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Direction of conservation management of coastal forests from the residents' evaluation of their multifaceted functions in Okinawa Prefecture

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Abstract: This study aims to evaluate the multifaceted functions of coastal forests as well as the impact of tsunamis on the community's perception of coastal forests to understand the future direction of coastal forest conservation. The study was conducted in Ishigaki (three locations) and on Okinawa Main Island (two locations). Questionnaire surveys were conducted at each site. After an evaluation of the different scales, with scores from 1 to 5, an exploratory factor analysis was conducted regarding perceptions related to the 'Currently-felt extent' (F-score), 'Expected extent in the future' (E-score), and 'Dissatisfaction with coastal forests' (Demerits). A t-test (at the 5% level) was conducted to determine whether there was a significant difference between F-score, E-score, and Demerits scales. Overall, E-score showed significantly higher values than F-score. However, no significant difference was found for the scale 'Protection of a house against typhoons'. Regarding Demerits, the average value of 'Garbage dumping site' was significantly higher than the other scales. When comparing areas with and without coastal forests, the only significant difference was in the 'Blocking sea view', showing significantly lower values in areas with coastal forests. The existence of differences in evaluation and perception in a target region is regarded as a crucial element to be recognized for more effective conservation and management of coastal forests.

1 Introduction

After the tsunami caused by the 2011 Great East Japan Earthquake, attention was paid to the reevaluation of the function of coastal forests against tsunamis. In the Tohoku region, a project has been initiated for the restoration of coastal forests damaged by the tsunami. Along with increasing awareness of disaster prevention against tsunamis, various areas began to review the use of coastal forests (MAFF 2012). However, cooperation with and the opinions of the local people living around the coastal forest are unavoidable in future planning and management of coastal forests. Thus, it is equally important to have a coastal forest that is cared for and protected by residents while committing to its maintenance and benefitting from its resources.

Coastal forests were created with the main purpose of disaster prevention functions such as sand-drift prevention and windbreak. Recently, however, they have shown varied multifaceted function tendencies (Okada 2020). Taking advantage of this multifaceted function, a coastal forest that has a production capability function in 'normal times,' functioning as seawalls and mitigating other physical hazards in 'emergency times,' also needs to be properly recognized. Therefore, there is a need to formulate a conservation and utilization plan that makes use of the multifaceted functions of coastal forests, concerning residents' current perceptions of those resources. It is thus necessary to clarify the current level of awareness of residents towards coastal forests and their multifaceted functions. Moreover, to be more effective, the future direction of resource use and conservation plan should reflect the evaluation of residents, thereby recognizing this resource as a 'coastal forest of the community.'

Therefore, in this study, we will evaluate the multi-faceted functions of coastal forests as well as the impact of tsunamis on the community's perception of coastal forests to understand what the future direction of coastal forest conservation should be.

2 Materials and Methods

2.1 Study sites

The study was conducted on Ishigaki Island (hereinafter referred to as Ishigaki), which was heavily damaged by a large-scale tsunami (the 1771 Meiwa tsunami). For comparison, a second study area, Okinawa Main Island (hereinafter referred to as Okinawa) was selected. Both sites belong to the same prefecture (Okinawa Prefecture).

Questionnaire surveys were conducted at three locations in Ishigaki (Miyara-Shiraho, Inoda, and Arakawa) and two locations in Okinawa (Toubaru, Afuso). More detailed information on the questionnaire survey locations, coastal forest location, and descriptions of their characteristics are shown in Figure 1. The results of a general survey of planted tree species in the surveyed locations are shown in Table 1.

Questionnaire survey sites on Okinawa Main Island were chosen among those considered by Okada et al. (2012), which had coastal forests within their region. Consequently, the study demonstrated the differences in awareness and perceptions before and after the major impact of the Great East Japan Earthquake and Tsunami. Table 2 shows the run-up height of the 1771 Meiwa tsunami and estimated tsunami inundation height at each location based on the inputs from the Great East Japan Earthquake according to Okinawa Prefecture (2015).

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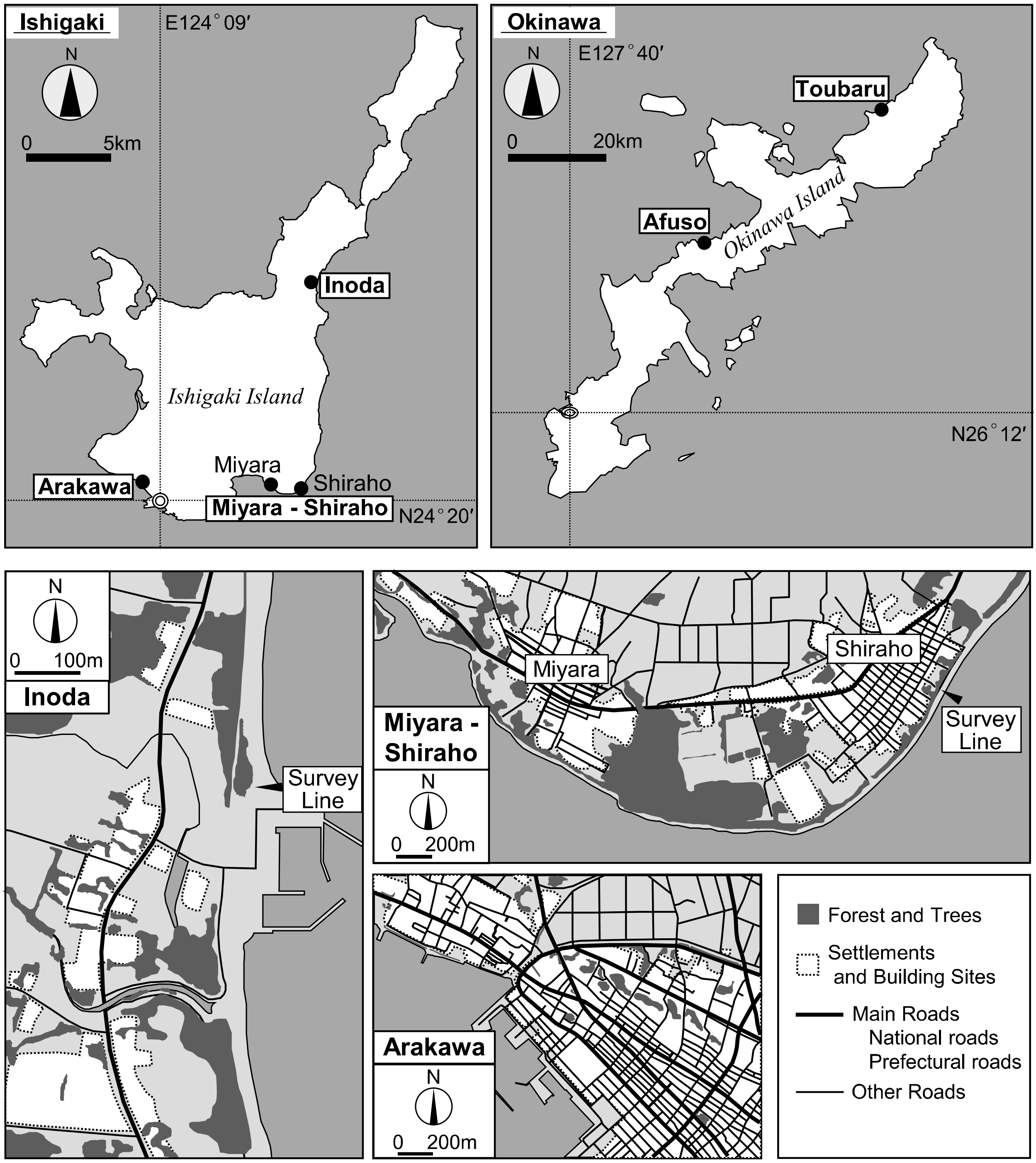

Figure 1: Location and overview of the surveyed area

Table 1: Tree species composition of the coastal forest in the surveyed area

	Shiraho	Inoda
Calophyllum inophyllum L.	◎	
Casuarina equisetifolia J. et G. Forst.		◎
Garcinia subelliptica Merr.		○
Morus australis Poir	○	
Terminalia catappa L.		○
Thespesia populnea Soland.	○	◎
Messerschmidtia argentea Johnston	○	
Pandanus odoratissimus L.f	○	

◎ : main tree species

2.1.1 Description of the 1771 Meiwa tsunami

The 1771 Meiwa tsunami was caused by the M7.4 earthquake centered on the Sakishima Islands in the Okinawa Prefecture around 8:00 am on April 24, 1771. This major tsunami caused approximately 12,000 casualties. Human casualty conditions in the surveyed sites are shown in Figure 2.

Research on tsunamis has been conducted since the discovery of ancient documents describing the Meiwa Great Tsunami in the 1920s and following the reorganization of ancient records leading to the publication titled 'The Great Meiwa Tsunami of Yaeyama' in 1968 (Makino, 1968). The maximum run-up height of the tsunami was reported to be 30 m or more (Japan Meteorological Agency, 2012; Okinawa Prefecture, 2015). The recorded and estimated values (Goto, 2012) of the old run-up height in the study area are shown in Table 2.

In addition, Ishigaki City sets April 24th every year as a citizen disaster prevention day and holds the Meiwa Tsunami Evacuees Memorial Festival to commemorate the victims' memorial service and raise disaster prevention awareness (Ishigaki City, 2020). On Okinawa Main Island, prior to the Great East Japan Earthquake, discussion about the tsunami was negligible, unlike the Ishigaki Island, where local residents were more familiar with the tsunami (Goto, 2020). This has been reported to be due to the culture of oral tradition within families in Ishigaki, citing the 'mermaid' legend as a typical example of the tsunami lore related to the Meiwa tsunami. More than 88% of the respondents reported that they were aware about the 1771 Meiwa tsunami (before the Great East Japan Earthquake) and approximately 10% reported becoming aware after the Great East Japan Earthquake (Figure 3). Goto (2020) also reported the existence of other tsunami traditions in the Yaeyama Islands that are related to the Meiwa tsunami.

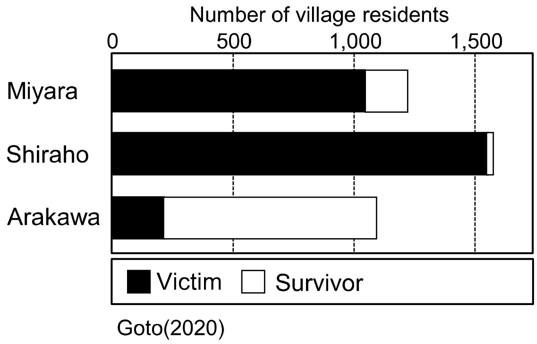

Figure 2: Damage caused by the Meiwa tsunami in the surveyed area

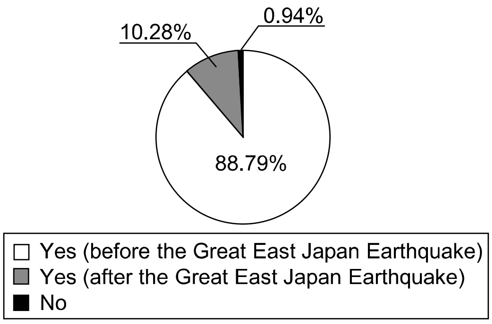

Figure 3: Knowledge of the 1771 Meiwa tsunami before and after the Great East Japan Earthquake

2.1.2 Impacts of the 2011 off the Pacific coast of Tohoku earthquake-led tsunami in the Okinawa region

The impacts of the tsunami from the 2011 off the Pacific coast of Tohoku earthquake on March 11, 2011, was also observed in Okinawa Prefecture. The first wave was observed at the observation points in the prefecture approximately 3 h after the earthquake. Table 2 shows the maximum inundation height around the study area (Japan Meteorological Agency 2012).

Following the event, Okinawa Prefecture released the maximum undulation height and maximum run-up height (Table 2) of the estimated tsunami in 2015 as a tsunami inundation assumption (Okinawa Prefecture 2015). In addition, in the "Tsunami Disaster Prevention Manual" for the Yaeyama region, including Ishigaki Island, the effect of coastal forests (tidal forests) was introduced to reduce the energy of the tsunami and prevent drifting objects as a tsunami disaster prevention measure (Yaeyama Regional Disaster Prevention Liaison Committee 2013).

2.2 Methods

For the questionnaire survey, public halls and neighborhood associations in each district were asked to distribute and collect survey questionnaires from residents. The survey period was from November 2012 to January 2013. In the questionnaire, the scale for each function of the multifaceted functions of coastal forests was the same

Table 2: Information on tsunami and related damages in the surveyed area

Islands and Survey Area	Runup height of the 1771 Meiwa tsunami (m) ※1		Maximum Inundation height of the 2011 off the pacific coast of Tohoku earthquake tsunami (m) ※2	Maximum Runup height of the expected tsunami (m) ※3
	Ancient document	Goto(2012)		
Ishigaki			0.23 ※2a	
Miyara	85.4	21.4 – 33.2		24.2
Shiraho	59.9	19.2 – 25.1		23.4
Inoda	10.7	>7.0		38.4
Arakawa	8.2	3.6 – 10.0		14.9 ※3a
Okinawa			0.60 ※2b	
Afuso				5.6
Toubaru				9.3 ※3b

※1 Goto(2012)
※2 Japan Meteorological Agency (2012) ※2a Ishigaki Port ※2b Naha
※3 Okinawa Prefecture(2015) ※3a Ishigaki Port ※3b Hentona

Table 3: Description of each evaluation scale and their respective scores

score	scale: F-score Demerits	scale: E-score
1	No feelings	No expectations
2	Low feelings	Low expectations
3	No opinion	
4	Some feelings	Some expectations
5	Great feelings	Great expectations

Table 5: Number of respondents to the questionnaire

Islands	Survey Area	Coastal Forest	N 2011※	N 2012
Ishigaki	Miyara	○	-	37 (Miyara and Shiraho)
	Shiraho	○	-	
	Inoda	○	-	39
	Arakawa	×	-	31
Okinawa	Afuso	○	31	14
	Toubaru	○	30	20

※ Okada(2012)

Table 4: List of variables used in the evaluation in both sites

F-score / E-score	Ishigaki	Okinawa 2011※	Okinawa 2012
Windbreaking	○	○	○
Capturing salt from sea spray	○	○	○
Improving scenery	○	○	○
Protection for a house against typhoon	○	○	○
Blown sand control	○	○	○
Mitigating big waves such as tsunami	○	○	○
Observing plants	○	○	
Protection from strong sunshine	○	○	
Habitat of animals and plants	○	○	
Resting place under the shade of trees	○	○	
Source of materials used in everyday life	○	○	
Source of food	○	○	
Use as firewood	○	○	
Capturing dust	○	○	
Creating a local landscape	○	○	
Absorbing CO_2 in the air	○	○	
Forest therapy for healing	○	○	
Place for teaching about nature, animals, and plants	○	○	

※ Okada(2012)

Demerits
Aggravation of scenery
Increase in shade, barring sunlight
Blocking sea view
Hinders cool wind
Closed atmosphere
Difficulty in walking because of complicated plants
Habitat for many insects and animals
Bad scenery because of withered trees
Threat of falling branches
Threat by being large
Increase in work burden such as processing of fallen leaves and branches
Fear or insecurity because of the peace
Difficulty in walking because of prickly plants
Garbage dumping site

as in the questionnaire survey conducted by Okada et al. (2012) in February 2011. In Ishigaki Island, 'Currently felt extent' (hereinafter referred to as the F-Score), 'Expected extent in the future' (hereinafter referred to as E-Score), and 'Dissatisfaction with coastal forests' (hereinafter referred to as Demerits) were evaluated in five scales and scored from 1 to 5 (Table 3). The number of evaluation units in the F-score and E-score was 18 (including parameters such as, 'Capturing salt from sea spray', 'Wind breaking ability', and 'Improving the scenery'), while those of the Demerits were 14 (including, 'Blocking sea view', and 'Hindering cool wind') (Table 3).

On Okinawa main island, with regard to the F-score and E-score, the evaluation concerned the six highest representative scales selected from those used in Ishigaki Island based on Okada et al. (2012) (Table 4). Table 5 shows the number of respondents at each distribution site, showing three sites 'with coastal forests' in Ishigaki, and two sites on Okinawa Island. A statistically significant difference in evaluation scores between locations was found between Miyara-Shiraho and Inoda on 7 of the 50 scales; no significant difference was found in Okinawa.

To determine the potential evaluation criteria, as well as the underlying latent variables, an exploratory factor analysis with Promax rotation (oblique rotation) was performed on each scale of the F-score, E-score, and Demerits.

3 Results

3.1 Extraction of underlying latent variables and their mean values

The exploratory factor analysis results (Table 6) showed that the F-score was classified into 3 factors, the E-score 4 factors, and the Demerits into 3 factors (based on an eigenvalue of 1). The latent evaluation scale was interpreted according to the scale with a large factor loading (>|0.3|) for each factor. Factor 1 was interpreted as a disaster prevention function, Factor 2 as a health rest function, and Factor 3 as a resource supply function.

In E-score, Factor 1 is a health rest function, Factor 2 is a resource supply function, Factor 3 is a disaster prevention function against the sea breeze, and Factor 4 is a function with a large difference between the evaluation values of the F-score and E-score (mean values). All the top five scales with large value differences are included. In the Demerits, Factor 1 was interpreted as an apparent problem, Factor 2 was a litter problem, and Factor 3 was a problem of the adverse effects on daily life.

The mean evaluation values of each F-score and E-score scale are shown in Figure 4. Overall, the E-score showed significantly (t-test at 5% level) higher values compared to the F-score. However, no significant difference was found for 'Protection for a house against

Table 6: Result of factor analysis for each scale

F-score	factor loading ①	②	③	communality
sand	0.880	-0.191	0.058	0.625
salt	0.731	0.128	-0.168	0.596
CO_2	0.583	0.007	0.262	0.512
tsunami	0.523	0.148	0.121	0.465
typhoon	0.515	0.183	-0.046	0.396
wind	0.499	0.273	-0.300	0.404
teach	0.449	0.260	0.306	0.678
dust	0.383	0.049	0.402	0.451
scenery	0.078	0.776	-0.066	0.632
shade	-0.115	0.744	0.178	0.616
habitat	0.116	0.629	0.085	0.569
landscape	0.276	0.552	0.021	0.588
observing	0.035	0.521	0.235	0.483
sunshine	0.203	0.499	0.078	0.473
therapy	0.282	0.358	0.254	0.539
firewood	-0.132	-0.035	0.946	0.807
materials	-0.079	0.113	0.839	0.768
food	0.068	0.083	0.706	0.678
eigenvalue	8.1627	2.216	1.0821	
contribution ratio (%)	31.841	35.416	26.161	

E-score	factor loading ①	②	③	④	communality
shade	0.769	0.115	0.121	-0.200	0.628
observing	0.744	0.174	-0.015	-0.091	0.616
scenery	0.585	-0.034	0.176	0.048	0.483
landscape	0.555	-0.040	0.020	0.279	0.529
therapy	0.537	-0.007	-0.072	0.373	0.564
teach	0.483	0.092	-0.006	0.312	0.533
habitat	0.435	0.000	0.243	0.014	0.350
materials	0.316	0.622	-0.099	-0.042	0.602
firewood	-0.146	1.041	0.003	0.042	1.000
food	0.207	0.523	-0.046	0.023	0.407
dust	0.014	0.311	0.133	0.427	0.439
salt	-0.047	0.038	1.008	-0.023	0.961
Wind	0.213	-0.110	0.462	0.080	0.384
typhoon	0.135	-0.042	0.396	0.176	0.335
tsunami	-0.139	0.003	0.017	0.895	0.713
CO_2	0.156	0.074	0.166	0.518	0.542
sand	0.123	-0.182	0.297	0.370	0.396
sunshine	0.240	0.244	0.278	0.214	0.490
eigenvalue	6.9875	2.2068	1.2890	1.1117	
contribution ratio (%)	29.182	17.409	20.239	23.419	

Demerits	factor loading ①	②	③	communality
scenery	0.776	0.020	0.023	0.646
shade	0.732	0.122	-0.127	0.519
sea view	0.707	-0.123	0.035	0.449
wind	0.638	-0.001	-0.109	0.321
closed	0.554	0.047	0.353	0.755
walking	0.419	0.132	0.384	0.683
habitat	0.395	0.176	0.053	0.306
withered	0.341	0.238	0.219	0.474
branches	0.001	0.954	-0.005	0.906
large	-0.004	0.943	0.048	0.935
work	0.218	0.334	0.263	0.487
insecurity	0.041	-0.083	0.873	0.738
prickly plants	0.027	0.069	0.643	0.493
dumping	-0.154	0.077	0.515	0.214
eigenvalue	6.8141	1.2139	1.1251	
contribution ratio (%)	39.177	31.118	35.081	

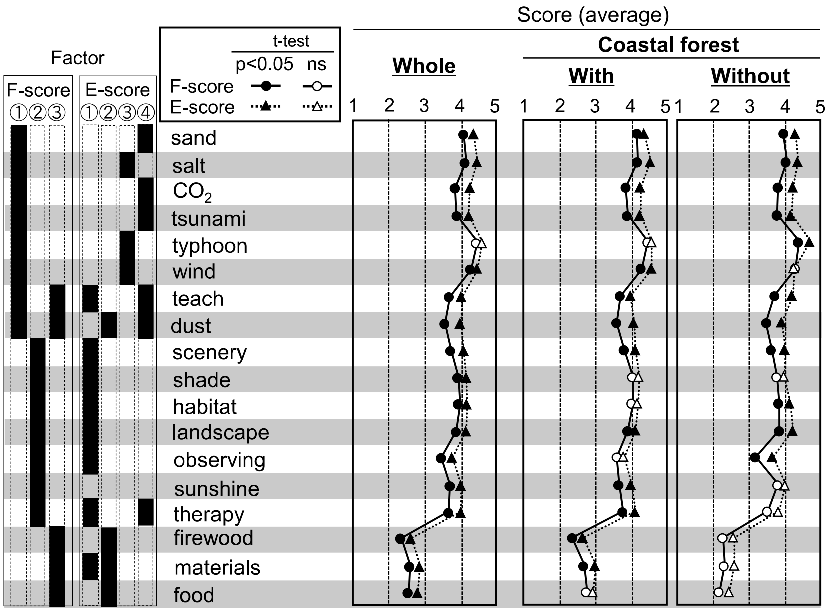

Figure 4: Mean evaluation values of each scale of F-score and E-score

typhoon' (noted as 'typhoon' in Figure 4). When divided into villages with and without coastal forests, the number of scales for which there was no significant difference by the t-test between the F-score and E-score showed 5 scales for "with coastal forest", and 7 scales with "no coastal forest". There was no significant difference among villages with coastal forests (with the 'health rest function') and without coastal forest (with resource supply function).

Figure 5 shows the average value of each scale in the Demerits and the difference between the presence and absence of coastal forests. As a result, the average value of the "Garbage dumping site (noted as 'dump')" was significantly higher than other scales. When comparing areas with and without coastal forests, a significant difference by the t-test (5% level) was observed only in 'Blocking sea view' (sea view), showing significantly lower values in areas 'with coastal forests'.

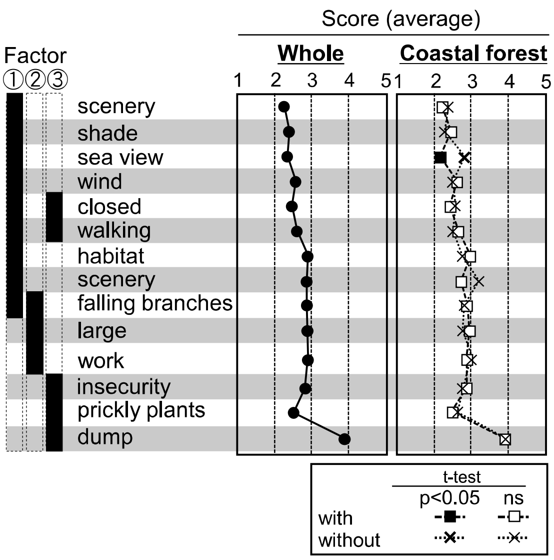

Figure 5: Mean evaluation values of each scale of Demerits

3.2 Comparison of evaluation values between Ishigaki and Okinawa

To investigate the functional evaluation between Ishigaki and Okinawa, the mean evaluation values of the six overlapping scales were compared (Table 7). As a result, no significant difference was found between Ishigaki and Okinawa at any scale by the t-test. However, looking at the difference between F-score and E-score on each island, Ishigaki confirmed a significant difference by the t-test (5% level) on all scales except for the 'Protection of a house against a typhoon (noted as 'typhoon')'. Although the E-Score had a higher evaluation value in Ishigaki, no significant difference was observed in Okinawa.

3.3 Comparison of evaluation values before and after the occurrence of the tsunami from the 2011 off the Pacific coast of Tohoku earthquake

Table 7: Mean evaluation values of each scale for F-score and E-score

	score (average)				t-test			
	Ishigaki		Okinawa		Ishigaki - Okinawa		F-score - E-score	
	F-score	E-score	F-score	E-score	F-score	E-score	Ishigaki	Okinawa
wind	4.34	4.58	4.31	4.43			**	
salt	4.29	4.54	4.03	4.28			*	
scenery	3.89	4.11	4.06	4.04			**	
typhoon	4.54	4.59	4.33	4.35				
sand	4.23	4.40	4.25	4.33			*	
tsunami	3.95	4.22	3.77	4.03			**	

*: p>0.05, **: p>0.01

Table 8: Comparison of 2011 and 2012 evaluation values (average values) in Okinawa

	score (average)				t-test			
	2011		2012		2011 - 2012		F-score - E-score	
	F-score	E-score	F-score	E-score	F-score	E-score	2011	2012
wind	4.56	4.26	4.50	4.31			**	
salt	4.51	4.49	4.35	4.00	*			
scenery	3.81	3.86	4.08	4.12	*			
typhoon	4.63	4.42	4.42	4.50	*		*	
sand	4.42	4.26	4.42	4.19				
tsunami	4.25	4.33	4.12	3.96				

*: p>0.05, **: p>0.01

To understand the difference between the evaluation values before and after the tsunami from the 2011 off the Pacific coast of Tohoku earthquake (2011.3.11), evaluation values between the 2011 and 2012 F-score and E-Score evaluation values (mean values) were compared using a t-test (Table 8). As a result, there was a significant difference between the 2011 and 2012 evaluation values in the F-score ‘salt’, ‘scenery’, and ‘typhoon’ values. However, there was no significant difference in the E-score. Regarding the comparison (by t-test) between the F-score and E-score, there was a significant difference in ‘wind’ and ‘typhoon’ in 2011 but no significant difference in 2012.

4 Discussion and Conclusions

4.1 Evaluation of the multi-dimensional function of coastal forest by residents

Regarding the evaluation of the multifaceted functions of coastal forests, from the extraction of latent evaluation scales, it was found that the residents’ perceptions were roughly divided into ‘Disaster prevention function’, ‘Health rest function’, and ‘Natural resource supply function’. This finding is in line with previous studies (Okada et al. 2012; Okada 2015).

Moreover, in the E-score, a latent evaluation factor noted as a ‘function with a large difference in evaluation from the F-score’ was included. This function should be treated separately from the classification of the overall functions by the local residents. It might also be effective to focus on functions with large factor loadings, prioritizing them over other functions.

4.2 Difference in the evaluation of coastal forests by region

Considering the differences in evaluation between Ishigaki and Okinawa, there was no statistically significant difference in the evaluation values of each function. In Ishigaki, except for the ‘typhoon’ function, there were significant differences in all functions between the F-score and E-score. No significant difference was found for Okinawa.

Based on the evaluation results found in Okinawa and Ishigaki, the direction of coastal forest conservation is different for the two islands. While the former tends toward improvement, the latter gives importance to maintenance. Assuming that the evaluation value of each function is high in both regions, the influencing factor that might have led to the above difference between the two regions is the ‘further expectations’ found in Ishigaki.

In addition, as the influence of the Meiwa Tsunami has been present in Ishigaki, a stronger perception of threats from the sea is considered an important factor. In fact, among the opinions mentioned by survey respondents in the questionnaire figure, a description noted that “the coastal forest is being managed using the lessons learned from the Meiwa tsunami”. Although it is difficult to derive a clear relationship with the results of this survey, it can illustrate the importance of this factor. Therefore, the association of culture and tradition with coastal forest conservation management is effective in raising awareness of the region.

4.3 Changes in evaluation before and after the Great East Japan earthquake

Before and after the Great East Japan Earthquake, there was a change in evaluation values in the F-score but no statistically significant change was found in the E-score. From this finding, it is highly possible that information on major impacts (such as the tsunami in this study) will be reflected in the current assessment of coastal forests.

However, future expectations may not have a similar trend. If expectations for coastal forest functions can be known in a timely manner and if the direction of conservation management of coastal forests is set on that basis, it is believed that the occurrence probability of major problems or the need for a necessary redirection of conservation management would be less expected.

Moreover, looking at the change in the evaluation values in F-score, 'salt' and 'typhoon' showed lower evaluation values, coinciding with the period of occurrence of typhoon No. 2 in May 2011 and typhoons No.15, No.16, and No.17 from August to September 2012, which caused enormous damage to the Okinawa Prefecture (The Okinawa Times 2011; The Asahi Shimbun 2013). Lower evaluation values are believed to be due to the enormous damage caused by these typhoons, greatly affecting the perception of the residents.

Although the tsunami generated by the Great East Japan Earthquake was felt in Okinawa Prefecture, the direct damage was less perceived than that of the typhoons. This might have affected the residents' perception of the 'tsunami' variable and resulted in the absence of perceived change in the evaluation. However, the evaluation value itself is high for both the F-score and E-score. As shown in various comments and opinions in the free answer section of the questionnaire, the threat from the tsunami remains crucial for the region.

4.4 Direction of conservation management of coastal forests based on evaluation results

Demerits were classified into 'visual problem', 'deciduous litter problem', and 'impact on daily life' by extracting latent evaluation scales. Improving the listed demerits is largely related to improving the evaluation of residents to coastal forests. Setting a direction for each issue and confirming which category includes the issues mentioned in that area enables efficient responses and addresses issues that were not given in this questionnaire.

In addition, regarding the multi-faceted functions of coastal forests, it is crucial to set which functions should be given priority and what direction should be taken to implement the conservation management of coastal forests. Similar to previous studies (Okada et al. 2012; Okada 2015), the findings from this study showed that it is effective to set the improvement direction for each classification of "disaster prevention function", "health rest function" and "natural resource supply function". In addition to this, the extent of evaluation values (mean values) of each scale, combined with the existence or absence of a difference between F-score and E-score was the main focus in this study.

Regarding the extent of evaluation values, the scores given by the residents in their evaluation were simply categorized based on whether they were lower or higher than 3. Scores lower than 3 correspond to 'no feelings', 'low feelings' and 'no opinion' with regard to F-score and Demerits; and 'no expectations', 'low expectations', or 'no opinions' with regard to E-score. Scores higher than 3 indicate those corresponding to ''some feelings', 'great feelings' with regard to F-score and Demerits; and 'some expectations', 'great expectations' with regard to E-score (as shown in Table 3).

This approach can be improved in future studies to reflect residents' perceptions in a more effective way. Moreover, the evaluation differences were classified according to the existence of a statistically significant difference between the mean F-score and E-score values. As the E-score was higher than the F-score for all scales, it was assumed that the evaluation of coastal forests would be improved by improving the scales that differed. The direction of improvement and its priority were thus set by multiplying the above two viewpoints, shown as types 1, 2, 3, and 4 (Table 9).

As shown in Table 9, because Type 1 has a high evaluation value, thereby showing a larger evaluation difference, it was interpreted as a function that should be improved in the future with a high priority. Specifically, Factor 4 of the E-score, including the 'tsunami' variable corresponds to this group. Type 2 showed a high evaluation value without a significant difference in evaluation. Thus, it was interpreted as a function that should maintain the current status setting it as a high priority because the current evaluation was high (the case of 'typhoon'). As Type 3 has a low evaluation value with a significant evaluation difference, it was interpreted as a function with the potential to enhance its evaluation in the future; the current evaluation was low. Therefore, the priority was set as medium. This concerns the Factor 2 of the E-score, namely, the 'natural resource supply function'. In the case of Type 4, where there was a low evaluation value characterized by the inexistence of evaluation difference, it was interpreted as a function that is not particularly required to be targeted for improvement, setting it as one with low priority. This was the case of 'food' in areas with coastal forests.

The approach addressed in this study appears to be effective when setting the direction of coastal forest conservation based on local residents' evaluations. The existence of differences in evaluation and perception in a target region is regarded as a crucial element to be

Table 9: Direction of coastal forest conservation management from the viewpoint of evaluation

Type	Evaluation score	Difference of evaluation	Directionality of improvement	Priority	Example of functions and factors (E-score)
1	High	significant	necessary improvement	high	factor 4
2	High	not significant	keep	high	typhoon
3	Low	significant	effective improvement	medium	factor 3
4	Low	not significant	(improvement)	low	food (existence)

recognized in establishing more effective coastal forest conservation and management, one that reflects local residents' views and perceptions, and the characteristics of the target region.

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