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Sustainability performance assessment focusing on coral reef protection by the tourism industry in the Coral Triangle region

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HIGHLIGHTS

- Development of a systematic approach to assess sustainability performance.
- Focus on the tourism industry in the Coral Triangle region.
- Economic, social, environmental, and wildlife indicators were used.
- Efficient, inefficient, and overall performance models were developed.
- Indonesia had the best relative performance, and the Solomon Islands the worst.

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ABSTRACT

Coral reef based tourism in the Coral Triangle region is responsible for economic benefits but also for negative social and environmental impacts, thus an approach to evaluate this industry's sustainability performance would be valuable. We selected 10 key indicators, out of 681, that were directly relevant to the impacts of tourist activities on coral reefs in economic, social, environmental, and wildlife aspects of sustainability. Efficiency, inefficiency and overall models were developed to measure relative sustainability performance focusing on coral reef protection by the tourism industry for all six countries in the Coral Triangle, from 2008 to 2012. Our results showed that Indonesia had the best relative performance among countries in the region, followed in descending order by; Papua New Guinea, Malaysia, Philippines, Timor-Leste, and Solomon Islands. Future plans to achieve higher performance by the tourism industry in each country can be made if a comprehensive sensitivity analysis is carried out.

1. Introduction

Tourism, directly or indirectly, accounts for around 10 percent of the world's gross domestic product (US$7.6 trillion annually), and is one of the main sources of employment worldwide (about 227 million jobs) (WTTC, 2015a,b). But in addition to economic benefits, it is also responsible for negative social and environmental impacts (Burke, Reytar, Spalding, & Perry, 2012; Choi & Sirakaya, 2006; UNEP, 2005). Sustainable tourism development is being recognized at an international level as a solution to optimize the use of environmental resources, respect the socio-cultural perspective of local communities, and ensure long-term economic gain (Blancas, Lozano-Oyola, González, Guerrero, & Caballero, 2011, Blancas, Caballero, González, Lozano-Oyola, & Pérez, 2010; Lozano-Oyola, Blancas, González, & Caballero, 2012). An approach to evaluate the sustainability performance of the tourism industry is hence necessary in order to ensure that its overarching goals are being met.

Indicator-based systems have commonly been used to design and implement tourism performance models focusing on sustainability; some of them used indicators individually, others built frameworks connecting different indicators, and a few used mathematical formulas to aggregate several indicators. In all three cases, single or multiple sustainability aspects were addressed

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(Table 1). However, none of these indicator-based systems suggested a procedure to select key indicators for assessing tourism sustainability performance, which is important in order to not only simplify this complex task, but also to reflect on the purpose of the evaluation, especially considering the comprehensive range of aspects involved in sustainability (Huang, Pan, & Kao, 2011). After key indicators are selected, a method to aggregate all three main sustainability aspects; social, economic and environmental, into an assessment approach must be determined in order to evaluate multi-dimensional performance.

Currently, there are no optimization models that can be used in performance assessments related to sustainability in the tourism industry. In this paper, we developed new efficiency models based on Data Envelopment Analysis (DEA, Charnes, Cooper, & Rhodes, 1978), as well as inefficiency models based on Reverse DEA (RDEA, Huang & Kao, 2011), and relative overall performance models based on Inefficiency Countervailed DEA (ICDEA, Huang & Kao, 2011), to measure sustainability performance focusing on coral reef protection (SPFCRP) by the tourism industry in countries located in one of the most diverse coral reef areas in the world; the Coral Triangle region (McLeod et al., 2010).

According to the National Oceanic and Atmospheric Administration (NOAA), in 2012 the annual net economic benefit from coral reefs to global tourism was approximately US$10 billion (NOAA, 2012). Nature-based marine tourism contributes approximately 36% of the overall tourism market in the Coral Triangle, providing an important source of income for local communities as direct or indirect employment (2iis Consulting, 2015; UNWTO, 2014). Yet, there is great potential for reef-based tourism to increase (2iis Consulting, 2015).

The Coral Triangle area includes the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands, and Timor-Leste. These six countries have collaboratively committed to a regional plan in 2007, known as the Coral Triangle Initiative, to protect their coastal biodiversity. Moreover, national plans aligned with the regional plan were also developed in 2009 in order to preserve the marine ecosystems of this area (Coral Triangle Initiative, 2016). In addition to its importance to tourism, coral reefs are also the main source of protein for local communities and provide shoreline protection (Asian Development Bank, 2014a; Burke et al., 2012).

Despite the significant economic and ecological value of these ecosystems in the Coral Triangle, they are endangered by local human activities and global climate change (Allen, 2008; Veron, 2009). Over 85% of the reefs in this region are estimated to be locally threatened by human activities, much more than the estimated worldwide average of 60% (Burke et al., 2012). Both direct and indirect impacts of tourist activities can contribute to the degradation of coral reefs, and a long-term partnership between the tourism industry and government agencies is greatly needed to reverse this trend (GBRMPA, 2014).

The most significant local threats to coral reef ecosystems in the Coral Triangle region are overfishing and destructive fishing (2iis Consulting, 2015). Tourist visitors in this area increased 63% from 2005 to 2013, and the overall market of the tourism industry is expected to grow by 75% in next 10 years, which will likely lead to even greater fishing demand and intensification of the issues (2iis Consulting, 2015; Outra, Sari, Sukandar, Malik, & Prabuning, 2016). Some of the other main local threats include; watershed-based pollution, poorly planned coastal development that can increase sedimentation and nutrient runoff, as well as, coral removal from reefs for use as construction material or sold commercially in the aquarium trade or as souvenirs (Burke et al., 2012; Jompa et al., 2016).

The Coral Triangle Initiative addresses many of the issues listed above, and among its goals is to identify priority seascapes for focused support (CTI-CFF, 2009). Considering the central importance of the tourism industry in the economy of these countries, it would be helpful to assess its sustainability performance as additional information to be used in their prioritization analysis. The main target of this study was to distinguish in which countries the tourism industry had a relative high sustainability performance and could potentially be used as an example of best practices in the region, as well as to pinpoint in which countries the tourism industry performed particularly poorly, highlighting a greater need for improvement. Also, after key indicators have been identified, specific recommendations for improvements can be made in further studies using comprehensive sensitivity analysis methods (Saisana, Saltelli, & Tarantola, 2005). Our approach could possibly be applied at a local scale as well, provided that the models' assumptions are met and there is enough data available.

We initially identified potential indicators from a literature review in the field of ecotourism and coral reef protection, and, then classified sustainability indicators into four aspects; economic, social, environmental and wildlife. Key indicators were selected using a set of criteria described by Huang et al. (2011). After indicator selection, we developed; efficient, inefficient, and overall performance assessment models, that evaluated the relative sustainability levels in the tourism industry among different countries in the Coral Triangle region from 2008 to 2012.

2. Methodology

In this section, we explain the criteria for selecting key indicators, as well as the models used to measure the tourism industry's SPFCRP.

Table 1
Indicator-based systems for designing and implementing tourism performance models focusing on sustainability.

Aspect	Indicator-based systems		
	Indicator-only[a]	Framework[b]	Mathematical[c]
Environmental	Lozano-Oyola et al. (2012), Marques, Ramos, Caeiro, and Costa (2013), Pérez, Guerrero, González, Pérez, and Caballero (2013), UNEP (2005)	Choi and Sirakaya (2006), Lamb and Willis (2011), Parolo, Ferrarini, and Rossi (2009)	Blersch and Kangas (2012), Gössling, Hansson, Hörstmeier, and Saggel (2002)
Economic	Reddy (2008)		
Social	Blancas et al. (2011), Park and Yoon (2010)		
Multiple	Jachmann et al. (2011), Johnsen, Bieger, and Scherer (2008)		Lacitignola, Petrosillo, Cataldi, and Zurlini (2007), Waite et al. (2014)

[a] Used indicators individually.
[b] Built frameworks connecting different indicators.
[c] Used mathematical formulas to aggregate several indicators.