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Research Paper

The *ISOST* index: A tool for studying sustainable tourism

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ABSTRACT

This study tackles the primary problems facing sustainable tourism: the absence of any defined limits on sustainability in this sector and the difficulty of measuring sustainability. Based on a system of indicators calculated in municipalities that are representative of the different tourist areas and environments of Catalonia (Spain), the key variables in the study of sustainable local tourism are identified so that they can subsequently be normalised, weighted and aggregated in a single global score: the ISOST index. This index enables the definition of thresholds of sustainable tourism, thereby establishing a destination's level of sustainable tourism. It is a tool that can be applied to the definition of sustainable tourism strategies for the future.

1. Introduction

Indicators enable the description and measurement of the reality of a given context in terms of objective parameters, providing a simplified, comparable view of complex phenomena (Schernewski, Schönwald, & Katarzyte, 2014) and facilitating the understanding of the territory and of the elements and processes that occur there. Indicators can both characterise an existing situation and monitor its evolution: that is, they can identify the weaknesses and strengths of the prevailing model and define strategies to restructure and reorient that model for the future (Crabtree & Bayfield, 1998; Gahin, Veleva, & Hart, 2003; James, 2004).

In full awareness of the utility of this tool, and in seeking to move towards a new tourism model, many of the sector's stakeholders have proposed indicators of sustainable tourism. Here, a distinction can be drawn between two types of indicator: (a) simple indicators, and (b) composite indicators (Sánchez Rivero & Pulido Fernández, 2008). This distinction is based primarily on the degree of sophistication of the information that each indicator contains. Simple indicators present statistics obtained directly from reality or are based on a straightforward processing of these data, while indices are 'dimensionless' measures created by combining several simple indicators using a weighting system that ranks the components in terms of their relative significance. Lying between these two types there is a third: the indicator system, which comprises a structured set of simple indicators, the results of which are interpreted jointly (Torres-Delgado & Saarinen, 2013).

Recent years have seen an increasing number of proposals for indices that aim to offer a more comprehensive and integrated understanding of a phenomenon. As Schuschny and Soto (2009) claim, indices present a better contextual picture and are easier to interpret, given their ability to provide a composite image that reduces a list of indicators into a single comparable value for different geographical regions at different times.

The present study describes the methodology used to construct an index of tourism sustainability, known as the ISOST (based on its Catalan name, *Índex de Sostenibilitat Turística*), which was created via an empirical analysis of the present situation of Catalonia, Spain, and which may prove of value when applied to other contexts. Using a system of indicators calculated for 20 municipalities which represent a wide cross-section of the tourist amenities and services on offer in Catalonia, the key variables for the study of the sustainability of local tourism are identified and then normalised, weighted and aggregated in a single global score: the ISOST index. With the ISOST index it is possible to define thresholds and apply the methodology to other destinations in order to establish their level of sustainable tourism.

2. Objectives

In the context of the study of sustainability in the tourism sector, this research has the following objectives:

1. The construction of a composite index that can provide both a statistical summary and a single, simple result of the sustainability of tourism at the municipal level.
2. The study of the sustainable tourism of a sample of municipalities in Catalonia (Spain).

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3. The establishment of empirical limits for the classification of destinations on the basis of the degree of sustainability of their tourist practices.

3. Composite indicators or indices

3.1. Definition and characterisation

Composite indicators or indices emerged from the need to provide more comprehensive and integrated interpretations of phenomena, that is, from the aim to undertake a joint evaluation of their multidimensional characteristics. Thus, Mayer (2008, p.279) writes that an index is 'a quantitative aggregation of many indicators and can provide a simplified, coherent, multidimensional view of a system'. The present paper's interest in indices lies in their ability to summarise complex issues, provide the 'big picture', attract public interest and help in reducing prevailing lists of simple indicators (Saltelli, 2007). It is hardly surprising, then, that this tool is enjoying increasing recognition as it is adopted not only in the planning and public management of tourism (Mendola & Volo, 2017), but also in processes of communication and social awareness.

The main advantage of an index is that it presents information in a simplified form that can be readily interpreted, which means the general public finds it easier to understand composite indicators that highlight general trends by using simple indicators (Saltelli, 2007). However, such indices are not free of criticism, given that the simplification involved in the aggregation of indicators can conceal certain significant phenomena, while the weighting of components requires a high dose of subjectivity (Céron & Dubois, 2000; Mayer, 2008; Singh, Murty, Gupta, & Dikshit, 2009; Salvati & Carlucci, 2014). Hence, one of the maxims applied to the construction of indicators is the need for transparency in the procedures adopted to select and weight indicators that should involve participatory processes and/or the consultation of experts.

3.2. The construction of indices

The construction of an index is necessarily based on an initial selection of simple indicators that when organised constitute a system of relevant indicators of the phenomenon. These simple indicators then have to be normalised to obtain a 'dimensionless' measure that can be weighted and aggregated to generate a single index value.

OECD (2008) identifies ten steps to be followed in the construction of a composite indicator, the careful monitoring of which should avoid any data handling errors and misinterpretations, thus guaranteeing the transparency of the methodological procedure: 1. Theoretical framework; 2. Data selection; 3. Imputation of missing data; 4. Multivariate analysis; 5. Normalisation; 6. Weighting and aggregation; 7. Uncertainty and sensitivity analyses; 8. Back to the data; 9. Links to other indicators; 10. Visualisation of the results. Most sustainability indices built to date adhere to this general methodological procedure. Moreover, many of these indices incorporate the same underlying data in their calculations, due to the small number of available sustainability datasets (Mayer, 2008).

The theoretical framework defines the most basic variables on which the index is subsequently based, which, in turn, determines the system of indicators generated. The latter is structured according to its underlying rationale and so it may vary greatly depending on the model of organisation chosen (sectors, environments, themes and sub-themes, causal model, etc). Moreover, the mathematical processes involved in creating the index, i.e. the normalisation, weighting and aggregation of indicators, also introduce a wide range of variations.

4. The use of indices for measuring the sustainable development of tourism

Most international indices used in measuring sustainability do not take an integrated approach to the study of the phenomenon; that is, they do not carry out joint analyses of the social, economic and environmental dimensions, but tend to focus on just one of these (Kumar Singh, Murty, Gupta, & Dikshit, 2009). This has much to do with the ambiguity in current definitions of sustainable development, which leads to different, often incomplete, interpretations and to considerable practical difficulties (Tanguay, Rajaonson, & Therrien, 2013; Torres-Delgado & López Palomeque, 2012). This ambiguity, combined with the shortage of data on which to base indicators and the lack of political monitoring, is one of the reasons why the indices have failed to achieve real sustainability (Wilson, Tyedmers, & Pelot, 2007). Yet, Miller (2001) claims that the development of indicators is nevertheless useful to parameterise a concept, and indeed the desire to progress in this direction has generated much information that has helped improve interpretations (Torres-Delgado & Saarinen, 2013).

A number of proposals have been made for the application of sustainable development indices to the tourism sector, including those of 'carrying capacity' (Canestrelli & Costa, 1991; Garrigós Simón, Narangajavana, & Palacios Marqués, 2004; Navarro et al., 2012) and 'ecological footprint' (Huiqin & Linchun, 2011; Hunter & Shaw, 2007; Li & Yang, 2007). Likewise, sector-specific indices unrelated to sustainable tourism can be found, including for example the Travel and Tourism Competitiveness Index developed by the World Economic Forum (WEF, 2015), which measures the factors and policies that allow the development of the sector; or the Brand Image Index proposed by Varela Mallou et al. (2006), which based on surveys of Spanish tourists proposes a methodology for quantifying the value of the brand image of tourist destinations.

Indices dedicated specifically to sustainable tourism are rare and those that do exist are difficult to apply and face significant problems of data availability. One of the first attempts resulted in the development of the Tourism Penetration Index, proposed by McElroy and Albuquerque (1998). The authors had detected that expanding mass tourism was threatening the sustainability of small Caribbean islands and, on the basis of this case study, they built an index to measure the degree of economic, social and environmental penetration of tourism. Despite their conceptual efforts, the need to simplify the calculation and the lack of available data in the destinations studied served to condition the development of the index, which was eventually reduced to a combination of just three indicators: daily tourist densities, tourist spending and number of hotel rooms. Later, Sánchez Rivero and Pulido Fernández (2008) presented the Sustainable Tourism Index, which calculates sustainable tourism based on the weighted sum of composite indices generated by each component of the DPSIR (Driving Forces-Pressure-State-Impact-Response) causal framework for 14 indicators in the Spanish System of Environmental Indicators of Tourism (MMA, 2003). Similarly, Castellani and Sala (2010) proposed a Sustainable Performance Index, which includes 20 indicators concerned with demographic dynamics, the economic and social conditions of local communities, environmental factors, and the tourism characteristics of the regions under investigation. The sustainability indicators selected were the outcome of a prior process of analysis and consultation with local stakeholders, as well as of an analysis of the local situation and its tourism planning, subsequently aggregated to provide decision-makers with local policy guidelines. Along similar lines, Blancas, Gonzalez, Lozano-Oyola, and Perez (2010) developed a multi-dimensional index of 32 simple indicators that they applied to Spanish coastal destinations so that their results might serve as a guide for tourism policy development.

The various proposals have all had to face the uncertainties that

arise out of the lack of consensus concerning the best methodology for constructing such indices. Moreover, the multi-dimensionality of sustainability and the transversal nature of tourism both add to these difficulties. However, there is a clear desire to create composite indicators for the joint evaluation of the variables that condition and determine the sustainability of tourist destinations.

The planning and management of tourist destinations increasingly requires tools that allow a more comprehensive and essentially comparative vision in order to identify trends (Salvati & Carlucci, 2014) and promote projects for balanced development. The management of destinations is no easy task; it often encounters major difficulties, due to the disparity of the stakeholders' aims and perspectives, the differences in their organisational culture and management, the imbalance in their economic capacity, and their reluctance to share decision-making power – as well as the administrative inertia of government bodies (Vera, López Palomeque, Marchena, & Anton, 2013). Government policies for tourism planning are, however, directed toward a tourism model based on diversity, quality and sustainability as elements to improve competitiveness of destinations (Pérez, Guerrero, González, Pérez, & Caballero, 2013). In this context, indicators play a key role as the main quantitative instruments for determining parameters of sustainability, and therefore, from the point of view of public management, they are able to highlight, and thus ideally help to prevent, the undesired effects of tourism, and contribute to increase its benefits (Hung & Hsin-Pei, 2016).

5. Methodology

5.1. The underlying system of indicators

The starting point for the construction of an index to measure sustainability is a prior study (Torres-Delgado & López Palomeque, 2014), which scientifically validated a system of indicators to quantify the sustainability of tourism at the local level. The system comprises 26 indicators organised in accordance with two conceptual models: the dimensions of sustainability and the DPSIR causal framework, which provides it with both a holistic perspective of sustainable development and an awareness of the relations of cause-and-effect in its systemic operation, respectively (see Table 1).

The proposal was based on a review of theoretical research and prior experiences in sustainable tourism and a study of the tools used in the quantification of sustainable tourism. Thus a first extensive list of simple indicators was defined, and the following ones were selected: (a) indicators that were consistent with the objectives of sustainable tourism, (b) those which were applicable at local/municipal level, (c) those which provided data that could be used for the calculation, and (d) those which were easy to process and communicate. In addition, it was validated by conducting a Delphi survey with 54 experts in the sustainable development of tourism, and its efficiency and utility were tested by applying it to 20 tourist municipalities in Catalonia (Spain) (see Table 2 and Fig. 1).

These case studies were chosen on the basis of the following criteria: (a) territorial diversity: municipalities representative of different geographical environments (coastal, mountain, urban, rural/interior); (b) degree of specialisation in tourism: municipalities with more places in tourist accommodation and second homes than their census population; (c) socioeconomic and territorial significance: tourist accommodation places (hotels, campsites, rural tourism establishments and second homes) in the selected municipalities accounted for 10% or more of total places in the comarcas where they are located, and at least 0.1% of the total number of places in Catalonia (Spain); and (d) diversity of tourism practices: municipalities representative of different forms of tourism.

Table 1
Proposal for a system of sustainable tourism indicators. Source: Based on Torres-Delgado and López Palomeque (2014).

	A. Driving force indicators	B. Pressure indicators	C. State indicators	D. Impact indicators	E. Response indicators
1. Sociocultural dimension	A.1.1. Tourist population A.1.2. Source of tourism demand	B.1.1. Image conveyed through promotional material	C.1.1. Resident population C.1.2. Diversification of tourist attractions and resources	D.1.1. Level of tourist satisfaction	E.1.1. Tourism products accessible to disabled
2. Economic dimension	A.2.1. Seasonality of tourism offer	B.2.1. Supply of tourist accommodation B.2.2. Presence of second homes	C.2.1. Tourist accessibility C.2.2. Basic facilities and services C.2.3. Volume of commerce and leisure	D.2.1. Tourist spending D.2.2. Population employed in the tourism sector D.2.3. Unemployment rate in the tourism sector	E.2.1. Public investment in tourism
3. Environmental dimension	A.3.1. Energy consumption A.3.2. Water consumption A.3.3. Waste generation	B.3.1. Potential human pressure on natural and urban spaces	C.3.1. Land use distribution	D.3.1. Tourist anthropisation factor	E.3.1. Selective waste collection E.3.2. Environmentally certified tourism establishments E.3.3. Environmental criteria applied to tourism planning

Table 2
Data on the municipalities selected for the application of the system of indicators. Source: Own elaboration based on data from the Statistical Institute of Catalonia (IDESCAT).

Environment / Municipality	Area (km^2)	Population (2010)	Tourist accommodation places (2011)	% places in the comarca[a] (2011)	% places in Catalonia (2011)	Main tourism resources
Coastal						
Castelló d'Empúries	42.3	12,220	36,861	14.76	1.33	Coast, nature
L'Escala	16.3	10,387	48,250	19.32	1.74	Coast, culture
Roses	45.9	20,418	82,056	32.86	2.96	Coast, nature, business
L'Ampolla	35.6	3540	10,229	22.89	0.37	Coast, nature
Torroella de Montgrí	65.9	11,522	40,503	15.13	1.46	Coast, nature
El Vendrell	36.8	36,068	72,630	35.42	2.62	Coast, culture
Sitges	43.8	28,130	29,883	36.14	1.08	Coast, culture, business
Calella	8.0	18,625	24,305	13.85	0.88	Coast
Alcanar	47.1	10,545	11,386	37.42	0.41	Coast
Lloret de Mar	48.7	39,794	64,600	34.35	2.33	Coast, business
Salou	15.1	27,016	95,128	34.50	3.43	Coast
Mountain						
La Vall de Boí	219.5	1076	3921	52.93	0.14	Culture, snow
Alp	44.3	1733	9630	20.74	0.35	Snow
Llívia	12.9	1608	6570	14.15	0.24	Nature, culture
Camprodon	103.4	2479	6233	25.06	0.22	Nature, culture
Naut Aran	255.8	1729	14,074	49.65	0.51	Snow
Rural						
Mediona	47.6	2363	3107	13.05	0.11	Nature, wine
Piera	57.2	14,576	14,633	40.76	0.53	Gastronomy, traditions
Urban						
Girona	39.1	96,236	23,159	71.58	0.84	Culture, business
Tarragona	57.9	140,184	39,695	14.40	1.43	Culture, coast, business

[a] A comarca is a Catalan region or administrative division.

5.2. Selection of key indicators

The selection of key indicators to construct a sustainable tourism index is based on the battery of 26 simple indicators presented above (see Table 1), from which the intention is to extract a simplified set of variables that is sufficient and effective to identify trends and levels of sustainability. The following criteria were therefore fixed for the discrimination of indicators:

- The initial system of indicators contains specific indicators of tourism as well as more general indicators that, although not directly related to tourism, are likely to impact or to be modified by the activity (C.1.1. Resident population and E.3.1. Selective waste collection). To construct the index, priority is given to indicators that have a more direct relationship with tourism, so that the immediate effects of the activity are assessed more clearly.
- The index should permit a comparison of case studies and allow these to be ranked in terms of their respective degrees of sustainable tourism. Therefore, the indicators that do not present a definite tendency in relation to sustainability are eliminated (A. 1.2. Source of tourism demand).
- The index should be constructed from variables placed at the same step in the cause-effect chain of tourism (CDS, 2001). Thus, those indicators were chosen that parameterise real impacts as opposed to those that describe potential impacts (B.1.1. Image conveyed through promotional material; C.2.1. Tourist accessibility and B.3.1. Potential human pressure on natural and urban spaces).
- The aggregation of some of the indicators might result in certain elements of sustainability being included more than once. For this reason, those indicators were elimated that measure aspects that

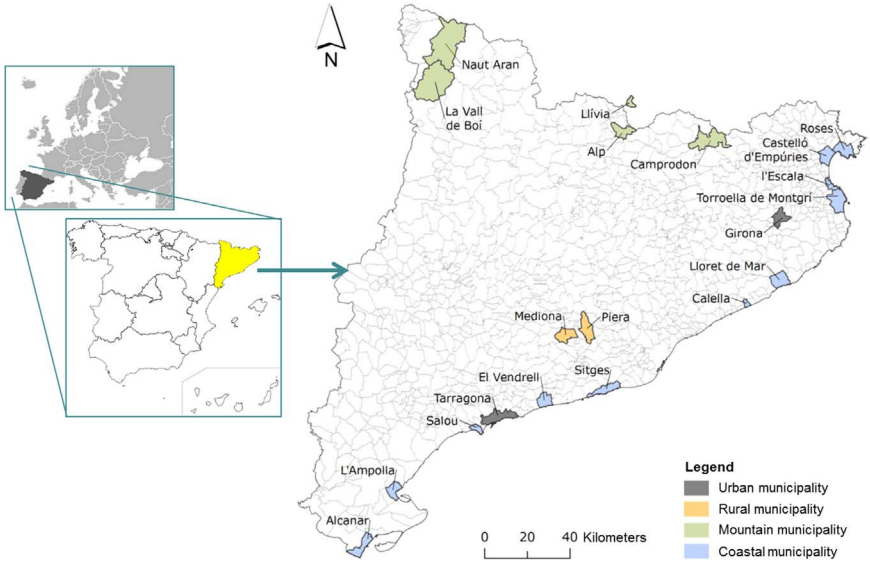

Fig. 1. Location of the municipalities studied.

Table 3
Results of the 16 variables selected from the system of indicators constructed by Torres-Delgado and López Palomeque (2014). Source: Based on Torres-Delgado and López Palomeque (2014).

Indicators[a]	Calculation	Alcanar	El Vendrell	Sitges	L'Ampolla	Roses	L'Escala	Castelló d'Empúries	Lloret de Mar	Calella	Torroella de Montgrí	Salou	Llívia	Alp	Camprodon	Naut Aran	La Vall de Boí	Piera	Mediona	Girona	Tarragona
A.1.1. Tourist population (2011)	% seasonal tourist population	7.98	11.37	14.63	19.04	26.03	27.19	34.29	40.02	41.58	44.78	55.72	3.22	17.88	27.73	48.59	49.22	0.12	0.16	1.72	4.94
C.1.2. Diversification of tourist attractions and resources (2011)	Number of different types of tourism resources	6	7	9	6	8	5	6	10	8	6	6	2	8	4	5	6	3	2	6	10
E.1.1. Tourism products accessible to disabled (2010)	Number of different types of adaptations for the disabled	0	2	3	2	2	4	2	0	2	2	3	0	1	2	2	3	0	0	1	1
A.2.1. Seasonality of tourism offer (2011)	% tourism places available (annual mean)	80.09	72.83	87.67	100.0	77.46	93.62	51.92	83.02	74.52	52.27	78.32	98.93	90.40	99.90	84.64	94.43	0.00	0.00	99.79	91.58
B.2.1. Supply of tourist accommodation (2011)	Places/resident	0.19	0.17	0.25	0.50	0.47	0.68	0.95	0.85	0.73	1.49	1.46	0.07	0.55	0.66	1.77	2.24	0.00	0.00	0.02	0.08
B.2.2. Presence of second homes (2001)	% second homes	36.29	58.27	32.29	69.54	75.41	73.04	44.31	41.81	27.86	49.82	46.17	72.88	78.39	47.73	80.43	45.88	39.98	54.03	11.98	11.66
C.2.3. Volume of commerce and leisure (2011)	Firms/tourist	0.05	0.02	0.04	0.06	0.03	0.04	0.03	0.02	0.01	0.02	0.01	0.52	0.14	0.05	0.05	0.03	3.59	0.80	0.19	0.04
D.2.2. Population employed in the tourism sector (2005)	% employed in tourism	8.24	10.52	29.51	20.92	23.02	24.39	20.72	37.27	23.47	19.89	47.23	26.28	21.09	14.92	43.71	40.33	5.57	2.34	4.52	4.63
D.2.1. Tourist spending (2010)	Spending per capita (€/resident)	1.121	1.698	3.079	3.074	5.337	4.782	6.505	11.075	9.851	10.137	19.234	556	4.008	3.082	16.632	14.734	6.433	6.433	292	592
E.2.1. Public investment in tourism (several years)	% of budget spent on tourism	1.15	0.72	0.82	7.23	1.37	2.93	0.11	1.70	1.24	0.27	2.57	6.23	1.86	0.99	1.86	4.01	0.02	0.00	1.16	1.01
A.3.1. Energy consumption (2008)	Consumption kW h/PTP/day	9.27	15.72	18.07	25.81	10.87	13.26	10.95	9.87	9.15	11.50	9.80	11.10	31.50	8.68	34.57	15.22	10.14	118.3	37.60	36.78
A.3.2. Water consumption (2010)	Consumption litres/PTP/day	296.0	254.0	278.0	361.0	303.0	394.0	292.0	222.0	154.0	253.0	238.0	472.0	1.433	234.0	788.0	413.0	203.0	360.0	309.0	349.0
A.3.3. Waste generation (2010)	Waste kg/PTP/day	1.45	1.81	1.79	2.16	1.90	2.21	2.97	1.47	1.10	1.45	1.27	1.63	2.33	1.25	1.21	0.70	2.18	2.16	1.21	1.30
C.3.1. Land use distribution (2009)	% urban land use	5.29	16.52	7.93	6.20	8.90	22.86	8.82	15.69	12.41	3.82	18.22	3.80	2.83	0.84	0.29	0.09	8.93	2.66	13.96	19.60

(continued on next page)

Table 3 *(continued)*

Indicators[a]	Calculation	Alcanar	El Vendrell	Sitges	L'Ampolla	Roses	L'Escala	Castelló d'Empúries	Lloret de Mar	Calella	Torroella de Montgrí	Salou	Llívia	Alp	Camprodon	Naut Aran	La Vall de Boí	Piera	Mediona	Girona	Tarragona
E.3.2. Environmentally certified tourism establishments (2011)	% environmentally certified tourism establishments	0.00	0.00	5.88	0.00	1.96	0.00	8.70	3.76	1.85	6.25	15.07	0.00	0.00	0.00	0.00	8.14	0.00	0.00	7.14	0.00
E.3.3. Environmental criteria applied to tourism planning (several years)	Number of tourism plans incorporating environmental criteria	0.00	1.00	1.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00

[a] The indicators are computed using the latest data available in each case and correspond to different years.

overlap or which are better represented by another indicator (D.2.3. Unemployment rate in the tourism sector and D.3.1. Tourist anthropisation factor).

- The lack of information in the case studies is a limiting factor when choosing between one indicator or another. When no data are available, the comparison of case studies is incomplete and the imprecision to which this gives rise increases if the indicator is combined with others to construct the index. In such circumstances, there are three general methods for resolving the difficulty (OECD, 2008): (1) variable deletion, (2) single imputation, and (3) multiple imputation. The first option is applied to those indicators that provide very little information (D.1.1. Level of tourist satisfaction), while for incomplete indicators we impute the mean of the other values and include this in the analysis.

This initial discrimination reduced the list of indicators from 26 variables to 16; although it is still necessary to undertake a correlation analysis to identify the relationships between the indicators, and eliminate, if necessary, those deemed redundant. Based on the results obtained in Torres-Delgado and López Palomeque (2014) for the 16 indicators (see Table 3), the scores were standardised so as to obtain for each municipality the distance between the value of an indicator and the mean for the set of cases, expressed in units of standard deviation. With the normalised data, Pearson's correlation coefficients were then calculated, which allow us to estimate objectively and precisely the relationship between the variables (Raso Nadal, MartínVide, & Clavero Paricio, 1987). A correlation is considered significant at the 99% confidence level, so that absolute values higher than 0.6 (n = 20; 20 municipalities) identify very high levels of correlation between variables; that is, the behaviour of one indicator explains that of the others, or what amounts to the same, the others do not provide any new information. Therefore, those indicators were eliminated that were highly correlated with each other, leaving the one that was of greatest interest for sustainable tourism. This procedure resulted in the elimination of a further four indicators (B.2.1. Supply of tourist accommodation; B.2.3. Volume of commerce and leisure; D.2.2. People employed in the tourism sector and D.2.1. Tourist spending).

Finally, the formulation of the index also requires grouping the indicators in sub-indices based on the nature of the data. Although the initial system of indicators combines two organisational models (the dimensions of sustainability and the DPSIR causal framework), the index requires a greater degree of simplification and, hence, the selection of one or the other. The researchers opted to base the index on the three dimensions of sustainable development, as the calculations and interpretations conducted from this point of view are considerably clearer and more interdependent for the case of sustainable tourism.

After implementing all these processes, the system of indicators on which the tourism sustainability index is to be built comprises 12 simple indicators organised into sociocultural, economic and environmental dimensions (see Table 4).

5.3. Constructing the Index of Tourist Sustainability (ISOST)

Based on the indicators selected (see Table 4) and their corresponding results (see Table 3), the first step in building the Index of Tourist Sustainability or *ISOST* is to normalise the indicators using the standardisation method corresponding to the equation:

$$Y_{qc} = \frac{X_{qc} - \overline{X}_q}{\sigma_q}$$

X_{qc} = value of indicator "q" in territorial area "c", $\overline{X}_q$ = mean value of indicator "q", σ_q = value of the standard deviation of indicator "q", Y_{qc} = value of indicator "q" normalised in territorial area "c".

Once the indicators have been normalised, the next step was to weight and aggregate them – first in the three dimensions of

Table 4
Simple indicators chosen to construct the index of sustainable tourism.

Indicators by dimension	Calculation
1. Sociocultural dimension	
A.1.1. Tourist population	% seasonal tourist population
C.1.2. Diversification of tourist attractions and resources	Number of different types of tourism resources
E.1.1. Tourism products accessible to disabled	Number of different types of adaptations for the disabled
2. Economic dimension	
A.2.1. Seasonality of tourism offer	% tourism places available (annual mean)
B.2.2. Presence of second homes	% second homes
E.2.1. Public investment in tourism	% of budget spent on tourism
3. Environmental dimension	
A.3.1. Energy consumption	Consumption kW h/PTP/day
A.3.2. Water consumption	Consumption litres/PTP/day
A.3.3. Waste generation	Waste kg/PTP/day
C.3.1. Land use distribution	% urban land use
E.3.2. Environmentally certified tourism establishments	% environmentally certified tourism establishments
E.3.3. Environmental criteria applied to tourism planning	Number of tourism plans incorporating environmental criteria

Table 5
Ranking of the municipalities in the study by *ISOST* scores.

Municipality	*ISOST* score	Ranking
Sitges	0.55	1
La Vall de Boí	0.52	2
Girona	0.33	3
Tarragona	0.32	4
Calella	0.27	5–6
Salou	0.27	6–5
L'Ampolla	0.25	7
Lloret de Mar	0.12	8
Camprodon	0.06	9
El Vendrell	0.04	10
Alcanar	0.01	11
Llívia	−0.03	12
L'Escala	−0.07	13–14
Roses	−0.07	14–13
Torroella de Montgrí	−0.15	15
Castelló d'Empúries	−0.24	16
Alp	−0.35	17
Naut Aran	−0.36	18
Piera	−0.56	19
Mediona	−0.91	20

sustainability so that three sub-indices were obtained for each municipality studied, and then a global index (*ISOST*). Having done that, one of the most controversial steps in the methodology of index construction was initiated: that of the weighting. This step is problematic on at least two levels: (1) the weighting of individual indicators within each of the three dimensions of sustainability, and (2) the weighting of the three dimensions (Finkbeiner, Schau, Lehmann, & Traverso, 2010).

Here we give equal weights to the indicators that make up the sub-indices and to the combination of the latter in the *ISOST* Index. Weighting with equal weights means the same importance is attached to each of them in the dynamics of the phenomenon studied. It avoids value judgments having to be made about aspects of sustainability and it is consistent with the initial research approach, i.e. it strikes the necessary conceptual balance between the social, economic and environmental dimensions of sustainable tourism.

Thus, the 12 simple indicators are aggregated for each of the dimensions from an arithmetic mean of the normalised values according to the following formula:

$$S_{kc} = (1/p) \sum_1^p Y_{qc}$$

Y_{qc} = value of indicator "q" normalised in territorial area "c", p = number of simple indicators used to measure each dimension, S_{kc} = value of the sub-index of dimension "k" in territorial area "c".

Then, the resulting three sub-indices are combined using the arithmetic mean of their aggregated values to obtain a global index that indicates the degree of tourist sustainability of each municipality, which can be readily compared with the rest of the cases. Accordingly, the *ISOST* fulfils the following equation:

$$ISOST_c(1/3) \sum_1^3 S_{kc}$$

S_{kc} = value of the sub-index of dimension "k" in territorial area "c", $ISOST_c$ = Index of Tourist Sustainability in territorial area "c".

The model of equal weights used to rank the sub-indices is appropriate given that the dimensions of sustainability analysed are equally important. By contrast, the dimensions have a different number of indicators to be used in the calculation of their sub-indices. Mathematically, this entails an overweighting in dimensions with fewer variables. The previously explained selection process, however, conceptually justifies this imbalance.

The aggregation processes derived from it are affected by the trade-off of impacts that an arithmetic aggregation of variables entails. Thus, a deficit in one indicator or sub-index is offset by the higher value of another. To minimise the interpretation error to which this might give rise, it is important not to lose sight of the contribution made by each indicator/sub-index to the aggregated value.

6. Results

The application of the *ISOST* index to the same case studies as those examined in Torres-Delgado and López Palomeque (2014) allows a comparative sustainability ranking of the tourist destinations to be established (see Table 5).

In interpreting the *ISOST* scores, it should be borne in mind that the index has no lower or upper limits; rather, the scores indicate the distance separating a municipality from the sample mean. For this reason, we cannot speak in absolute terms of the sustainability or unsustainability of a municipality; we can only speak in comparative terms. It should also be remembered that a negative score does not necessarily indicate that the variable makes a negative contribution to tourist sustainability but rather that it contributes less than the mean, and vice versa.

Based on this ranking, in the 20 municipalities studied the *ISOST* thresholds of sustainable tourism can be established (see Table 6) taking into account two criteria: (1) the mean (*ISOST* score = 0) indicates a turning point, at which a municipality can be considered to have an 'average score' on the *ISOST* index or a 'low score', so that negative index scores identify the least sustainable tourist municipalities and positive scores the most sustainable municipalities within the analysed sample as a whole; and (2) the distribution of the case studies by quintiles identifies the limits (the first and fourth quintiles) to further distinguish between municipalities that have an 'average score' or 'high score' on the *ISOST* index; and vice versa, if they have a 'low score' or 'very low score'.

Applying the thresholds defined by the *ISOST* index, the

Table 6
The thresholds of sustainable tourism according to the *ISOST* index in the municipalities under study.

ISOST ≥ 0.3 = Municipalities with high *ISOST* index scores
0.3 > ISOST ≥ 0 = Municipalities with average *ISOST* index scores
0 > ISOST > −0.3 = Municipalities with low *ISOST* index scores
ISOST ≤ −0.3 = Municipalities with very low *ISOST* index scores

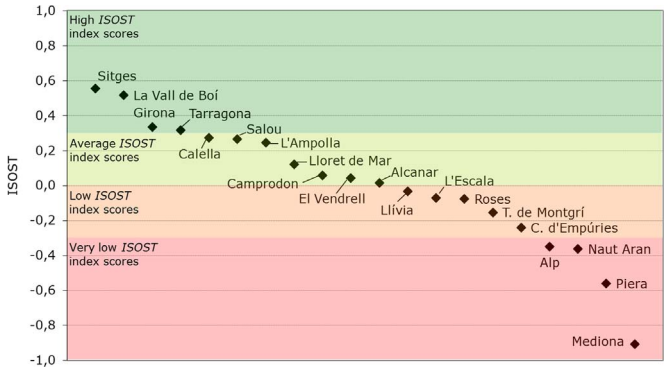

Fig. 2. *ISOST* scores and thresholds for sustainable tourism in the municipalities under study.

municipalities in the study can be classified as in Fig. 2. This shows that most municipalities occupy a central position, while the extremes discriminate between those municipalities that present a more marked behaviour (both positive and negative) on the *ISOST* index.

An analysis of the results allows a relationship between the different tourist environments of Catalonia and the degree of sustainable tourism to be identified. Thus, the tourism of the urban municipalities tends in relative terms to be more sustainable, while that of the rural/interior municipalities is not all sustainable. Among the coastal and mountain environments no clear trend emerges. However, a relationship can be identified between the model of tourism development and the relative degree of sustainability in mountain areas, where the more crowded municipalities tend to be the least sustainable (Alp and Naut Aran). Along the coast, however, there are no easily discernible differences and, in fact, there is a general trend towards the concentration of scores around the sample mean.

Of the 20 municipalities studied, Sitges and La Vall de Boi show in comparative terms the highest degree of sustainable tourism, while Piera and Mediona present the lowest. However, these four municipalities are strongly differentiated from the rest of the sample, in that they present extreme values that are substantially different (in absolute terms) from the next municipalities in the ranking. Thus, Sitges and La Vall de Boi record *ISOST* scores of 0.55 and 0.52, respectively, while the next municipality in the ranking (Girona) has a score of just 0.33. Likewise, Piera and Mediona record *ISOST* scores of −0.56 and −0.91, respectively, and are markedly less sustainable than the next municipality in the ranking (Naut Aran with an *ISOST* score of −0.36). Bearing in mind that the tourism sustainability calculated by the *ISOST* Index considers environmental as well as economic and social variables, it may well be that Mediona and Piera obtain such low index scores because of the incipient nature of their tourism; that is, the sector does not as yet enjoy the active involvement of the areas' stakeholders, nor do they have an effective supply structure or the requisite resources. Sitges and La Vall de Boi, in contrast, have achieved a more balanced development of their tourist activity, ensuring that it is both economically viable and well integrated in the territory in a responsible and socially equitable fashion.

7. Conclusions

Sustainability is a factor of competiveness for tourist destinations (ECORYS, 2009; WEF, 2015), which accounts for the numerous proposals that have been generated in the sector for its identification and quantification. However, in many cases a reductionist conception of the term has been adopted, associating sustainability primarily with the environment or considering the balance of the three dimensions of sustainability solely in terms of the conceptual definition of a particular framework of study (Torres-Delgado & Palomeque López, 2012). Moreover, the methodologies proposed are often difficult to implement due to data shortages or problems of calculation (Torres- Delgado- & Saarinen, 2013).

The *ISOST* Index aims to improve existing measures by integrating the three dimensions of sustainability, not only at a theoretical level but also practically. In this way it strives to be highly applicable as an instrument and, indeed, it is the outcome of the results obtained from a system of indicators calculated for a set of case studies.

The territorial scale at which this study has worked – the tourist municipality – is the administrative and management level that has the most immediate impact on the territory, which means that it is here that sustainable tourism policies can be most effective. The *ISOST* Index is designed to be useful for municipal tourism managers and to guide activities towards more sustainable scenarios. Indeed, the Index was constructed from the results of a representative sample of the diversity of tourist destinations in Catalonia (Spain), so that the comparison of these cases has defined certain thresholds that allow us to classify the tourist destinations of Catalonia according to their degree of sustainable tourism.

However, to interpret the results of *ISOST* correctly it should be borne in mind that we have worked with relative data and so have adjusted the scales between different geographical areas and different socioeconomic characteristics. This procedure allows a realistic comparison between cases, but we run the risk of losing sight of the full magnitude of the phenomenon. For example, a municipality with an intensive exploitation of its resources, but which at the same time is efficient in terms of its relative consumption, may appear in the final index as being more sustainable than others that have a much smaller overall impact.

Moreover, it should also be borne in mind that the aggregation of variables based on the arithmetic mean results in a trade-off of impacts that is not always desired. However, Finkbeiner et al. (2010) recognise that the trade-off of weights between the dimensions of sustainability frequently occurs in real world decision-making processes, at least implicitly.

Despite the limitations, the *ISOST* Index can be a useful tool for the decision-making, management and planning of municipal tourism, not only because it is designed specifically for local managers, but also because it has been constructed on the basis of data available from official agencies or from measures that are easily calculated. Therefore, it is a functional instrument that generates information about the critical aspects of a destination in relation to its sustainability, allowing the identification of those aspects that managers need to focus on in order to move towards more sustainable economic, social and environmental scenarios.

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