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Case study

The social-ecological status of small islands: An evaluation of island tourism destination management in Indonesia

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ABSTRACT

A social-ecological system approach has been applied to measure the complexity of sustainable tourism development on small islands. In general, tourism development and ecosystem management have been shown to be relatively unbalanced. Tourism development attempts have not yet been accompanied by environmental management efforts. In this paper, the social-ecological status is measured to improve the sustainable development mechanism with appropriate indicators. Using the Gili Matra Islands as a case study, the social-ecological status of tourism in the region was examined using the social-ecological status index (SESI), a coupling index of the coastal waters quality index (CWQI), the coordination degree model (CCDM) and the index of information entropy weight (IEW) as tools for measuring and evaluating the social-ecological status and sustainable development of small island tourism.

1. Introduction

Tourism can be considered an ecosystem service, namely, a cultural ecosystem service. Its existence is beneficial to human life (Layke, Mapendembe, Brown, Walpole, & Winn, 2012); thus, it is important to build social-ecological systems (SESs) in spatiotemporally sustainable areas (Bunce, Mee, Lynda, & Gibb, 2009), especially small islands and conservation areas. The United Nations World Tourism Organization (UNWTO)[1] states that islands are the most visited destinations by tourists each year. In small island developing states (SIDS), tourism is an important sector, though it also shows a remarkable growth rate worldwide (Salpin, Onwuasoanya, Bourrel, & Swaddling, 2016; UNWTO, 2014). Additionally, tourism varies significantly by the economic and social performance of SIDS, with 40.83 million overnight visitors and receipts of US$ 53,418 million in 2013 (UNWTO, 2014). In fact, tourism has been able to transform traditional fishing communities into tourism actors (Chen & Chang, 2017).

Tourism, including coastal and marine tourism and the ecosystem itself, is highly interconnected and has complex interactions. Tourism development is strongly influenced by the natural environment, but tourism also has a negative impact on the environment, as demonstrated by a lack of appropriate sustainable development strategies (Gladstone, Curley, & Shokri, 2013; Tang, 2015; Zhong, Deng, Song, & Ding, 2011). Tourism can be directly linked to the pollution and decreased quality of seawater (Laapo, Fahrudin, Bengen, & Damar, 2009; Ngah, Hashim, Nayan, Said, & Ibrahim, 2012; Sundra, 2011), coral reef depletion (Barkes & Roberts, 2004; Hannak, Kompatscher, Stachowitsch, & Herler, 2011; Kurniawan, Adrianto, Bengen, & Prasetyo, 2016b), seagrass destruction (Cullen-Unsworth et al., 2014; Daby, 2003), etc. from both existing tourist activities and intensive development; these factors are capable of rapidly changing the landscape because of the growing human population of both visitors and urbanization as the need for space increases (Carpenter et al., 1998; D'Angelo & Wiedenmann, 2013; Kurniawan, Adrianto, Bengen, & Prasetyo, 2016a; Kurniawan et al., 2016b; NAS, 2002; Ngah et al., 2012; Orpin et al., 2004). This is a two-edged sword because tourism development is relatively unregulated and tends to ignore eco-environmental conditions and impacts. In addition, many tourist areas do not use the carrying capacity in managing visits and tourist activities (Cupul-Magaña & Rodríguez-Troncoso, 2017; Kurniawan, Adrianto, Bengen, & Prasetyo, 2017; Zhong et al., 2011).

This paper describes the correlation of balanced development between tourism and ecosystem management on islands using an SES approach with the Gili Matra Islands of Indonesia as a case study.

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Specifically, the aims of the study are to 1) classify the principle indicators responsible for the most influential factor in the system; 2) estimate the coupling coordination degree in SESs; and 3) to assess the social-ecological system index (SESI) of the Gili Matra Islands as a marine tourism park (MTP) in Indonesia.

2. Literature review: measuring the sustainable tourism of small islands using a social-ecological system approach

A social-ecological system (SES) is defined as "an ecological system intricately linked with and affected by one or more social systems" (Anderies, Janssen, & Ostrom, 2004). SESs are typically capable of providing complex interactions and changes between processes on different spatial and temporal scales, and the results are widely understood to be complex adaptive systems that serve as a basis for managing resilience (Lauer et al., 2013; Walker et al., 2002). SES approach has become important within sustainable development (Anderies et al., 2004; Bunce et al., 2009; Ostrom, 2009; Virapongse et al., 2016; Young et al., 2006).

Implementing SES theory in management practices is challenging; however, it can help environmental managers predict and adapt to environmental change to support policy options (Mehryar, Sliuzas, Sharifi, Reckien, & Maarseveen, 2017; Virapongse et al., 2016). Therefore, all the dimensions in the sustainable development indicators (SDIs) must be achieved (Tanguay, Rajaonson, Lefebvre, & Lanoie, 2010). In the short and long term, the coupling and status of social (humans) and ecological (environment) aspects must be understood to estimate the development impact, system resilience and sustainability (Castellani & Sala, 2010; Estoque & Murayama, 2014, 2017), including the coupled tourism-environment system in the tourism context (Tang, 2015; Zhang, Gu, Gu, & Zhang, 2011).

UNWTO has defined sustainable tourism as "tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities." It describes the complex interaction between the human-environment system and social-ecological system in this perspective. Sustainable tourism is also concerned with how to reduce the negative effects of tourism activities on the environment, society and the economy so that ecological sustainability, economic feasibility and social equality can be achieved (Pan et al., 2018).

Tourism is a complex and dynamic system (Mai & Smith, 2015), with all of its effects present in the social aspects and ecology of islands, such as solid waste (Sealey & Smith, 2014), livelihoods (Su, Wall, & Jin, 2016), social networks (Partelow & Nelson, 2018), attitudes (Ribeiro, Pinto, Silva, & Woosnam, 2017), the political economy (Bojanic & Lo, 2016; Hampton & Jeyacheya, 2015), the quality of life and well-being (Croes, Ridderstaat, & van Niekerk, 2018; Volo, 2017), landscape change (Kurniawan et al., 2016a; Yang, Ge, Ge, Xi, & Li, 2016), etc. The SES approach can help identify changes in the spatiotemporal scales of each system so that sustainable management can be implemented (Dressel, Ericsson, & Sandström, 2018; Holdschlag & Ratter, 2016).

Meanwhile, Agyeiwaah, McKercher, and Suntikul (2017) concluded that sustainable tourism can be seen from seven key indicators, namely, job creation, business viability, quality of life, water quality, waste management, energy conservation and the maintenance of community integrity, that are grouped into four dimensions, i.e., economic, social, environmental and cultural. Mai and Smith (2015) agreed that sustainability is seen from four domains, i.e., natural-environmental, social-political, business-economics and policy-governance, while Lee and Hsieh (2016) only identified two dimensions, i.e., the stakeholder dimension (with five subdimensions: tourists, residents, for-profit organizations, governments, and nongovernment organization) and the environment dimension (with six subdimensions: loss of renewable resources, rate of ecosystem degradation, environmental impact of the tourism activity, rate of reuse/recycling, health of the human population, and the loss of nonrenewable resources).

Specifically, the assessment of tourism sustainability on small islands has been applied in several studies. Mai and Smith (2015) measured sustainable tourism using a system dynamic model, and the indicators were the number of tourists, investment, tourism infrastructure, waste, pollution and attractiveness; they implemented the model in tourism development planning using scenario-based planning (Mai & Smith, 2018). Ng, Chia, Ho, and Ramachandran (2017) evaluated the sustainable tourism of an island using the sustainable ecotourism indicator system (SEIS), which has social, environmental, and economic dimensions, through three interdependent relations between community, tourism and resources.

Based on the review, the assessment results were not clustered based on the social and ecological systems but on the relations between the two systems (effect and feedback). This is occasionally difficult in the evaluation and management implementation phase because each indicator is assessed independently. Regionally, Tang (2015) and Li, Li, Zhou, Shi, and Zhu (2012) tried to integrate the assessment of the systems using the coupling coordination degree model (CCDM) to evaluate the degree of coupling coordination between the social and ecological systems in tourism development and coastal areas. Tang (2015) classified the indicators from the development scale and the economic benefits as a social system, and ecological quality, resource consumption and environmental protection were classified as an ecological system; Li et al. (2012) assessed the demographic, economic, social and spatial aspects of social systems and the aspects of pressure, level and control of the environment for ecological systems. However, these studies did not make any conclusions about the social-ecological status. Estoque and Murayama (2014, 2017) try to answer these challenges; however, their study was still on a large spatial scale. Therefore, the assessment of tourism sustainability on small islands and the conservation of biocultural diversity in SESs become interesting because small islands have different ecological and social characteristics than mainlands or large islands and conservation areas (Aburto & Gaymer, 2018; Mauerhofer et al., 2018).

3. Case study area: Gili Matra Islands

The Gili Matra Islands are scattered small islands that have been become a conservation area and a tourism destination in Lombok Island, Indonesia. The islands are located in North Lombok Regency, from 116°01′34″ E to 116°05′18″ E and 8°20′02" S to 8°22′16" S, with a total area of 2954 Ha (Fig. 1). The Gili Matra Islands are actually three small islands, namely, Gili Meno, Gili Ayer, and Gili Trawangan. Tourism in the area is experiencing accelerated growth, especially the landscape change due to hard infrastructure development both for residential and tourist accommodation. This acceleration has resulted in vast increases in ecological change and island vulnerability (Kurniawan et al., 2016a, 2016b). The Tourism Department of North Lombok Regency recorded that the average number of tourists increased by 19.08% from 2011 to 2014 (*Dinas Pariwisata Kabupaten Lombok Utara/* Tourism Department of Lombok Utara Regency, 2015). The top tourism activities on the islands include scuba diving, snorkeling, sunbathing, canoeing, sport fishing and surfing (Dodds, Graci, & Holmes, 2010; Yulianto, Fahrudin, & Kusmaningsih, 2007).

4. Materials and methods

4.1. Structure of the index system

The use of composite indexes to evaluate the social-ecological status of small islands is fairly new, as this study tries to modify the framework that was built by Li et al. (2012), Mai and Smith (2015), Mai and Smith (2018), Ng et al. (2017), Tang (2015) and Zhang et al. (2011) in the context of tourism and environmental relations using the CCDM. To strengthen the island status assessment, the SESI framework was established, which considers the previous studies by Estoque and

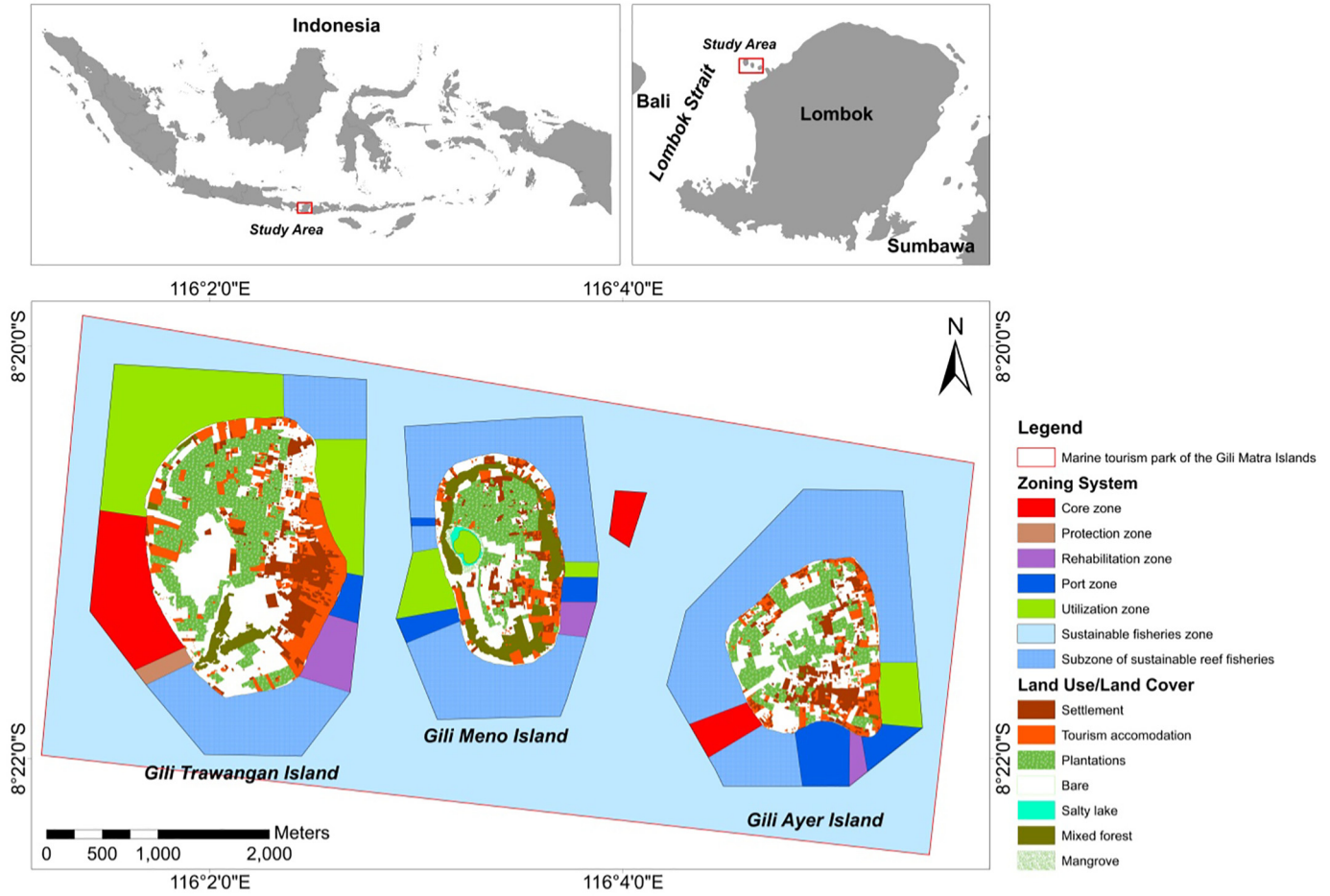

Fig. 1. Study area.

Murayama (2014) and (2017). Previously, the entropy model was used to weigh each indicator in each system. The weighting structure is independent and comparative to obtain the principal parameters in the evaluation process based on the appropriate categories and systems (Fig. 2).

4.2. Indicator selection

The potential indicators were identified based on the assessment of previous studies related to the location of the study and the system's social and ecological relationships conducted by Li et al. (2012), Zhang et al. (2011), Tang (2015), Kurniawan et al. (2016b) and Kurniawan et al. (2017). Then, the indicators were selected through a comparison of the correlation coefficients and the significance levels using qualitative analysis by considering the principles of vulnerability, resilience and the SESs on small islands as well as the available data in the study area. Finally, the two systems (the social and ecological systems), five categories and twelve indicators were formulated (Table 1).

The indicators were identified and developed based on the argument that the Gili Matra Islands should be developed using a balanced tourism-ecosystem coupled system. As tourists visit the islands, there is a need for better development to increase the tourism sector on the islands both in terms of increased tourist arrivals and the number of travel agencies as well as the supporting facilities, such as hotels, cottages and motels. Thus, the demographic and economic aspects were also developed in terms of the population growth and employment, which also reflect the increasing economic benefits. However, tourism development also leads to an escalating pressure on the environmental system, as tourism activities and anthropogenic waste have detrimental effects on ecosystem quality, including coastal water quality, landscape changes and other social-ecological system changes. In the absence of the proper management of these ecological pressures, tourism development causes severe eco-environmental damage and affects tourist satisfaction such that the tourism development and conservation efforts will be disrupted.

4.3. Data sources and preprocessing

The data for developing the indexes were obtained from The Tourism Department of North Lombok Regency (*Dinas Pariwisata Kabupaten Lombok Utara/* Tourism Department of Lombok Utara Regency, 2015) and the Gili Indah profile (*Desa Gili Indah/Gili Indah Village,* 2016), while the ecosystem quality data were collected from the Indonesian Institute of Sciences (LIPI, 2014) and the Ministry of Marine Affairs and Fisheries (KKP, 2015). Additionally, the spatial aspects were based on the previous reports by Kurniawan et al. (2016a, 2016b), while the coastal water quality data (coastal waters quality index, CWQI) were obtained in 2014 and 2015 during this study (peak and low tourism seasons), as presented in Table 2. Data standardization was carried out to reduce the effects of dimension and magnitude and was performed as follows:

$$X_i' = \frac{X_i - X_{min}}{X_{max} - X_{min}} \quad (1)$$

where X_i' = the standardized value of indicator i, X_i = the original value of indicator i, X_{max} = the maximum value of the indicator, and X_{min} = the minimum value of the indicator.

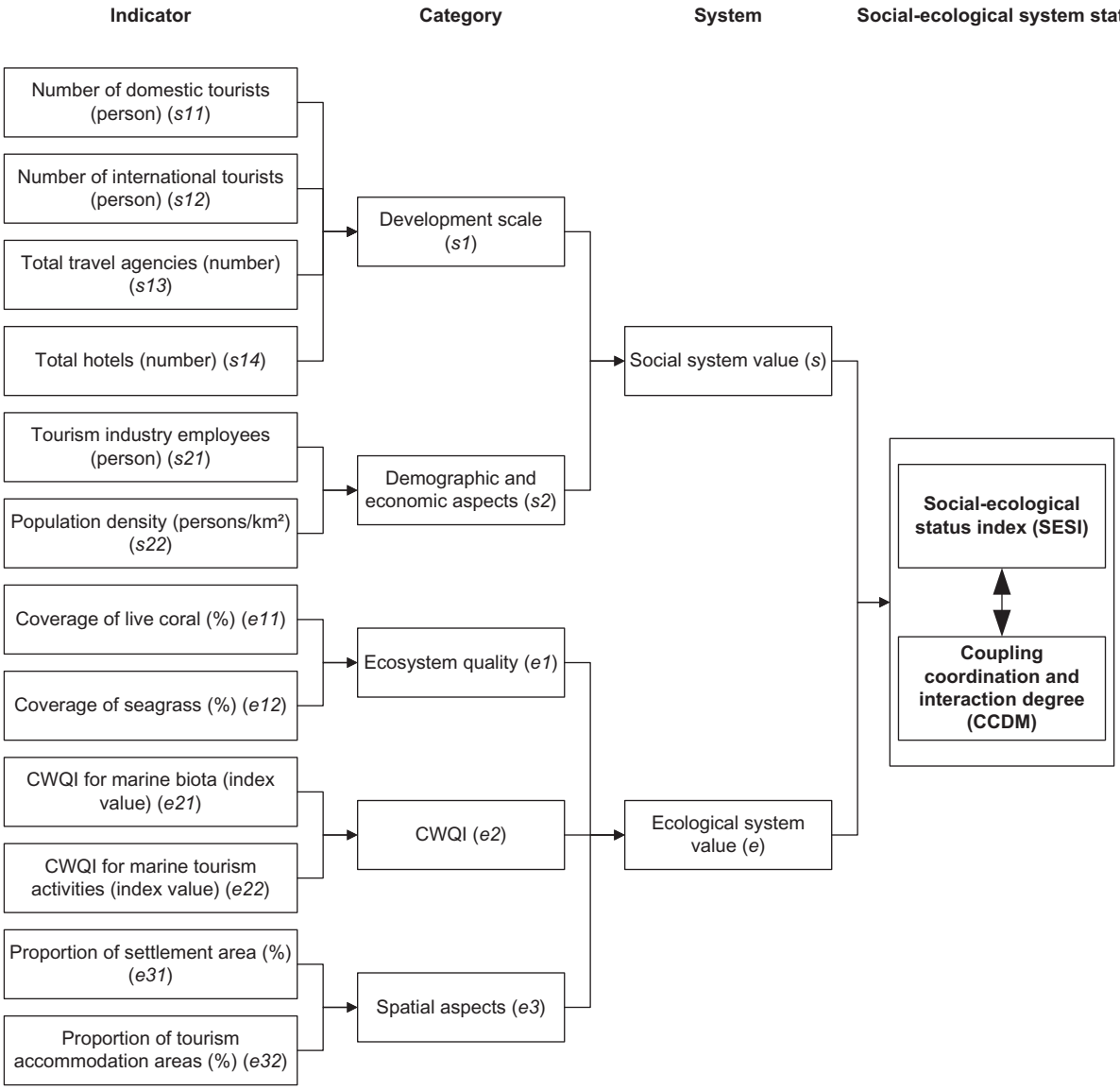

Fig. 2. Conceptual framework for assessing the social-ecological status of tourism on small islands.

4.4. Evaluation of the social and ecological index weight

The social level and ecological quality were analyzed using the information entropy weight (IEW) proposed by Shannon in 1948 (Shannon, 1948) and developed by Zhang et al. (2011), Li et al., 2012, and Tang (2015). Entropy refers to the system uncertainty connected with a random variable and enables the elimination of bias affected by subjectivity. The steps were as follows:

1) Calculating the indicator proportion j in island i (R_{ij}),

Table 1
Index system.

System	Category	Indicator
Social system value (*s*)	Development scale (*s1*)	Number of domestic tourists (person) (*s11*)
		Number of international tourists (person) (*s12*)
		Total travel agencies (number) (*s13*)
		Total hotels (number) (*s14*)
	Demographic and economic aspects (*s2*)	Tourism industry employees (person) (*s21*)
		Population density (persons/km^2) (*s22*)
Ecological system value (*e*)	Ecosystem quality (*e1*)	Coverage of live coral (%) (*e11*)
		Coverage of seagrass (%) (*e12*)
	Coastal water quality index (CWQI) (*e2*)	CWQI for marine biota (index value) (*e21*)
		CWQI for marine tourism activities (index value) (*e22*)
	Spatial aspects (*e3*)	Proportion of settlement areas (%) (*e31*)
		Proportion of tourism accommodation areas (%) (*e32*)

Table 2
Baseline data of the Gili Matra region.

Island region	Social system value (*s*)						Ecological system value (*e*)					
	s1				*s2*		*e1*		*e2*		*e3*	
	s11	*s12*	*s13*	*s14*	*s21*	*s22*	*e11*	*e12*	*e21*	*e22*	*e31*	*e32*
Gili Ayer	2437	82,719	2	82	657	918	11.78	59.19	45.99	51.37	15.69	12.82
Gili Meno	1169	31,790	2	57	402	367	17.74	53.86	47.40	52.10	8.79	10.08
Gili Trawangan	43,783	272,176	11	260	2520	485	17.37	38.60	47.10	51.43	11.70	16.81

Note: *s* = social system value; *e* = ecological system value; *s1* = development scale; *s11* = number of domestic tourists (person); *s12* = number of international tourists (person); *s13* = total travel agencies (number); *s14* = total hotels (number); *s2* = demographic and economic aspects; *s21* = tourism industry employees (person); *s22* = population density (persons/km^2); *e1* = ecosystem quality; *e11* = coverage of live coral (%); *e12* = coverage of seagrass (%); *e2* = coastal water quality index (CWQI); *e21* = CWQI for marine biota (index value); *e22* = CWQI for marine tourism activities (index value); *e3* = spatial aspects; *e31* = proportion of settlement areas (%); and *e32* = proportion of tourism accommodation areas (%).

$$R_{ij} = X'_{ij} / \sum_{i=1}^{n} X'_{ij} \quad (2)$$

where $X_{ij}^{'}$ = the standard value of indicator j on island i. If $X_{ij}^{'} = 0$; 0.00001 is substituted for 0 to calculate H_j.

2) Calculating the information entropy value of indicator j (H_j),

$$H_j = -\frac{1}{\ln i} \sum_{i=1}^{n} R_{ij} \times \ln R_{ij} \quad (3)$$

where the index value ranges from 0 to 1.

3) Calculating the entropy redundancy of the indicator j (d_j).

$$d_j = 1 - H_j \quad (4)$$

4) Calculating the indicator weight j (w_j),

$$w_j = d_j / \sum_{i=1}^{n} d_j \quad (5)$$

where n = the number of indicators in each system.

5) Calculating the integration value of the social and ecological system index,

$$s = \sum_{s=1}^{n} w_{js} \times X'_{ijs} \quad (6)$$

$$e = \sum_{e=1}^{n} w_{je} \times X'_{ije} \quad (7)$$

where s and e are the integration values of the social and ecological system, respectively, $X_{ijs}^{'}$ and $X_{ije}^{'}$ are the single values of indicators s and e, and n is the number of indicators used in systems s and e.

4.5. CCDM analysis

The coupling coordination degree model (CCDM) is a tool for investigating the interaction degree between systems (Li et al., 2012; Tang, 2015), and thus, the status of the coupling coordination between the systems of social and ecological quality can be measured and evaluated quantitatively to achieve sustainable development. The CCDM is calculated as follows:

$$D = \sqrt{C \times T} \quad (8)$$

$$C = \left(\frac{s \times e}{\left(\frac{s+e}{2}\right)^2} \right)^{\frac{1}{2}} \quad (9)$$

$$T = \alpha \times s + \beta \times e \quad (10)$$

where D = the coupling coordination degree ($D \in [0,1]$), C = the coupling interaction between the social and ecological system, T = the total effect of the social and ecological system, and α and β = the social and ecological system contribution, respectively, based on the number of categories divided by the total number of categories used from all the systems (five categories). Thus, $\alpha = 2/5 = 0.4$ and $\beta = 3/5 = 0.6$ (equivalent values). In addition, maintaining ecological quality is crucial for sustainable tourism in marine conservation regions. The standard of the coupling coordination degree (D) was referred to by Tang (2015) (Table 3).

4.6. SESI analysis

Finally, the SESI (social-ecological status index) was measured based on the concepts of an SES, where the ecology system as the service provider strongly influences or affects the tourism as a social system. The SESI values range from −1 to +1 (the lowest value or least desirable to the highest value or most desirable). The SESI was derived by the following formulas (Estoque & Murayama, 2017):

$$SESI = e_i - s_i \quad (11)$$

and,

$$e_i \text{or } s_i = \frac{1}{N} \sum S_{1,2,3,\ldots,n} \quad (12)$$

where S = the indicator value and N = the indicator number for e_i or s_i.

5. Results and discussion

Based on IEW analysis on the social system, the development scale had the greatest weight (71%), and the main indicators responsible for the most influential effect on the system were the total travel agencies (*s13*), the number of domestic tourists (*s11*), and the tourism employees (*s21*). Regarding the ecological system, the highest impact was the CWQI (41%), meaning that it was a large contributor to the changes in

Table 3
Standard of the degree of coupling coordination.
Source: Modification from Tang (2015) and Li et al. (2012).

Development class	Development subclass	
Balanced	> 0.8–1	Superiorly
	> 0.6–0.8	Favorably
Transitional	> 0.5–0.6	Barely
	> 0.4–0.5	Slightly
Unbalanced	> 0.2–0.4	Moderately
	0–0.2	Seriously

Note: s = social system value; e = ecological system value. $s > e$ is categorized as an ecology lag; $s = e$ is categorized as a social and ecology balance; and $s < e$ is categorized as socially hindered.

Table 4
The index values of entropy and redundancy and the weights of the social and ecological system indicators.

Indicator	H_j	d_j	w_j	Category	Total w_j
Number of domestic tourists (person) (*s11*)	0.119244	0.880756	0.199750	Development scale	0.712979
Number of international tourists (person) (*s12*)	0.421946	0.578054	0.131099		
Total travel agencies (number) (*s13*)	0.000228	0.999772	0.226742		
Total hotels (number) (*s14*)	0.314843	0.685157	0.155389		
Tourism industry employees (person) (*s21*)	0.310646	0.689354	0.156341	Demographic and economic aspects	0.287021
Population density (persons/km^2) (*s22*)	0.423792	0.576208	0.130680		
Coverage of live coral (%) (*e11*)	0.630521	0.369479	0.132998	Ecological quality	0.269461
Coverage of seagrass (%) (*e12*)	0.620897	0.379103	0.136463		
CWQI for marine biota (index value) (*e21*)	0.624528	0.375472	0.135156	Coastal water quality index (CWQI)	0.407020
CWQI for marine tourism activities (index value) (*e22*)	0.244742	0.755258	0.271864		
Proportion of settlement areas (%) (*e31*)	0.553838	0.446162	0.160601	Spatial aspects	0.323519
Proportion of tourism accommodation areas (%) (*e32*)	0.547401	0.452599	0.162918		

Note: H_j = the information entropy value of indicator *j*; d_j = the entropy redundancy of indicator *j*; and w_j = the indicator weight of *j*.

the ecological system, particularly the ecosystem quality. Meanwhile, the main indicators that had the highest influence are the CWQI were the marine tourism activities (*e22*), the tourism accommodation area proportion (*e32*), and the settlement area proportion (*e31*) (Table 4).

The integration level of the social system showed that Gili Trawangan Island had the highest value (0.897258), followed by Gili Ayer Island (0.202361) and Gili Meno Island (0.00001) (Table 5). These values indicate that the intensity of tourism development on Gili Trawangan Island is very high compared to other islands. This can be seen from the values of each indicator in the class index of the development scale and the demographic and economic aspects, excluding the population density indicator (*s22*). However, the integration level of the ecological index showed contrasting values. As shown in Table 5, Gili Meno Island had the highest value (0.641159), followed by Gili Ayer Island (0.484281) and Gili Trawangan Island (0.363305).

The coupling interaction level between the social and ecological system (C) indicated that Gili Trawangan and Gili Ayer Island had high scales (0.95 and 0.96, respectively), whereas Gili Meno Island had a very low scale (0.01). Conversely, regarding the total social and ecological effects (*T*), Gili Ayer and Gili Meno Island showed average levels of 0.30 and 0.38, respectively, while Gili Trawangan Island demonstrated the highest level (0.65) (Table 5). Appropriately, according to the values, the coupling coordination degree (*D*) of the SES indicated that Gili Trawangan Island had a high degree (0.79), in which the social system unit showed a much larger value than the ecological system, i.e., $s > e$, or favorably balanced development with an ecological lag. Conversely, Gili Meno Island had a low degree (0.06), with a much higher ecological system level than the social system level, i.e., $s > e$, or seriously unbalanced development with a hindered social system. Furthermore, Gili Ayer Island demonstrated a moderate degree (0.54), in which the level of the ecological system was slightly higher than that of the social system, i.e., $s > e$, or barely balanced development with a social lag (Table 5).

This condition was consolidated by the SESI analysis. The result showed that Gili Ayer Island and Gili Meno Island displayed a 'positive' SESI, i.e., 0.03 and 0.11, respectively, or $e > s$ (ecological index higher than the social index), whereas Gili Trawangan Island demonstrated a 'negative' SESI value (−0.07), or $e < s$ (ecological index lower than the social index) (Table 5). Although it had a positive SESI, the tourism development and management on Gili Ayer Island indicate a "dangerous" condition. Continued unregulated development on Gili Ayer Island will result in a negative value in the near future or lead to the 'least desirable' condition. In other words, in the context of tourism development in the Gili Matra region, the social and ecological developments are present in a relatively unbalanced way.

Thus far, small island development has been regarded along the same lines as large island development, particularly in spatial planning (Fernandes & Pinho, 2017). The management efforts on the Gili Matra Islands are also partially different between land and sea. The ecological qualities, especially coral reef ecosystems, become the main domain, while the environmental aspects, such as water quality and land use, and the aspects of the social system are moderately minimized. With the absence of SES approaches, the tourism management models in conservation areas and small islands are still incomplete; consequently, the system connectivity is not well understood and integrated, and the management is relatively ineffective and inefficient. Finally, this unbalanced approach of changes can negatively affect the experience quality and trip satisfaction of tourists (Moon & Han, 2018). Although the Gili Matra islands are geographically located in a group of islands, the efforts and tourism development focus on each island (in the land context) can vary. However, because the Gili Matra Islands are managed under an MPA management plan, the risk of ineffective management efforts can be controlled (Kabbadj, Van Wynsberge, & Andréfouët, 2018).

Based on the SESI results using the SES approach, a limited arrangement of the social system must be employed on Gili Trawangan Island. The tourism industrial practitioners and the number of tourists must be limited according to the carrying capacity. Kurniawan et al. (2017) stated that the utilization in the Gili Matra region was over the carrying capacity (biocapacity), especially on Gili Trawangan Island; hence, the imports increase from year to year. Furthermore, the arrangement of the spatial aspects, both the development of tourist accommodation and settlement areas and the control of seawater quality, especially from hotel and household waste, must be carried out; accordingly, environmental protection efforts and tourist satisfaction can be maintained.

In contrast to Gili Trawangan Island, there are more development opportunities that can be completed to meet the tourist needs on Gili

Table 5
Degree of coordinated coupling and the social and ecological system index in the Gili Matra region.

Island region	*s*	*e*	*C*	*T*	*D*	Category	SESI
Gili Ayer	0.202361	0.363305	0.96	0.30	0.54	Barely balanced development with a social lag	0.03
Gili Meno	0.000010	0.641159	0.01	0.38	0.06	Seriously unbalanced development with a social hinderance	0.11
Gili Trawangan	0.897258	0.484281	0.95	0.65	0.79	Favorably balanced development with an ecology lag	−0.07

Note: s = social system value; e = ecological system value; C = the coupling interaction between the social and ecological system; T = the total effect of the social and ecological system; D = the coupling coordination degree; and SESI = social-ecological status index.

Meno Island. However, this development opportunity should be balanced with the better arrangement of the ecological status through the maintenance of coastal water quality, improvements to the quality of coral reefs as tourism spots, or new site creation. For Gili Ayer Island, balanced development between the social and ecological systems should be consistently applied. The access of tourism workers and residents must be properly regulated and accompanied by capacity building efforts.

Overall, it is essential to support the planning and policies of MPA managers and sustainable tourism development using several SES indicators (Vogt, Jordan, Grewe, & Kruger, 2016; Wu & Tsai, 2016). The optimization of islander houses to be used as guest houses is a very worthy method for accommodating tourists compared to continued hotel developments; thus, the pressure on the ecology and vulnerability of the island does not increase, but the hospitality aspects must remain a priority and be present in the necessary standards. Numerous studies have reported significant evidence related to the vulnerability of Gili Matra Island, including increased land conversion for settlement areas and tourist accommodations (Hampton & Jeyacheya, 2015; Kurniawan et al., 2016a, 2016b), coastal erosion, declining coral reef ecosystem quality (Kurniawan et al., 2016b), a shallow groundwater level and changes from brackish to salty water (Bakti, Lubis, Delinom, & Naily, 2012).

These conditions show that the SESs on small islands are highly dynamic and sensitive. Development activities and the implementation of a management system can rapidly change the SES at a local level, both the spatial and temporal dimensions (Aburto & Gaymer, 2018; Thiault et al., 2018). The SES approach is able to provide important implications for MPA managers, tourism industrial practitioners, islanders and governments. Additionally, the SES status of small islands can better describe the condition and status of sustainable development at present and in the future in the region and on each island, the local and tourism aspects, and the important indicators; hence, the positive evaluation of island tourism destination management can be properly assessed, and effective and efficient policies can be made according to the needs. Finally, sustainable tourism and small island development can be achieved. That is, the SES approach is able to assess the complexity and adaptation of systems from multiple subsystems in a larger system. The management of small islands must be holistic, including all of the resources and resource users on the land and in the water.

However, this study has some limitations and challenges in terms of its application. First, the case study was conducted in a region with three small islands, and therefore, this study cannot answer the diversity of characteristics of small islands. Second, the use of the IEW method requires comparative data that are either in the form of the number of islands or time series data. The number of islands or data series used in each indicator will improve the quality of the results of the analysis for the next stage. That is, the IEW analysis can be used with a minimum number of two data points from each indicator used in the island units. However, the availability of data at the island scale is very limited, especially for remote islands. Generally, data are available within the scope of an administration unit, such as villages, subdistricts, districts, or region, and they are not available by island; for that, primary data must be collected, and this requires a large cost and takes a considerable amount of time to accomplish, especially for spatio-temporal data. Third, small islands have different social and ecological characteristics depending on the geomorphological and location aspects of the island. Thus, the importance of each indicator can only be determined on a case by case basis. Finally, the use of indicators needs to be retested quantitatively to increase the value sensitivity and to obtain the key indicators so that the number of indicators used can be eliminated.

For future research, the SES approach on small island studies can be comprehensively assessed using system dynamics modeling to support policymakers in applying scenarios from management to be chosen appropriately by understanding their implications in the future. The SES indicators and categories used can be broadly explored to obtain more relevant aspects and represent the conditions on small islands. Group model building (GMB) can be used to understand the characteristics of the SES approach and select the key management indicators in each island region (see Vugteveen, Rouwette, Stouten, van Katwijk, & Hanssen, 2015). Additionally, the determination of the SESI classification needs to be more detailed based on the threshold on small islands. This requires a comprehensive study approach with more island representatives both regionally and nationally.

6. Conclusion

An integrated evaluation system using an SES approach for tourism management on small islands was used to identify the important indicators and measure the intersystem interactions. A better and integrated understanding of the dynamics of small island tourism development using an assessment of the social-ecological status index of small islands is very important for improving management effectiveness and efficiency. The index can be used to assist small island managers in making objective and quantitative policies and approaches in the managed area. However, selecting the indicator of the index systems is a significant step in developing the important points from each system that are relevant and can visualize the conditions on small islands.

In this study, the key indicators that affected the social systems included the total number of travel agencies, the number of domestic tourists, and the employees of the tourism industry, while the indicators influencing the ecological systems were the CWQI for the marine tourism activities, the proportion of tourism accommodation areas, and the proportion of settlement areas. The island tourism (social system) and environment showed a great coupled degree that was either positive or negative; however, the relationship was dynamic.

In a certain period of time, the SES would be in the 'least desirable' condition. Therefore, management attempts should be evaluated based on the highest contributing indicators and the most important factor influencing the SES, including integrated marine spatial planning (MSP), particularly an ecological system. Causally, intensive tourism without considering appropriate environmental protection and management will result in imbalanced development and conservation efforts.

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