference demand of different groups and provide more diversified recreational facilities [27,46]. The specific demands of stakeholders can be targeted. Market segmentation based on the spatial heterogeneity of recreationists' preferences can assist operators in formulating recreational products along the interest locations of different stakeholders [42], thus maximize different stakeholders' satisfaction with applications.

3.2.3. Cross-Service Governance

Cross-Service Tradeoffs conflicts can occur when one ES is reduced as a consequence of increased use of another [63,64]. Weighing up the relationships between RES and other ecological services in a region and making rational land-use decisions are the key to maximizing well-being and achieving sustainable development [65]. This is because RES, while meeting the needs of users and providing benefits to the region, can also pose many environmental threats [66]. In present studies, Cross-service trade-off studies are mostly oriented toward nature conservation areas (e.g., national parks, mountain landscapes, etc.). Cross-service governance studies have four main types of applications and governance.

- Mitigating conflicts between different ecosystem services

Reducing conflicts between RES and other ES can guide the decision concerning the optimal land-use scheme, in which ecological and economic concern are balanced. Specific trade-offs include a service currency value ratio based on willingness to pay and travel costs [67,68], a model simulating the impact of multiple land use options on biodiversity [48], accurate spatial information provided by GPS track networks, and a GIS analytical map for analyzing potential conflicts. In practice, such trade-offs lead to a compromise in services. For example, one study found that a small portion of areas with marine recreation opportunities overlaps with areas suitable for aquaculture [47]. To achieve diversified goals and maximize benefits, potential use conflicts need to be considered during development to reduce negative impacts. Some studies have suggested that rational zoning of recreation use intensity or the development of new multi-service coexistence mode (e.g., wetland leisure agriculture) can be beneficial [48].

- Prioritizing the projects for construction or restoration

Ecological restoration plans can be prioritized by quantifying the benefits that result from improving various RES [69]. Similarly, revealing the risks to different segments of the RES supply chains can guide the prioritisation of conservation interventions when resources are limited. For example, parks in coastal areas can determine RES vulnerability based on storm surge exposure levels, visitor numbers, and occupancy rates of nearby lodging facilities, and thus identify spatial areas for prioritized investment in drainage and green infrastructure improvements [49].

- Reconciling the conflicting interests of local residents and visitors

The spatial distances from RES can affect stakeholders differently, which can result in obstacles to Cross-Service governance [68]. For some distant visitors, more recreational activity building or provision based on existing services can bring benefits in terms of where and how they engage in activities. They can also benefit local residents who depend on them for their livelihood, but the effects on other residents may not be as positive[70]. For the related studies to date, both theory and practice are moving away from excluding visitors and towards creating partnerships with them [27], thereby reconciling the conflicting interests of local residents and visitors. For example, a field case linking the livelihoods of Bangladeshi residents to community-based tourism can provide more RES for tourists, increase local economic income and prevent local people from stealing and logging trees to the detriment of local biodiversity [32]. Other studies of RES governance suggest that distant visitors might react more strongly to recreation restrictions but might be less interested in governance participation compared to those living close to the recreation area they use [33]. Local residents, however, are more likely to doubt that their demands can be effectively considered in governance [34]. Thus, the governance participation of local residents can be enhanced.

4. Discussion

4.1. Limited Transformation of RES Research into Practice

Our review suggests that studies of RES have not been effectively transformed into decision-making as studies of other ESs. ES is initiated to characterize and visualize the

ways that ecosystems benefit people for decision-making. However, the uses of ES in decision-making have long been noticed to be difficult and challenging [24,71,72]. Application of RES is extremely rare, as shown in our study. There is only 12% of studies reviewed have specific applications, and about 40% of reviewed papers never mentioned any application potentials of their research. Despite the fact that CES is suggested to be the most relevant ES in decision-making [73] and recreation is not the only component of CES but also a carrier of the personal experiences of ES [12], the strong relevance of RES to personal experience and decision-making has not guaranteed its application in reality. Successes in combining RES research and decision-making are scattered and have not been fully achieved so far.

Another prominent finding is that the spatial application of RES studies is rare. Among the few research mentioning applications, there are only limited studies proposing service improvement strategies spatially, with the majority discussing non-spatial solutions. This indicates that the connections between RES research and landscape planning/design are yet established. One potential challenge that prohibits the spatial application of RES research is mapping techniques. As demonstrated in the review of ES mapping in practice, spatial scale, resolution mismatch, and expert-driven mapping techniques all contribute to gaps between ES mapping and practice [74]. How to conduct RES mapping appropriate to landscape planning/design with readily usable information is critical in future research.

Unlike many challenges and solutions that have been discussed and proposed to bridge ES research and practices in other studies, our paper would specifically advocate practice-oriented research of RES. That is, a study is better to be formulated with a practical problem to be solved at the beginning of the study design. In our review, we have found that a wide variety of research focuses and methods are involved in RES studies. And different research methods are linked to varied applications. Picking on scientific questions and research methods first can lead to random application results. Rather, if a study begins with a practical problem and then scopes for research questions from the practice problem, the relevant research methods can be easily selected, and the final application of the study can also be smoothly achieved. Here, we would like to propose a framework for transforming RES studies into applications and governance with a series of practical questions to be concerned about first.

4.2. A Suggested Framework to Integrate RES Research with Applications

As we have demonstrated in previous sections, current RES research is not necessarily comprehensive but can provide some insights in terms of application and governance. To better facilitate application, this paper develops a framework to better incorporate the application and research of RES from our analysis of the studies (Figure 5).

The framework emphasizes four practical questions to ensure the decision of RES research depends on the application purpose of the work. A RES study is suggested to start with contemplations of practical questions first: "Does the research address relationships between RES and other services?" "Does the research solve spatial issues?" "Does the research concern both supply and demand?" "Does the research address economic values?" An easy yes or no answer to these questions will facilitate in narrowing the scope of research. And the answers to these questions should consider the contextual characteristics and governance desires of different sites.

The contribution of practical questions in the framework is not only to guarantee applications but also can quickly assist in the selection of relevant research methods. There are many research methods of RES available, and the selection of the most appropriate methods can be quickly narrowed down using these practical questions. If a study aims to address conflicts between RES and other services, both evaluation methods of RES and other services should be explored. If a RES study is expected to direct spatial planning, spatial mapping of RES will be critical. Similarly, a study intending to balance supply and demand should map both supply and demand. And a study aiming to offer economic suggestions should explore monetary methods.

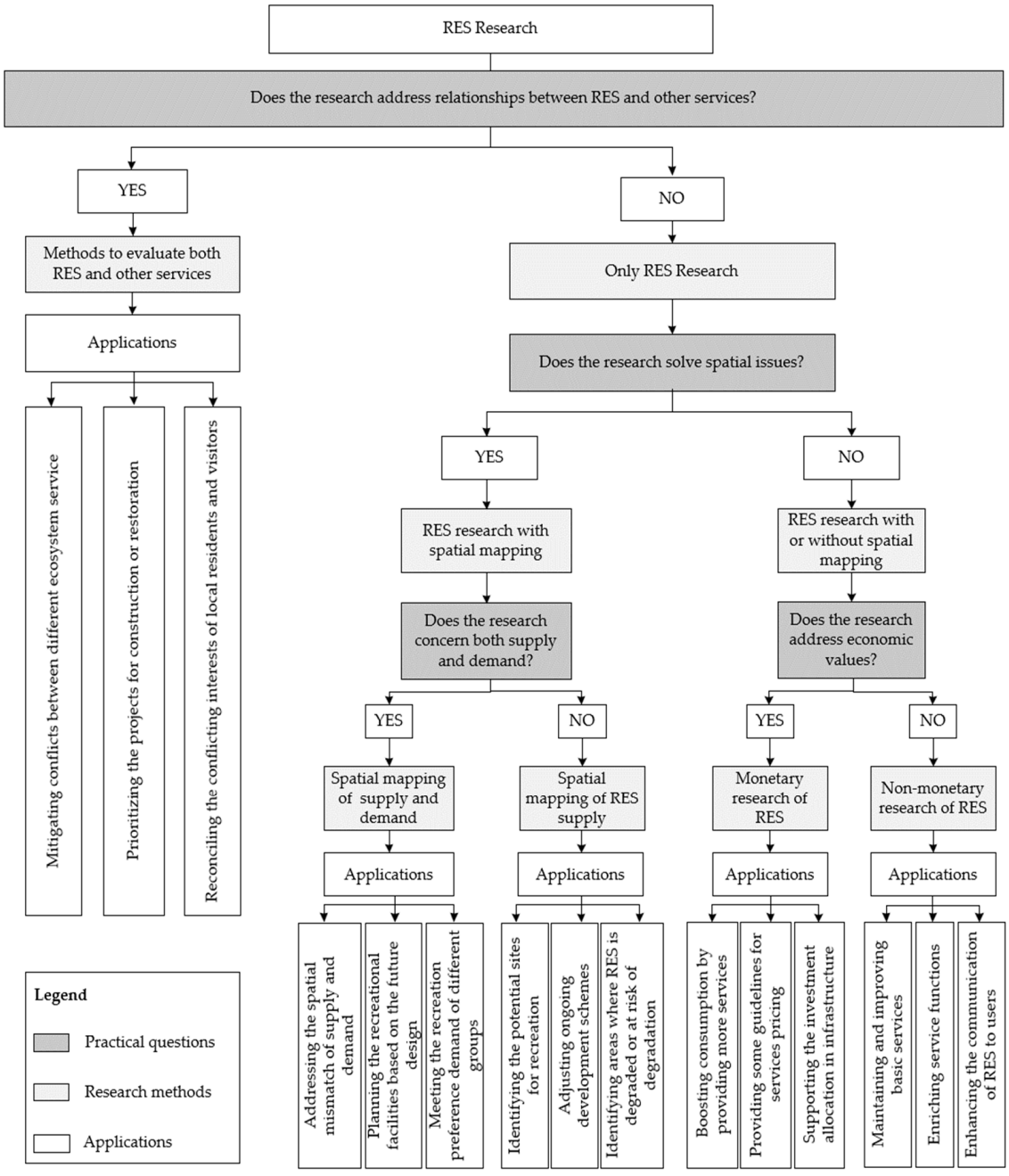

Figure 5. A framework to ensure RES research can be applied.

The framework highlights the importance of practical questions at the beginning of the research design. And the contributions of the framework are multifold by merging practical questions, research methods, and application potentials. It can not only guarantee the future application potentials of RES research but also assist in narrowing the research scope and research methods. We advocate that starting with applicable problems can better situate a RES study in a better position to bridge science-practice gaps.

4.3. Limitations

One limitation of our review is that selected studies may not sufficiently provide the forums and frameworks that ensure RES can be applied. Our review only examines how researchers have described and discussed applications of RES for decision-making. As most papers published in peer-reviewed journals are more concerned about scientific contributions, it is possible that some of the studies had far more connection to the application than

reported in the manuscript. Practical implementations are never an inherent requirement for most journals. Future research could be more intentional about the connections between research and practices in various contexts. And we would like to advocate those future studies of ES always support their research with at least one section of practical contribution to bridge the gaps between research and practice in the realm of ES. In addition, our review only selected English language literature, although most decision-making occurs in local languages. Future studies can extend the literature research to different regional linguistic contexts.

Another solution to further reinforce the application framework proposed in this paper is to scope for other relevant work outside the few papers we reviewed. This expanded search scope could include more case studies or reports that provide more indications of their potential applications. Reports that do not have the formal structure required by scientific papers can be much more flexible and include more information about their application. Conducting expert survey to systematically solicit opinions is another method of exploring the possibilities of RES in application and governance. Results considering both expert opinions and potential applications from papers can offer a more comprehensive framework for discussing how RES can impact the practice and governance of land uses or natural resources.

5. Conclusions

In the last few decades, the science-practice gaps in many fields have gradually become a hot topic. How to achieve better integration of useful ES knowledge into practice and governance is a challenging task. Recreation is not the only component of CES but also a carrier of personal experiences of ES [12]. However, the strong relevance of RES to personal experience and decision-making has not guaranteed its application in reality. Our review focuses on RES research for practice and governance while supporting decision-making. Though the inadequacy of the outreach capacity of RES research to make explicit connections with practice is apparent, the studies reviewed here still highlight some of how RES can be transformed into practices.

First, we conclude that a wide variety of applications in multifold aspects can be motivated by RES research, including the explicit service improvement of RES and applications for other ES-related governance. Among RES, existing studies described both spatial and non-spatial implementations of RES research in either improvement of RES or the remediation of degraded RES. Supply and demand of RES are often discussed for enhanced supply-demand balance in recreation governance. On the other hand, RES research is also a critical component in discussing trade-offs among ES values. RES is not always fully beneficial to or compatible with environmental sustainability. RES research contributes to more comprehensive practice and planning decision-making in contested circumstances concerning synergy or tradeoffs among RES, other ES values, and/or multiple stakeholders.

Second, the paper sought to contribute to the science-practice gaps of RES by offering an application framework of RES through the synthesis of existing studies. By asking four questions relevant to practices at the beginning of the research design, the paper classifies RES research into varied applicable potentials so that researchers can conduct effective and informative research toward practice and decision-making. Our experience in articulating the application of RES research with a practical question framework has identified much potential for trying borrowing from RES research. And we advocate that starting with applicable problems can better situate a RES study in a better position to bridge science-practice gaps.

It is worthwhile pointing out that the application framework proposed in this paper does not claim that the paths derived from the review are adequate to cover all aspects of RES research into practices. Rather, the framework offers a starting point for further research to modify and improve in bridging science-practice gaps of RES studies. It offers a procedure for researchers to think more about end-users and practical questions first so that research can be more explicit on the research methods and scientific knowledge that

are desirable for practices. By synthesizing useful insights into the linkages of RES and applications in an application framework, the ultimate goal of this review is to promote evidence-based decision-making and practice-oriented research of RES so that the desire for a better recreational environment and well-being of residents can be further fulfilled. Future research should be more intentional about the connections between research and practices in various contexts or expand information search and access to the potential for studies to transform into application and governance.

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