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Spatial characterization of cultural ecosystem services in the Ishigaki Island of Japan: A comparison between residents and tourists

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ABSTRACT

Cultural Ecosystem Services (CES) are non-material benefits that are indispensable for the health and well-being of communities. CES are often spatially explicit and fluctuate according to the knowledge, beliefs, and perception of users of the location. Therefore, understanding the spatial patterns of CES perceived by people from different backgrounds is important for decision-makers to carry out proactive landscape planning. In this study, we investigated the differences in the perception of CES between residents and tourists on Ishigaki Island, Japan. The study employed a Public Participation Geographic Information System (PPGIS) approach to spatially present the respective perceptions of residents and tourists regarding six types of CES, namely recreational, therapeutic, educational, spiritual, aesthetic, and historic CES, that are recognized as key contributors to human health and well-being. For data collection, we employed a combination of household-level postal surveys and in-person questionnaire surveys targeting residents *(*$n = 410$*)* and tourists *(*$n = 102$*)*, respectively. A series of statistical and spatial analyses was conducted on the survey results to understand the influence of the duration of residence and the frequency of visits in shaping the perceptions of CES, as well as the relationship between perceived CES and land-use types. This included the contribution of protected areas to the delivery of CES. The results showed that the average number of locations indicated by residents was significantly higher than that indicated by the tourists, resulting in density maps with distinct spatial patterns. In particular, the spatial pattern of CES identified by tourists was considerably simpler than that recognized by residents and centered on two popular tourist spots. As per the elements of landscapes and seascapes, the perception of "aesthetic," "recreational," "therapeutic," and "educational" CES by residents was associated with "forest" and "sea" and that of "spiritual" and "historic" was associated with "forest" and "farmland." In contrast, the CES perception of "recreational," "educational," "therapeutic," "aesthetic," and "historic" by tourists was associated with "sea" and "forest." "Spiritual" CES was associated with "forest" and "sea." Lastly, a higher proportion of "aesthetic" CES locations were identified within protected areas compared to outside the areas. Overall, our findings revealed that residents and tourists perceive and appreciate the numerous CES arising from landscapes and seascapes of the island differently. This indicates a possible trade-off resulting from land or sea developments to the benefit among stakeholders, for example, tourists. Hence, to sustain CES that underpin equitable health and well-being benefits, spatial planning should consider the different perceptions of stakeholders, particularly of residents and tourists, regarding CES types and locations.

1. Introduction

Cultural Ecosystem Services (CES) are the intangible or non-material benefits that individuals acquire via a variety of interactions with nature, such as aesthetic, spiritual, recreational, or educational experiences (Millennium Ecosystem Assessment, 2005). CES contribute to

Abbreviations: CES, Cultural Ecosystem Services; PPGIS, Public Participation Geographical Information System.

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human well-being in several different ways, for example, by creating a sense of place, reducing stress, promoting physical and mental health, developing social relations, and supporting spiritual practices, cultural heritage, and recreational activities (Cheng et al., 2019; IPBES, 2019; Jennings et al., 2016; Hartig et al., 2014; Chen et al., 2019; Pröbstl-Haider, 2015). Hence, it is essential for individuals and communities to recognize that CES are important for their health and wellbeing, as well as to establish their own cultural identity and sense of nature connectedness (Milcu et al., 2013; Hartig et al., 2014; Chen et al., 2019). CES are derived through interactions with healthy or often pristine ecosystems (Willis, 2015; Bryce et al., 2016). Exposure to nature is linked with a wide range of health benefits, including but not limited to reduced anxiety, improved behavior, enhanced cognitive ability in children, and lower cardiovascular risks (Kenige et al., 2013). In an increasingly urbanizing world, where individuals have less contact with nature, tourism, particularly nature-based tourism, provides a unique opportunity for a wider audience to experience CES and improve their health and well-being (Willis, 2015).

Despite accumulating evidence for the inseparable linkage between healthy ecosystems, CES and human well-being, the contemporary society lacks effective means to conserve and restore CES and underlying ecosystem health. It is difficult to assess and account for CES, owing to their intangible and debatable nature. CES primarily depend on individual experiences and encounters with nature (Johansson et al., 2019), and people perceive these services differently in distinct cultural contexts (Díaz et al., 2018). Despite their significance in improving the quality of life, CES are frequently disregarded in land-use decisions (Dasgupta et al., 2021; Milcu et al., 2013). Tourism can be a double-edged sword that provides vital opportunities for people to enjoy CES and improve their well-being, but can erode the foundation of healthy ecosystems. Consequently, taking full account of CES, considering the different perspectives among people, would aid in avoiding unexpected outcomes that may arise from divergent priorities and landscape value appraisals among people (Darvill and Lindo, 2016).

Numerous evaluation methods, including qualitative, quantitative, and mixed approaches, have been developed to capture the complexity of CES (Hirons et al., 2016). Among quantitative methods, biophysical indicator-based evaluation, such as the number of observed wildlife species or the frequency of visits, is often utilized as a proxy measure of CES (Geneletti et al., 2018). Economic evaluation methods, such as the Contingent Valuation Method and the Travel Cost Method, have been widely employed in quantitative CES evaluation (Barrena et al., 2014; Richmond et al., 2007). However, all these quantitative methods have inherent limitations owing to the fact that the supply of intangible benefits is often difficult to measure in biophysical or monetary terms (Cheng et al., 2019). According to researchers, CES are subjective and relational, necessitating subjective and socio-cultural evaluation (Johansson et al., 2019). In addition, the delivery of CES is contingent upon the nature and frequency of interactions and exposure.

Owing to the location-specific nature of CES, various researchers have developed geospatial evaluation methodologies for CES. Spatial analysis of CES, in conjunction with survey questionnaire, is frequently used to elicit subjective evaluations of CES by different user groups (Brown and Fagerholm, 2015; Dasgupta et al., 2021). Mapping exercises have been recognized as ameliorative tools for visualizing otherwise invisible human–nature relationships by reflecting various viewpoints, highlighting resource consumption, and promoting landscape conservation (Plieninger et al., 2013). Mapping is crucial for identifying critical areas to maintain ecosystem services and to understand zoning patterns within a discrete dataset (Martínez-Harms and Balvanera, 2012). Nevertheless, mapping exercises also have certain limitations in portraying CES; a key issue is the static representation or snap-shot view of human–nature relationships, which are dynamic and quick to evolve.

With regard to the spatial characterization of CES, the Public Participation Geographic Information System (PPGIS) has gained widespread interest as one of the useful approaches for CES evaluation to supplement the existing methodologies, such as quantification based on biophysical data (Brown and Fagerholm, 2015). PPGIS can generate spatial information on human–nature relationships by involving stakeholders, such as inhabitants and visitors to the study area (Brown and Fagerholm, 2015). Furthermore, it facilitates the inclusion of various perspectives from a wide range of stakeholders, such as community members, government officials, and experts (Brown and Fagerholm, 2015; García-Nieto et al., 2015). It is also a useful tool for planning and managing protected areas, as well as for ensuring the inclusion of local communities in the decision-making process (Bennett, 2016; Muñoz et al., 2019).

Previous studies have indicated that several factors including land-use type and topography have a strong influence on how CES are perceived (Dasgupta et al., 2021; Zoderer et al., 2016). In addition, the geographical distance and accessibility to the location further shape perceptions (Fagerholm et al., 2012). However, aside from the geographical and ecological characteristics, perceptions of people are heavily influenced by a multitude of socio-cultural factors (Quintas-Soriano et al., 2018), including gender, age, place of residence, and educational background (Dade et al., 2020; Katz-Gerro and Orenstein, 2015; Zoderer et al., 2016). Moreover, the frequency of visits also affects the human–nature relationship, especially in terms of how visitors perceive CES (Petrosillo et al., 2007).

Scenic natural landscapes, typically consisting of mountains and rivers, and the unique wildlife that inhabits them are crucial tourism resources (Bachi et al., 2020; Smith and Ram, 2017). However, despite the contribution of tourism to the local economy, tourism-related developments can occasionally threaten the availability of ecosystem services and negatively impact local communities (Petrosillo et al., 2013). Thus, it may be challenging to make landscape management decisions that strike a balance between the potentially conflicting interests of the residents and tourism enterprises (Brown, 2006; Munro et al., 2017). Identifying and contrasting the perspectives of tourists and residents over various ecosystem services could help decision making in landscape planning and management. Although spatial analysis techniques have been widely employed for CES evaluation, few studies have compared the perceptions of tourists and residents regarding CES. Muñoz et al. (2019), for instance, demonstrated the overlap between the places that were important for both residents and tourists but for different reasons (e.g., a variety of non-consumptive services for tourists, and consumptive services for residents). Similarly, Petrosillo et al. (2013) showed a difference in the perception of CES by seasonal and permanent residents. However, our understanding of CES remains limited and this could be an exciting area for further research.

The objective of this study was to gain a better understanding of the perceptions of CES held by residents and tourists in popular tourist destinations through a case study of the Ishigaki Island in Okinawa, Japan. We chose the Ishigaki Island because there has been a clear conflict between tourism development and nature conservation. In Ishigaki, there are plans by private companies for large-scale development of resorts, including golf courses, which triggered strong opposition from residents and conservation groups as the development could have negative impacts on the habitat of endangered species, or Crested Serpent Eagle (*Spilornis cheela*), coastal ecosystem, water quantity and quality, and sediment deposition (WWF Japan, online). Thus, we believe this region to be a prime location to assess the perceptions of residents and tourists on CES.

We employed the PPGIS approach to map the areas with high-perceived CES values for residents and tourists, and we quantified the difference in their perceptions. Furthermore, to draw implications for landscape management, we examined the protected area coverage of locations with high-perceived CES values.

2. Materials and methods

2.1. Study area

The Ishigaki Island is a remote subtropical island, located at the southwest end of the Ryukyu archipelago in Japan (N 25.55, E 124.33 and N 24.19, E 123.27) (Fig. 1). The island has a surface area of approximately 222 km^2, and hosts 49,131 residents and 25,004 households, registered as of January 2022 (Ishigaki, 2022). The Ishigaki Island, Iriomote Island to the west, and the coral reef waters and islands connecting them were declared as the Iriomote–Ishigaki National Park. The National Park encompasses 40,658 ha of terrestrial and 81,497 ha of marine areas and covers 7,121 ha (approximately 32 %) of the total terrestrial surface area of the Ishigaki Island, including 7,001 ha of special area and 557 ha of special protection zone (Ministry of the Environment, 2020). The Iriomote–Ishigaki National Park was established in 2007 through the expansion of the Iriomote National Park, and the current National Park surface area was established in 2016 following a series of National Park area revisions. The Ishigaki Island is also home to the Ramsar wetland, Nagura Ampal; it is also the native habitat of rare flora, such as Yaeyama palm (*Satakentia liukiuensis*) and Kanhizakura cherry trees (*Cerasus campanulata*) on Yonehara and Mt. Omoto, respectively. Tourism is the primary pillar of the local economy on the Ishigaki Island, with the advantage of the abundant wild natural resources, including sandy beaches, mountains, and mangrove forests (Ohtsuka et al., 2019; Yoshie et al., 2020). The island has become one of the most popular tourist destinations in Japan. Following the completion of the new Ishigaki airport in 2013, the number of domestic and foreign tourists increased sharply. Prior to the opening of the airport, the number of tourists was approximately 700,000, and exceeded one million the following year. Since then, the number of visitors has steadily increased, and almost 1.5 million people visited the Ishigaki Island in 2019, with 80% being domestic tourists or those who are from other parts of Japan, and the remaining being foreign tourists, mostly from China and Taiwan, who take advantage of their geographical proximity. Many residents are concerned about tourism developments on Ishigaki, such as resort hotels and golf course, since they present a serious threat to the natural ecosystem (Sugimoto et al., 2022).

2.2. Questionnaire survey

The primary method for data collection was a structured questionnaire survey. A paper-based questionnaire was used to elicit subjective evaluations of CES on the island of Ishigaki, targeting both residents and domestic tourists. The survey questionnaire was designed based on previous studies that employed similar mapping exercises (Alessa et al., 2008; Hashimoto et al., 2015). The respondents were asked to indicate up to four locations on a map of the Ishigaki Island that they consider important for each of the six categories of CES, namely, "recreational," "spiritual," "educational," "therapeutic," "aesthetic," and "historic" (Table 1), and to rate the relative importance of each of the four or fewer locations to the others using a rank number (from 1 to 4). The respondents were also advised that they were not required to indicate four locations for each CES type if they could not think of or were unaware of such locations. The map used in the mapping exercise showed the locations of several landmarks, such as popular tourist destinations and major road networks to help respondents identify places of CES importance (Supplementary material 1). The survey also included questions regarding socio-demographic attributes of the respondents, such as gender, age, marital status, and number of visits to the island. Supplementary material 2 presents the survey questionnaire for residents and tourists used in this study and their English translations.

The questionnaire was mailed to 3,000 Ishigaki residents between September 17, 2019 and October 15, 2019. The number of questionnaires distributed was chosen in a manner where more than 10% of household of the island, assuming a 10% response rate and considering the population distribution across the island. The survey was conducted using the services of the Japan Post Co., Ltd, which allowed us to mail a set quantity of questionnaires to specified zip code locations. The survey distribution was designed so that the questionnaire was distributed to all 20 administrative districts on the Ishigaki Island, based on their population size. Face-to-face structured interviews were conducted with domestic tourists using the same questionnaire at the Ishigaki airport, the entry point for practically all domestic tourists. The interviews were conducted from September 15, 2019 to September 18, 2019, which is close to the end of the peak tourist season in summer (Ishigaki, 2018). The period spanned overlaps consecutive holidays including a weekend and a national holiday (from September 14 to 16), when the availability of an adequate number of travelers for interviews at the airport was anticipated. The interviewees were domestic tourists awaiting their departures in the lobby of the domestic terminal of the airport; the lobby featured souvenir shops, cafés, and a food court, where travelers waiting for departures could spend their waiting time. All survey participants were Japanese tourists. Tourists who intended to be picked up and dropped off at the airport, as well as those who were not interested in sightseeing, were excluded from the survey. The interviews were performed by four trained interviewers who had been instructed in the standard interview procedure prior to the survey. However, as recording the response rate was not part of the interview protocol, we were unable to provide the response rate for the interview.

2.3. Data analysis

The geographical locations of the CES obtained during the mapping exercise were digitized using ESRI ArcGIS (Version 10.7), while the individual attributes of the respondents were recorded on a Microsoft Excel spreadsheet. Both spatial and spreadsheet data were linked with an identification number assigned to each respondent. We examined the following: (1) the difference between the residents and tourists in the number of places indicated for each CES category; (2) the effect of the duration of residence and the number of visits to the island on CES perception; (3) the spatial characteristics of important CES and differences in perception between residents and tourists; (4) the relationships between land-use classes and CES recognized by residents and tourists; and (5) the protected area coverage of the areas of locations that were of high CES importance. We used JMP® Pro 15 for the statistical analyses.

First, we calculated the total number of locations indicated by residents and tourists for each CES category. Subsequently, we confirmed the non-normality of the data using the Shapiro–Wilk test for normality at a significance level of 0.05. Thereafter, we conducted Wilcoxon's rank-sum test to analyze the variations in the number of locations for each CES between residents and tourists.

Second, we examined the effect of duration of residence and number of visits on the number of CES locations indicated by residents and tourists. We divided the years of residence into the following four categories: $<$10 years, 11–30 years, 31–50 years, and $>$50 years. We used the Kruskal–Wallis test and the Steel–Dwass test for post-hoc pairwise comparisons to analyze the difference in the total number of CES locations between the five groups. The number of visits to the island by tourists was divided into the following four groups: once (i.e., current visit), 2–5 times, 6–10 times, $>$10 times. We then examined the effect of the number of tourist visits on the number of CES points using the same methodology as for the analysis on the years of residence. All the statistical analyses utilized a significance level of 0.05.

Third, we spatially characterized the CES locations and their differences between residents and tourists by creating point density maps using the kernel density function in ArcGIS Spatial Analyst Version 10.7; ESRI as was done as in previous studies (Alessa et al., 2008; Hashimoto et al., 2015; Dasgupta et al., 2021). The inverse of the CES importance rank assigned by each respondent was extrapolated as the weight of each point, and an output grid size at 100 m with a search radius of 3500 m was adopted, based on the scale of the map used for the mapping

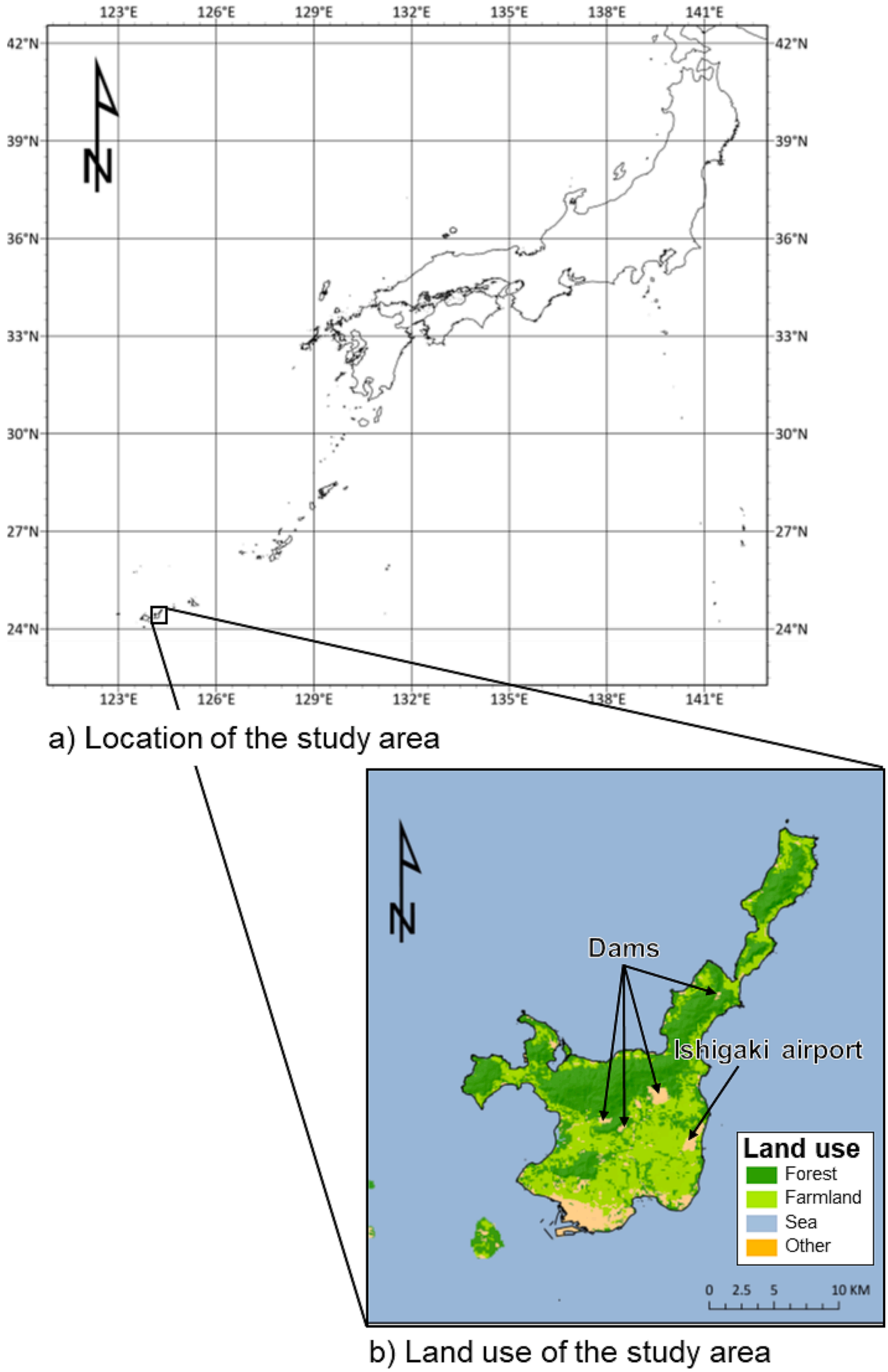

Fig. 1. Location and land-use of the study area. The lower map shows land-us classes at 100 m grid-resolution in 2016, according to the Digital National Land Information Project of Japan (Ministry of Land, Infrastructure, Transport and Tourism, 2016). “Other” land-use includes urban areas, airports, and dams.

Table 1
Categories of cultural ecosystem services (CES) used for Public Participation Geographic Information System (PPGIS) survey in the Ishigaki Island case-study.

Category	Description of areas that could provide CES
Recreational	Areas valued because they provide opportunities for outdoor, recreational activities, and experiences.
Spiritual	Areas valued because of their sanctity, religious, and spiritual significance.
Educational	Areas valued because they teach us about the environment.
Therapeutic	Areas valued because they improve the physical and mental health of people.
Aesthetic	Areas valued for their scenery.
Historic	Areas valued because they contain natural and human history, and allow future generations to learn about and experience these areas.

exercise. The raster cell values were adjusted from 0 (minimum) to 1 (maximum) to enable a comparison of the kernel density maps among the six CES categories.

Fourth, the relationship between land-use and the locations of the six types of CES reported by the residents and tourists was examined. Using the spatial join operation of ArcGIS, we produced the table data that demonstrated how each CES point corresponds to a land-use class, such as farmland, forest, sea, and others. The land-use classes were obtained from the 2016 land-use map at 100 m grid-resolution that was made available by the Digital National Land Information Project of Japan (Ministry of Land, Infrastructure, Transport and Tourism, 2016). The 2016 land-use data were the latest publicly available data at the time of the survey (i.e., 2019), and we anticipated that there were no major land-use alterations at the time of survey. Then, the chi-squared test was used to assess the independence between CES types and land-use classes for residents and tourists. The significance level was set at 0.05.

Finally, the protected area coverage of the locations of CES importance for residents and tourists was assessed by superimposing the protected area polygon data acquired from the Digital National Land Information Project of Japan (Ministry of Land, Infrastructure, Transport and Tourism, 2016) and the CES point layer data using ArcGIS (Supplementary material 3). The statistical significance of the difference in protected area coverage between the six CES classes and between residents and tourists was investigated using the chi-squared test and the Bonferroni correction. The significance level was set at 0.05.

3. Results

The questionnaire survey was completed by 410 residents (response rate of 13.7%) and 113 tourists. After excluding incomplete and invalid responses, 384 responses from residents and 102 responses from tourists were used for data analysis. Supplementary material 4 presents the attributes of the respondents.

Residents and tourists both responded to the highest number of CES points for “recreation.” This was followed by “aesthetic,” “therapeutic,” “educational,” “historic,” and “spiritual” CES categories. The Wilcoxon rank-sum test revealed that, for all CES categories, the average number of locations reported by residents was significantly higher than the number reported by tourists ($p < 0.01$) (Fig. 2). Supplementary material 5 shows the total and the average number of CES locations falling under each of the six CES categories identified by residents and tourists.

The number of CES points indicated by residents and tourists was influenced by the duration of residence and the number of visits to the island, respectively. The Kruskal–Wallis test revealed a statistically significant difference in the number of CES locations recognized by the island residents who resided there for varying durations of time ($p < 0.01$) (Fig. 3). Subsequently, the Steel–Dwass test of multiple comparisons showed that the resident groups with 31–50 and >50 years of residence indicated significantly more CES locations than the group with <11 years of residence ($p < 0.01$ and $p = 0.041$, respectively). No significant difference was observed between the other groups with various years of residence ($p < 0.05$) (Table 2). Similarly, the Kruskal–Wallis test revealed a significant difference in the number of CES locations

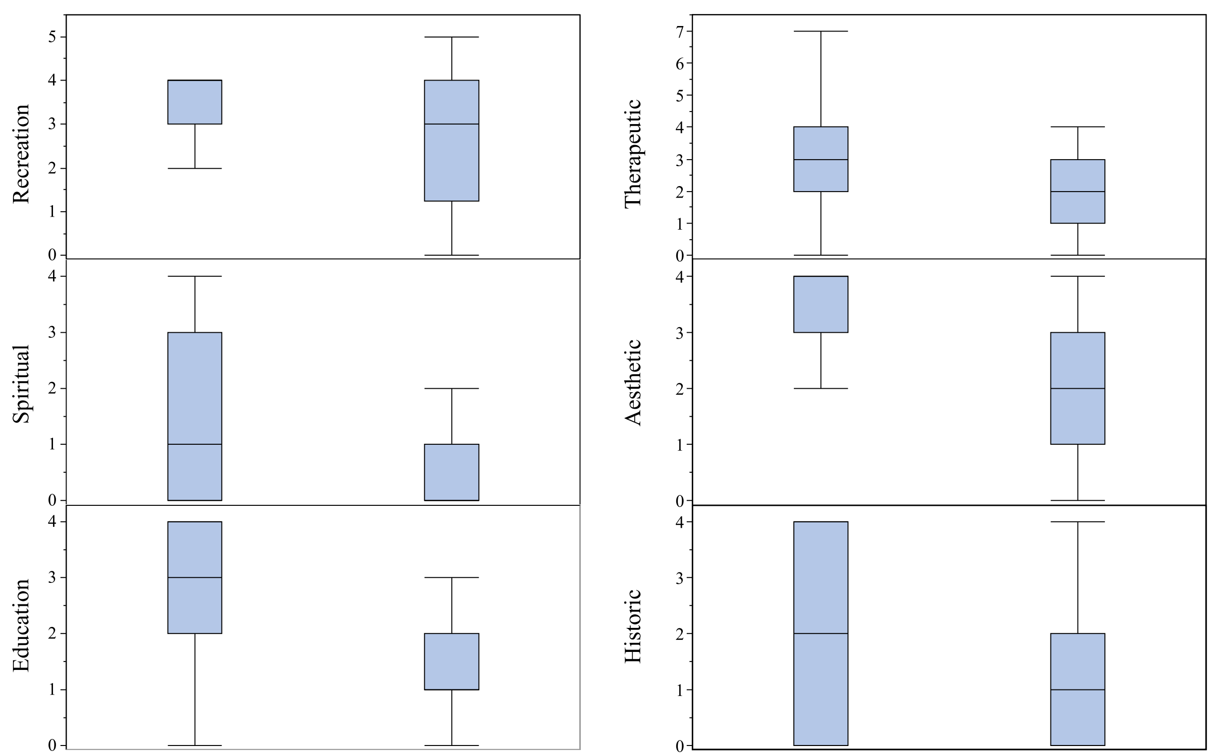

Fig. 2. Box plots illustrating the number of locations indicated by residents and tourists for each CES category. Box plots display the minimum, first quartile, median, third quartile, and maximum values, excluding outliers.

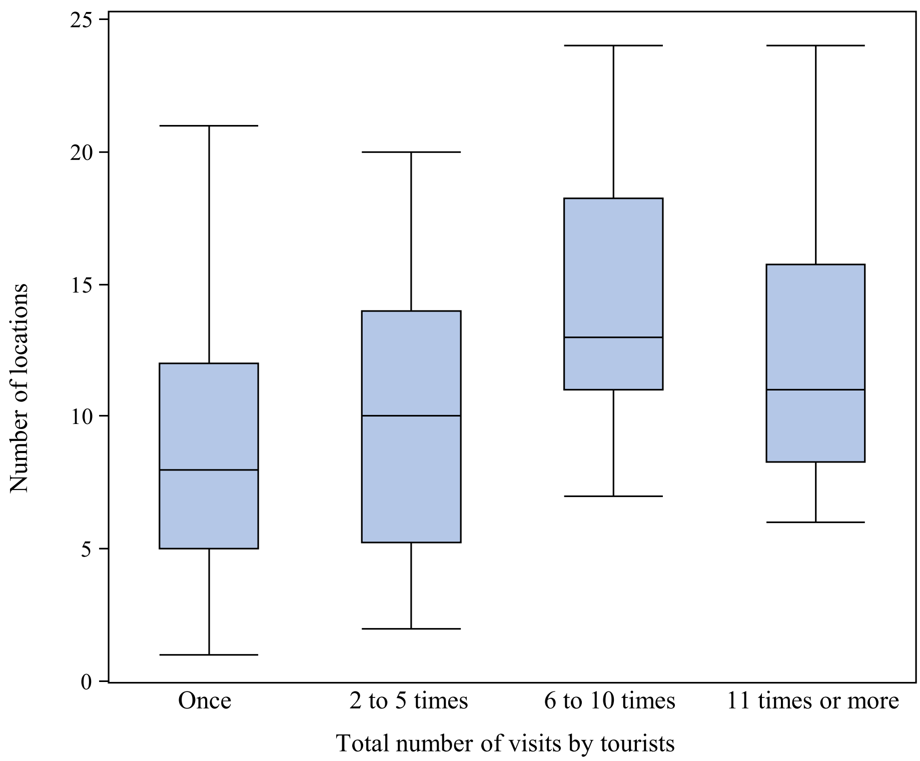

Fig. 3. Box plots illustrating the number of locations indicated by groups with varying number of visits for each CES category. Box plots display the minimum, first quartile, median, third quartile, and maximum values, excluding outliers.

Table 2
Summary of main statistical results of the Steel–Dwass test for residents and tourists for examining the difference in the total number of CES locations between the four groups with varying residence years.

Residents	Residence year class	Residence year class (years) for comparison	Score Mean Difference	Standard Error Difference	Z	p-value
	6 to 10 times ($n = 12$)	Once ($n = 52$)	18.359	5.946	3.088	0.011
	11 times or more ($n = 8$)	Once ($n = 52$)	12.260	6.610	1.855	0.248
	6 to 10 times ($n = 12$)	2 to 5 times ($n = 28$)	8.929	4.020	2.221	0.118
	2 to 5 times ($n = 28$)	Once ($n = 52$)	5.742	5.431	1.057	0.716
	11 times or more ($n = 8$)	2 to 5 times ($n = 28$)	4.500	4.210	1.069	0.709
	11 times or more ($n = 8$)	6 to 10 times ($n = 12$)	−2.292	2.691	−0.852	0.830
Tourists	Visiting frequency class (times)	Visiting frequency class (times) for comparison	Score Mean Difference	Standard Error Difference	Z	p-value
	6 to 10 times ($n = 12$)	Once ($n = 52$)	18.359	5.946	3.088	0.011
	11 times or more ($n = 8$)	Once ($n = 52$)	12.260	6.610	1.855	0.248
	6 to 10 times ($n = 12$)	2 to 5 times ($n = 28$)	8.929	4.020	2.221	0.118
	2 to 5 times ($n = 28$)	Once ($n = 52$)	5.742	5.431	1.057	0.716
	11 times or more ($n = 8$)	2 to 5 times ($n = 28$)	4.500	4.210	1.069	0.709
	11 times or more ($n = 8$)	6 to 10 times ($n = 12$)	−2.292	2.691	−0.852	0.830

indicated by tourists based on the frequency of their visits to the island ($p = 0.011$) (Fig. 4). The Steel–Dwass test of multiple comparisons showed that tourists who had visited the island 6–10 times recognized a significantly higher number of CES locations than those who were there for the first time ($p = 0.011$). No significant difference was observed among the other groups ($p < 0.05$) with varying numbers of visiting frequencies (Table 2).

The Kernel density maps depicting the concentration of the six categories of CES revealed distinct spatial patterns between residents and tourists (Fig. 5 and Supplementary material 6). Specifically, the locations with the highest concentration of CES (dark red areas) differed between residents and tourists with respect to five CES categories with the exception for "aesthetic" category. For residents, the maps highlighted the highest importance of areas centered around "Mt. Banna" for "recreational," "educational," and "therapeutic" CES, "Mt. Omoto" for "spiritual" CES, and the "Shiraho area" for "historic" CES. Other locations on the island were also identified for various CES, including, "Mt. Omoto" and "Yayeyama palm community of Maibara" for "educational" CES, "Kabira Bay," "Ishigaki downtown," and its western parts (southwestern potion of the island) for "historic" CES. The CES spatial pattern indicated by tourists was more straightforward than that indicated by residents, with the following two distinctive CES concentration centers: "Kabira Bay" and "Ishigaki downtown." Tourists ranked the highest at "Kabira Bay," one of the most popular tourist destinations, and its adjacent areas at the most important, for "recreational," "educational," "therapeutic," "aesthetic," and "historic" CES.

The chi-squared test of independence revealed a significant association between land-use categories and CES reported by residents ($\chi2 =$

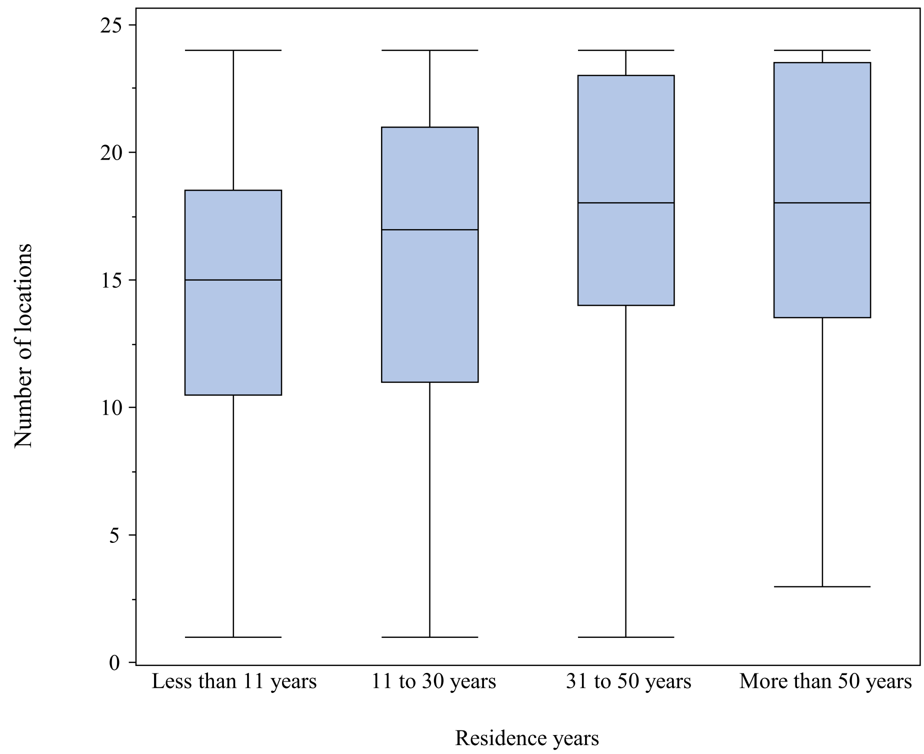

Fig. 4. Box plots illustrating the number of locations indicated by groups with varying residence years for each CES category. Box plots display the minimum, first quartile, median, third quartile, and maximum values, excluding outliers.

516.1, $df = 15$, $p < 0.01$) and tourists ($\chi 2 = 79.58$, $df = 15$, $p < 0.01$). The "aesthetic," "recreational," "therapeutic," and "educational" CES were associated with "forest" and "sea" land-use classes and were important for residents. "Spiritual" and "historic" CES were associated with "forest" and "farm" land-use classes (Fig. 6). Tourists associated "sea" and "forest" land-use classes with "recreational," "educational," "therapeutic," "aesthetic," and "historic" CES. "Spiritual" CES was associated with "forest" and "sea" land-use classes (Fig. 6).

Lastly, the chi-squared test of independence indicated that there was a significant difference between the CES categories for residents ($\chi 2 = 288.631$, $df = 5$, $p < 0.01$) and tourists ($\chi 2 = 25.240$, $df = 5$, $p < 0.01$) in terms of the ratio of the selected sites that were included or not included in the protected area. More specifically, the quantity of "recreational," "spiritual," and "historic" CES locations outside protected areas was significantly higher than that within protected areas ($p < 0.01$). In contrast, residents reported a significantly higher number of "therapeutic" and "aesthetic" CES locations within protected areas than that outside of them ($p < 0.01$). No significant difference was observed for "educational" CES between residents and tourists. As for tourists, protected areas had a significantly lower number of "educational" CES locations, and a significantly higher number of "aesthetic" CES locations than the respective numbers outside of the protected areas ($p < 0.01$).

4. Discussion

In this study, we used the PPGIS approach to investigate the perceptions of residents and tourists of CES for the better spatial planning to provide equitable health and well-being benefits to various stakeholders. Our analysis revealed that both residents and tourists evaluated CES in a comparable manner (i.e., the relative importance of various CES classes was the same for both the groups). In the order of importance, these were "recreational," "aesthetic," "therapeutic," "educational," "historic," and "spiritual." These CES classes are recognized as major contributors to the health and well-being of people (Cheng et al., 2019; Hartig et al., 2014). This finding is consistent with previous research that indicated the importance of "recreational" and "aesthetic" CES for residents and non-residents in landscapes and seascapes (Muñoz et al., 2019; Munro et al., 2017). However, the average number of locations indicated by residents was significantly more than that indicated by tourists, possibly owing to their extensive knowledge of locations on the island; thus, the extensive location knowledge of residents tends to contribute to their enhanced perception of CES (Seymour et al., 2010).

Long-term island residents tended to recognize a larger number of CES locations. Previously, Brown et al. (2015) noted the positive impact of occupation and residential locations on the appreciation of intangible landscape values. Similarly, a greater number of tourist visits contributed to a larger number of total CES points, although the contribution was not statistically significant among tourists groups with varying numbers of visits owing to the biased sampling. Similar to previous research, this finding suggests that the appreciation of CES requires a substantial investment of time to develop a socio-psychological space, either through inheritance or frequent visits to locations where people tend to appreciate nature. Nonetheless, we also discovered that more visits did not necessarily mean more locations would be indicated. There was no statistically significant difference in the number of indicated locations across all CES classes, owing to the unbalanced sample size for each class. In the face-to-face structured interviews of tourists, some respondents mentioned that although they had visited Ishigaki numerous times, they had only visited a limited number of tourist spots for specific reasons (e.g., scuba diving), and thus, had limited knowledge of the island. Such tourists were likely to indicate a lower selection and number of CES than other tourists.

Our results also elucidate the spatial patterns of CES across the island, which differed significantly between residents and tourists in terms of different land-use classes. Except for "aesthetic" CES, kernel density map displaying the point density of locations reported by residents and tourists for each CES revealed that areas with the highest density, or CES hotspots, were different for residents and tourists.

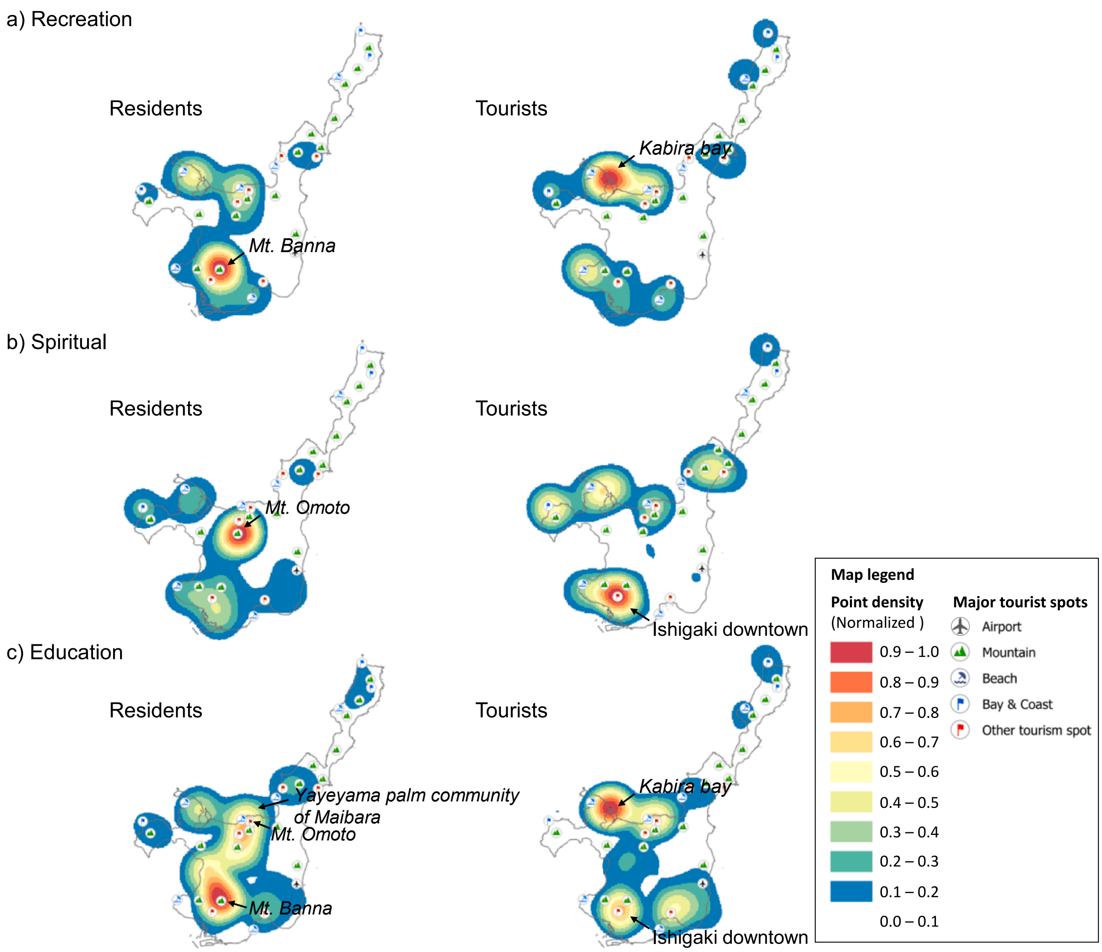

Fig. 5. Kernel density maps illustrating the distribution of cultural ecosystem services for residents and tourists. Kernel density surfaces were generated with a 3,500 m searching radius and at a 100 m grid resolution.

Overall, the CES hotspots of tourists exhibited a simpler spatial pattern than those of residents. These patterns for tourists, centering popular tourist destinations, were relatively consistent across different CES types and were located closer to the ocean. The kernel density map depicted the concentration of CES hotspots in the *Kabira Bay*, a popular tourist destination known for its scenic beauty and a range of nature-experiencing activities, such as scuba diving, snorkeling, paddleboarding, and grass boat riding (Ishigaki Island Travel Information, 2022). Therefore, the *Kabira Bay* is characterized by its pristine ecosystems which Willis (2015) identified as one of the essential prerequisites for CES supporting the well-being of the visitors. In fact, it is common for well-known tourist sites to be amplified in the PPGIS surveys (Dasgupta et al., 2021).

In contrast, a complex spatial pattern was observed for the CES hotspots of residents. These hotspots demonstrated a notable difference between various CES types and were more prevalent in forested lands. Statistical analysis showed a significant difference in the locations of "therapeutic" CES hotspots for residents and tourists, with the former being more typically located in forests and the latter located closer to the ocean. The "spiritual" CES hotspot of residents was centered around Mt. Omoto, the highest peak on the island and known by locals as the embodiment of their traditional deity, known as "Umtou-teirasunu-kan" (Banzai, 2015). Ryukyu archipelago societies, such as those on the Ishigaki Island, are renowned for their traditional beliefs in natural deities, which are frequently venerated in ancient sacred groves known as "Utaki" (Banzai, 2015). This persists as a cultural practice in the modern world, where the forest and other natural aspects of "Utaki" are the source of its sanctity, and are therefore carefully protected and preserved over generations. This reaffirms the significance of religious beliefs, customs, and traditions in the mediation of the delivery of CES.

These findings are consistent with those of Muñoz et al. (2019) and Munro et al. (2017), who have shown that the type of CES is influenced not only by the biophysical features of a location, but also by the individuals who experience CES. Zoderer et al. (2019) discovered the use of the same area for different ecosystem services by different stakeholders. Our results revealed that such disparities in CES locations and types among stakeholders can be attributed to their disparate knowledge regarding locations. The simple spatial pattern of the CES hotspots indicated by tourists and centering on popular tourism spots may have been constrained by prior tourist information and the limited range of places they visited in a short period of time, as also pointed out by Munro et al. (2017). In contrast, "spiritual" CES hotspot of residents was centered on "Mt. Omoto," which is revered by locals as a sacred mountain of their traditional deity.

Our spatial analyses highlight the importance of the protected areas and oceans waters surrounding the Ishigaki Island for the provision of "aesthetic" CES both for residents and tourists. There are contradictory findings regarding the contribution of protected areas to CES across different study regions. For instance, Eastwood et al. (2016) stated that the delivery level of CES was higher in protected areas than in non-protected areas, while Eigenbrod et al. (2009) suggested that the "recreational" level of CES was low in protected areas. In addition, Roux et al. (2020) demonstrated that the restrictions of activity in protected areas can reduce the perception of CES. However, these findings should

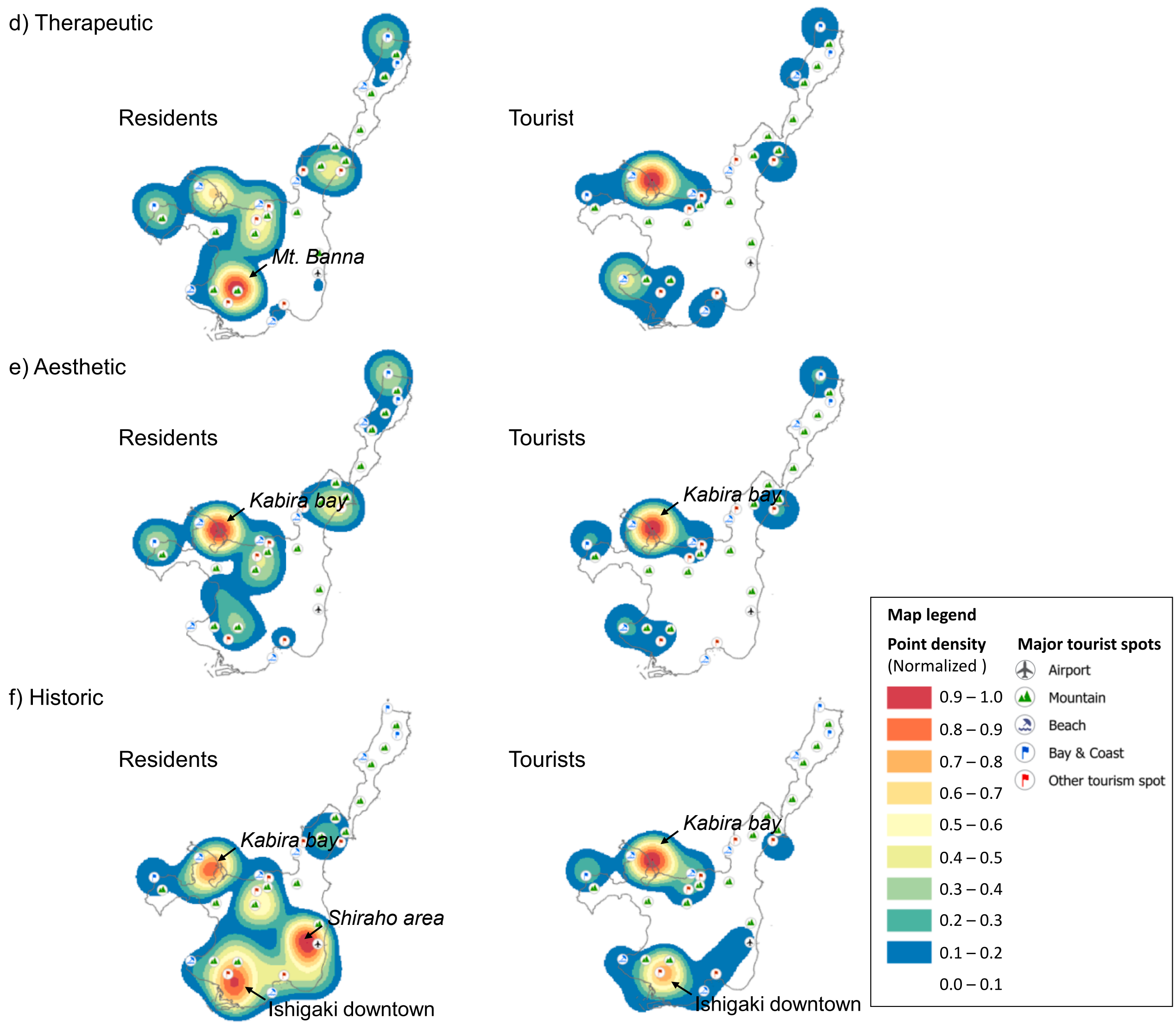

Fig. 5. (*continued*).

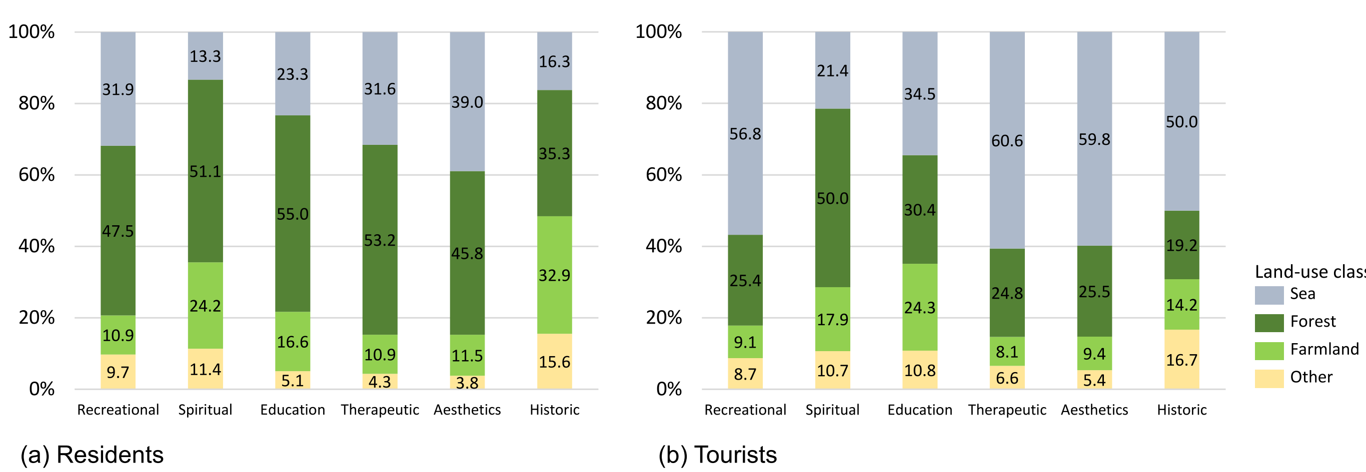

Fig. 6. Stacked chart displaying the relative percentage of each land-use class that the locations of each cultural ecosystem service are associated with.

not be generalized, as practical regulations within protected areas differ substantially in different countries and regions. The Natural Parks Act, which serves as the basis for the protected areas in Japan, "aims at the protection of the places of natural scenic beauty and also, through the promoted utilization thereof, at the contribution to the conservation and sustainable use of biological diversity as well as to the health, recreation and culture of the people" (Ministry of the Environment, 2009). Our findings show that the protected areas on the Ishigaki Island fulfill their primary purpose of maintaining and providing "aesthetic" CES as defined by the local authorities. However, the provision of other types of CES, such as "recreational," "educational," and "therapeutic" CES in protected areas remains ambiguous, and additional measures may be necessary. These measures can include providing more opportunities for camping in an environmentally friendly manner, as well as research and environmental education in the protected areas, additional nature camps, and experimental use of forests. In addition to National Parks, other plans, and regulations, such as the Ishigaki City Landscape Plan (Ishigaki, 2021), which is particularly concerned with "aesthetic" CES, can complement the measures to protect and use CES in a sustainable manner. As our study highlights, taking additional precautions necessitates consideration of disparity in CES types and locations as perceived by various stakeholders, particularly residents and tourists.

The study had some inherent limitations. First, the survey duration was brief and we collected samples on several days only from one season (i.e., the end of summer). Conducting the same research for a different season may yield different results, especially from tourists. For instance, tourists may not enjoy beaches during winter, because summer is the most popular season for beach tourism. Second, the response rate of the questionnaire survey of residents was relatively low (i.e., 13.7%), presumably due to complexities involved in the PPGIS approach, but it was not excessively low in comparison to other similar studies conducted in Japan (Hashimoto et al., 2015; Shoyama and Yamagata, 2016). The low response rate may have had an impact on some of the results; for instance, an uneven sample size of each class used in multiple comparisons may have prevented the detection of significant differences across classes with smaller sample sizes. Other than years of residence and number of visits, higher response rate could allow for a further in-depth analysis of the effect of demographic factors on CES perceptions. In addition, because the map highlighted several major landmark locations, it might have influenced the location choices while also assisting respondents in searching for their preferred locations. Lastly, we evaluated only two groups, that is, residents and tourists. A more precise classification of respondents, such as by occupation as attempted by Darvill and Lindo (2015) could provide further insights into participatory CES mapping if sufficient samples could be secured to examine the differences in individual attributes.

The Ishigaki City Fourth General Plan (2012–2021) (Ishigaki, 2012a) and the Ishigaki City Economic Development Plan (2012–2022) (Ishigaki, 2012b) aim to conserve and sustainably use the unique natural resources of the island for maintaining a good quality of life for individuals and for promoting tourism, which is the core industry of the island. As CES is essential for luring tourists to the Ishigaki Island, the properties of CES shown in our study will provide an important evidence base for future tourism development and administration. Particularly, the recent sharp increase in the number of tourists (Ishigaki, 2018), temporarily because of COVID-19, and the anticipated return of tourists indicate the need for preventive measures against the potential harmful effects of over-tourism. Diversifying tourist destinations would be one of the strategies to reduce tourist concentration (Bramwell, 2015). Similarly, sustainable use and protection of the CES locations of residents would be necessary to prevent opposition to tourism developments by residents. As our study revealed, knowledge of the properties of CES hotspots frequently recognized by residents and tourists would be valuable in any case. As a result, visualizing CES would permit better communication among people with different interests, more inclusive decision-making that ensures both future tourism development, and the health and well-being of residents.

5. Conclusion

Policy planners and decision-makers worldwide are increasingly being pressed to incorporate non-material values in land-use and conservation planning, though with limited success, thus far. To this end, in order to inform spatial planning that sustains CES for equitable health and well-being benefits, we attempted a comparative analysis of how two main stakeholder groups, namely tourists and residents, perceive CES on the Ishigaki Island, including their underlying spatial patterns and factors shaping these perceptions. Some of our findings are consistent with those of previous studies, such as, higher frequency of visits and longer residence duration contributing to stronger perception of CES. Nonetheless, this study provides key findings that could help decision-making by governments and stakeholders on the island in order to provide equitable health and well-being benefits. First, while residents and tourists appreciate similar types of CES, the overall importance of CES is higher for residents, and the CES locations chosen by residents extended far beyond popular tourist destinations. This finding implies that tourism development may have a negative impact on the well-being of residents if an area with a high CES importance for residents is converted into or developed as a tourist spot; however, this study did not go so far to present absolute evidence that local residents would not perceive the CES from tourist attractions. Second, the study reaffirms the importance of protected areas in sustaining the delivery of "aesthetic" CES, which is consistent with the primary purpose of protected areas in the Japanese legal context. The finding may prompt further empirical research on the contribution of protected areas and other effective area-based conservation measures (OECM) to the sustained delivery of multiple CES to various stakeholders, resulting in equitable health and well-being benefits on the island and beyond.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecoser.2023.101520.

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