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Measuring tourism sustainability: proposal for a composite index

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The methodological bases are established for the design of a global composite index, the ST index, to measure tourism sustainability. Tourism sustainability is a fairly complex concept due to its latent, multidimensional and relative nature. A method based on factor loadings is proposed to construct a global tourism sustainability index. After comparing it with various theoretical approaches, the authors apply it to the Spanish system of environmental tourism indicators. The robustness of the proposed ST index is tested by calculating composite correlations between the Euclidean distances of different tourism destinations.

Keywords: sustainability; sustainable tourism; composite index; ST index; factor loadings; weighted indicators

Twenty years have passed since the United Nations World Commission on Environment and Development (UNWED), the so-called Brundtland Commission, drafted its document on sustainable development. Since then, sustainability has become a recurrent theme in the policies of most governments and international organizations and of a growing number of firms and other social groups. One result has been the great number of projects, tools and management models in the field of sustainable development.

The process is far from reaching the stage at which changes can be implemented in the current leading model of development. Consequently, the main causes of unsustainability still remain, even though some of its symptoms have been dealt with. Neither has the real need for firm action on these problems been accepted by government institutions or the business world, or even by individuals.

As the WTO recognizes, progress towards sustainability in tourism has been slow, in addition to the sector's late beginning in applying monitoring models.

One also observes that, as yet, no model for the design of indicator systems has been created in tourism. Instead, indicators have been introduced on the basis of the already existing models designed for sustainable development in general (above all, the PSR and DPSIR models).

There is general agreement in the literature that one of the main obstacles to attaining sustainable tourism is the difficulty in measuring the sustainability level that has been achieved by any given tourism destination. This has hindered decision making in the corresponding management processes and made it difficult to recognize and meet the specific needs of these territories.

Although there have been notable advances in the design of indicators in the past decade, the results are still only partial. There is still no agreement on a universal list of indicators enabling the comparison of sustainability levels in different tourism destinations. This is due in part to the multivariate character of sustainability, together with the difficulty in aggregating the considerable amounts of information required.

This paper presents and compares a new methodological approach to the creation of a composite index of tourism sustainability, denominated the ST index. Its aim is to resolve the lack of aggregate information on tourism sustainability and to be of aid in evaluating management at tourism destinations and comparing the sustainability measures taken by those destinations.

The proposed composite index is calculated from a broad system of indicators that contribute information about four dimensions of sustainability – economic, social, environmental and institutional. The resulting single indicator that synthesizes all this information will facilitate analysis of the situation in tourist destinations and the decisions made by their stakeholders.

The final value of the index will depend on the quality of the system of indicators used. But, because the same system of indicators is employed in calculating the ST index for different tourism destinations, it can be used to compare the behaviour of these destinations in terms of tourist sustainability.

To validate the ST index method, it was compared with other existing methods, using the same system of indicators. It needs to be emphasized that the purpose of the work presented here is to describe a new methodological proposal, so that its initial interest is purely academic. Application of the ST index method to the analysis of a specific tourist destination will provide a real vision of its situation with respect to sustainability. This naturally will be of interest to the system's decision makers, since it will improve their ability to manage the destination.

The need for a measure of sustainable tourism

A succession of reports commissioned by the United Nations in recent years (*Millenium Project*,[1] *Millenium Ecosystem Assessment*, *Intergovernmental Panel on Climate Change*[2]) coincide in their diagnosis of the reasons why there has been hardly any progress on the path to sustainability in the past two decades. In this sense, the permanence of the main causes of unsustainability worldwide is also recognized in the scientific literature (Bass, 2007):

- Economic growth is still an indisputable principle, regardless of people's rights and welfare, and of the limits of environmental charge.
- Benefits and environmental costs are externalized.
- The poor are marginalized and social injustice is ignored.
- Present models of governance are not conceived to internalize environmental factors, to confront social injustice or to develop economic models that converge on sustainable development.

Consequently, there still remain all the paradoxes that one encounters in the debate on sustainable development. First, the same economic paradigm that is causing the persistence of poverty and environmental troubles is trusted to solve those problems. Second, this situation of unsustainability coexists with policies in support of sustainable development. Third, while a solid foundation has been given to the sustainability paradigm in theory and planning, further action is lacking.

With regard to tourism, the results of progress towards sustainability have been particularly disappointing. In spite of all the initiatives that have been put into effect in the past decade, not only by the public sector but also by firms and non-governmental organizations, the WTO's report submitted to the World Summit of Sustainable Development in Johannesburg in 2002 on international progress in sustainable tourism development left little room for illusions. It concluded that, 'Although, in general terms, the focus on the need for the application of a systematic planning in tourism is widely accepted, and strategies and policies recommended by international organizations allude to environmental subjects and the social economic sustainability, its effective application by national, regional or local governments is still slow and partial' (Yunis, 2003, p 19).

According to this report, the main challenge to overcome in achieving sustainable tourism is to fill the current gap between, on the one hand, the stage of designing methodological approaches, guidelines on tourism policies and technological know-how and, on the other, the implementation of those plans and the execution of tourism projects by public agencies, together with the usual activities of tourism firms.

Consequently, the first objective to aim at in every tourism destination is to measure the level of sustainability that it has achieved in its tourism development. The idea is to verify how far those objectives are in accord or disaccord with the destination's development model and to make changes if the original objectives are not being fulfilled. As Ko (2005, p 432) puts it, 'If sustainable development is one of the tourism industry's major contemporary objectives, then the industry needs to be able to measure its performance and impacts in this area.'

To meet this challenge, the WTO suggests (Yunis, 2003), among other measures, speeding up the adaptation of methods and technologies to the particularities of each territory. It also suggests that tools should be made available for public institutions (above all, local administrations), tourism firms and other stakeholders in tourism development to oversee the fulfilment of whatever sustainability criteria have been defined. An operational framework is needed to enable managers in a territory to determine systematically, objectively and at any moment how closely tourism development is abiding by the previously defined objectives of sustainability. These objectives are likely to need modifying if there are changes in the territorial situation, tourism patterns or local preferences.

Nevertheless, the measurement of sustainability is far from straightforward. The very ambiguity of the concept, and hence also of the concept of sustainable tourism, demands flexibility in applying the principles of any paradigm of sustainability in order to adapt them to a territory's particular characteristics. This flexibility has led to a broad-based acceptance of the concept of sustainability and consensus on the significance of its coining. But, in parallel, it has become an obstacle to agreement on the object, extent and time period of sustainability (Bell and Morse, 1999; Bartelmus, 2003; Parris and Kates, 2005; Pintér *et al*, 2005; White *et al*, 2006).

In fact, such measurement seems so complex that some authors (Stoeckl *et al*, 2004) suggest that sustainability itself cannot be measured, and its indicators are providing exclusively an 'indication of change' and, even then, sometimes only partially. There will always be a gap between what is of interest to us and what is measured, and another between what we want to measure and what can be measured. White *et al* (2006, p 7) argue that, 'This is the essence of the paradox whereby often we value what we can measure, rather than measuring what we value.'

Whichever the case, it is evident that coining the term 'sustainable' does not necessarily make it real. Thus, it has been recognized for some time now that there is an indisputable need for ceaseless supervision to ensure that any programme or initiative called 'sustainable' really does lead to sustainability. Butler (1998, p 16) goes even further in affirming that, 'The use of the term "sustainable" is meaningless' if there are no supervision and control tools available.

Certainly, in the past ten years or so, this consideration has paved the way for increasing interest in designing composite indices of sustainable development (and of sustainable tourism also) in developing and, above all, developed countries. The majority of the agents operating in the tourism sector recognize the great utility that these systems of indices have in most circumstances; hence the interest in their being implemented by international organizations, intergovernmental organizations, local, regional and national governments, economic sectors, managers, communities, non-governmental organizations and the private sector.

At the same time, these systems of indicators have been strengthened by the revolution in the world of information technology and conditioned by the need to distinguish between information relevant to decision making and information considered to be secondary or irrelevant.

The fact is, however, that while sustainability indicators have been gaining in popularity among researchers, non-governmental organizations and even parts of the private sector, their influence on real policies and the effectiveness of those policies when they are put into practice has often been only slight.

There is a major gap today between the potential and the real influence of sustainable development indicators on most policies and initiatives aimed at progress towards sustainability. Given the progress towards certain ideas of sustainability in a wide range of scenarios (Pintér *et al*, 2005), there is thus a great potential for improving the role that indicators can play.

As White *et al* (2006) point out, although we live in a world where indicators of various kinds influence many day-by-day decisions, the use of indicators to evaluate progress towards sustainable development, and sustainable tourism in particular, seems to be complicated. This is owing to the lack of a solid foundation to support their design. Nevertheless, Miller (2001, p 361) argues encouragingly that, 'Although it seems paradoxical to develop indicators for sustainable tourism when no satisfactory definition of the concept exists, the process of developing the indicators does help in determining the important tenets of the concept.'

The December 2005 revision of the *Compendium of Development Indicator Initiatives*, an ambitious database of initiatives towards obtaining a sustainable development indicator, included 669 entries (International Institute for Sustainable Development, 2005). Clearly, therefore, there have been advances in constructing these indicators in recent years.

The approval of the *Millennium Development Goals* demonstrated the need for indicators that would allow supervision of the progress towards those objectives, both individually and collectively. In this context, it is interesting to note the increasing number of attempts to obtain aggregate measures of the different aspects of sustainability.

In parallel with these initiatives, political interest has also focused on the possibility of the calculation of a 'green' GNP. This should take into consideration the increase in pollution costs and natural-capital losses. Nonetheless, its application has been rejected by politicians and statistical services due to technical and conceptual difficulties.

Similarly, there seems to be a persistent need for aggregate indices reflecting progress towards sustainable development, or at least in some of its dimensions.

There is, however, still no international agreement on the validity of most of these proposals (Bartelmus, 2001). If the four sustainability dimensions[3] (environmental, economic, social and institutional) are considered, the results so far have not been fully satisfactory. For instance, indices such as the genuine progress indicator (GPI) or the index of sustainable economic welfare (ISEW), proposed to measure the economic dimension of sustainability, are criticized for their inconsistency and subjectivity. Similar criticisms are made of the human development index, designed to quantify the social dimension of sustainability. And the measurement of the institutional dimension is in an even more precarious situation, since no relevant composite index proposal has yet been designed.

With respect to tourism, in recent years there has indeed been significant progress in the definition of indicators for the sustainable management of firms and tourism destinations (Marsh, 1993; Nelson, 1993; Payne, 1993; Manning, 1999; Twining-Ward, 1999; James, 2000; Miller, 2001; Sirakaya *et al*, 2001; Twining-Ward and Butler, 2002; Dwyer and Kim, 2003; Liu, 2003; Vera and Ivars, 2003; Bloyer *et al*, 2004; Blackstock *et al*, 2006a,b; White *et al*, 2006). Their application to real cases, however, is still slow and only partial, being restricted to specific cases, with almost no expression of generalities.

Therefore, in no way can one claim that there exists a universally and unanimously accepted list of indicators. In fact, if an indicator describes a specific control process (and not exclusively numerical information), its scope is related narrowly to that process. A consequence has been that approaches proposed hitherto will admit only very partial comparisons (variable-to-variable or indicator-to-indicator), since they do not establish any homogeneous composite global form for their implementation in different territories or economies (González *et al*, 2004). Furthermore, most proposals have focused on constructing indicators to evaluate separately one or more of the different dimensions of sustainability, but there has been little progress in the design of indicators that integrate those four dimensions (Pulido and Sánchez, 2007).

Methodology: WTTC and ESI versus ST index

The two most recent proposals for constructing composite indices in tourism or sustainable development research are the tourism competitiveness monitor of the WTTC (World Travel and Tourism Council) and the environmental sustainability index (ESI) of the WEF (World Economic Forum). Both have gained worldwide acceptance.

The tourism competitiveness monitor was designed originally to measure the level of tourism competitiveness in nearly 200 countries throughout the world. It was put into practice in 2001, with 65 tourism competitiveness indicators classified under eight main dimensions: price competitiveness, human tourism, infrastructure, environment, technology, tourism openness, social development and human resources. A detailed explanation of this approach is presented in Appendix 1.

The other relatively worldwide accepted initiative, the ESI, a proposal of the WEF, was designed by the Yale Center for Environmental Law and Policy of Yale University and by the Center for International Earth Science Information Network of Columbia University. It is obtained from 76 variables, grouped into 21 environmental sustainability indicators, and calculated for 146 countries. It analyses five broad categories (environmental systems, environmental stress reduction, reduction of human vulnerability to environmental stresses, social and institutional efficiency to respond to environmental challenges and global management).

The ESI should be interpreted in terms of probability, since it 'quantifies the likelihood that a country will be able to preserve valuable environmental resources effectively over the period of several decades' and 'it evaluates a country's potential to avoid major environmental deterioration' (World Economic Forum, 2005, p 23). Interested readers will find a more extended explanation of the ESI approach in Appendix 1 also.

As an alternative to these two methods, we propose a methodological framework based on the use of weights with the basic information of sustainability. The justification of the proposal is that to consider all indicators as equally important in forming a measure of sustainability is not a very realistic hypothesis. We denote the proposed weighted composite index, the ST index (an acronym of sustainable tourism index).

The ST index method uses a factor analysis model to establish each partial indicator weight in the construction of the aggregate index. Prior to the estimation of the factor loadings, the range of all the tourism sustainability indicators is normalized following the procedure of the United Nations

Development Programme (UNDP) calculation (which overall adopts the WTTC method).

After this first stage of normalization, the indicator values are standardized (to have zero means and unity standard deviations). This transformation, prior to model estimation, is usual in statistical packages that implement factorial analysis models.

Depending on the proportion of total variance explained, a single factor or more than one factor will be considered. After computing the values of the aggregate index of the *k*th sustainability dimension as a linear weighted combination of initial indicators, a transformation function is used to facilitate interpretation of the obtained values. Finally, the ST index is computed as a weighted sum of aggregate indices using a confirmatory factor analysis model. The algebraic details of this 'weighted indicators' approach are presented in Appendix 2.

Verifying the validity of composite tourism sustainability indices: the composite correlation

The essence of the proposal is how to estimate the different weights for the indicators used in constructing the composite tourism sustainability index and to show how their use helps considerably to establish significant differences among various tourism destinations, allowing them to be ranked in terms of tourism sustainability.

The analysis is based on the calculation of the Euclidean distances between the tourism destinations. These distances can then be used to check whether the final rankings obtained with the three methodological approaches described above are congruent with the differences that can be detected from comparing the original values of the variables corresponding to different tourism destinations.

Consider w countries (or regions, tourism destinations, etc). Then, the Euclidean distance between each pair of countries can be computed, taking as a basis the variables used to measure each dimension of tourism sustainability. Thus, if n_k tourism sustainability indicators are taken into account for the kth dimension, the square of the Euclidean distance is:

$$m_{rs} = \sum_{j=1}^{n_k} (x_{rj} - x_{sj})^2 \text{ for } r,s = 1,2,\ldots,w \tag{1}$$

These values form the elements of the wth order square symmetric matrix $\boldsymbol{M}_k$.

Similarly, between every pair of countries, the squared Euclidean distance is computed using the values of the final composite indices. If I_{kw} represents the value of the final composite tourism sustainability index reached by country w in the kth sustainability dimension, this Euclidean distance is:

$$s_{rs} = (I_{kr} - I_{ks})^2 \text{ for } r,s = 1,2,\ldots,w \tag{2}$$

Again, these distances s_{rs} form the elements of a wth order symmetric, square matrix, $\boldsymbol{S}_k$.

For the composite index to be consistent and statistically reliable, there must be a strong correlation between the elements of the matrices $\boldsymbol{M}_k$ and $\boldsymbol{S}_k$. Even though both matrices have a total of w^2 values, their symmetry and the null values of the diagonals mean that the number of elements of each matrix to take as a basis for the calculation of the *composite correlation* is $g = w\,(w - 1)/2$. Thus, the composite correlation is obtained as follows:

$$r_{M;S} = \frac{\sum_{u=1}^{g}(m_u - \bar{m})(s_u - \bar{s})}{\sqrt{\sum_{u=1}^{g}\,(m_u - \bar{m})^2\ \sum_{u=1}^{g}\,(s_u - \bar{s})^2}} \tag{3}$$

The greater the value of $r_{M;S}$, the more efficient is the aggregation of the partial indicators to obtain the single composite index.

Comparative analysis: the advantages of weighting the indicators

To compare the three methods (WTTC, ESI and ST index) and calculate the composite correlation, we used the Spanish system of environmental tourism indicators (SSETI). This system consists of 27 indicators targeted at evaluating the most environmentally relevant features in Spain's tourism sector and identifying the main stress factors and specific responses in this field. With this choice, each indicator is classified according to the element of the European Environmental Agency's DPSIR model (driving forces–pressures–state–impact–responses) (1999) that it represents.

In this sense, some comments are in order:

(1) The ST index method is based on obtaining a composite sustainable tourism index as the weighted sum of the composite indices S_{EC}, S_{SO}, S_{EN}, and S_{IN} (representing the economic, social, environmental and institutional dimensions of sustainability). Nevertheless, the SSETI, which is Spain's only available homogeneous system for its autonomous regions with which to validate our proposed composite index, does not classify its indicators according to the aforementioned four dimensions, but according to the elements of the DPSIR model. (No particular tourism sustainability indicator system has as yet been officially designated in Spain.) The indicators really should be classified according to the dimensions of sustainability, so that the system could be used to make temporal and spatial comparisons of each of these dimensions. The design of the ST index satisfies these methodological requirements, with the caveat that, given the information that is available, the weighted composite indices used in calculating the ST index refer to the driving forces–pressures–state–impact[4]–responses categories.

The practical difference between these two classifications is that using the elements of the DPSIR model is suited better to the estimation of partial weighted indicators of independent calculation and interpretation rather than to the calculation of a final composite index. On the contrary, classifying the indicators under the four sustainability dimensions would lead to greater interdependence in calculation and interpretation, and thus be suited better to the estimation of the final composite index.

Table 1. Tourism environmental indicators used in constructing the composite tourism sustainability indices.

Indicator	Description
	Driving forces
Indicator	**Description**
DR1	Total annual tourism expenditure (million euros)
DR2	Percentage of employees in the hotel restaurant sector
DR3	Percentage of equivalent tourism population
DR4	Number of bed places in tourist accommodations per 100 inhabitants
	Pressures
Indicator	**Description**
PR1	Potential pressure on natural areas (tourism density in sites of community interest)
PR2	Tourist density in urban areas
PR3	Interventions carried out by Seprona[a] on tourism and sports activities in natural areas
PR4	Urban waste production attributable to tourism
PR5	Consumption of urban drinking water attributable to tourism
PR6	Electricity consumption attributable to tourism
	State
Indicator	**Description**
ST1	Rating of the naturalness of the environment
ST2	Water quality of continental inland bathing areas (percentage compliance)
	Responses
Indicator	**Description**
RE1	Hotel establishments certified under environmental management regulation systems
RE2	Separated collection of packaging waste produced by tourism

Note: [a]Seprona: Spanish Police Service for Nature Protection.
Source: Spanish Ministry of Environment (2003). All indicators are dated to 2000 since no later data have been recorded.

(2) No environmental indicators referring to beaches and coasts are used in the analysis, since there are inland autonomous regions in Spain. A comparative analysis including these characteristics therefore would not be feasible.
(3) Some other SSETI indicators refer exclusively to certain tourist locations, without any presentation of aggregate data for the autonomous regions. Since the autonomous region is the basic unit that we employ in the present study, these indicators also are excluded from the analysis.

The 14 SSETI indicators finally used in the analysis are listed in Table 1. The following paragraphs present the results of applying the WTTC, ESI and ST index methods to these 14 indicators.

The WTTC method

Table 2 lists the values (on a scale of 0 to 100) of the aggregate indices for the driving forces, pressures, state and responses categories for Spain's 17 autonomous regions resulting from applying the WTTC method, together with the region's rank in each category. One observes that the Balearic Islands rank first in three out of the four categories of elements of the DPSIR model analysed. According to the WTTC method estimate, therefore, the Balearic

Table 2. Aggregate indices of driving forces, pressures, state and responses estimated according to the WTTC method.

Autonomous regions	Driving forces Value	Rank	Pressures Value	Rank	State Value	Rank	Responses Value	Rank
Andalusia	22.9	4	73.2	5	56.7	9	15.1	6
Aragon	8.8	11	28.3	10	0.0	17	3.8	7
Asturias	10.4	9	35.9	8	68.8	5	3.2	10
Balearic Islands	100.0	1	100.0	1	79.9	3	100.0	1
Basque Country	6.9	12	36.4	7	35.7	16	20.1	5
Canary Islands	93.4	2	76.4	4	100.0	1	2.4	13
Cantabria	12.5	7	7.7	15	72.3	4	0.7	16
Castilla and León	11.2	8	22.6	11	53.3	10	3.7	8
Castilla-La Mancha	0.3	16	18.5	13	42.3	14	1.4	14
Catalonia	34.7	3	91.1	2	66.9	6	73.4	2
Extremadura	0.0	17	16.0	14	42.5	13	0.0	17
Galicia	4.3	15	21.3	12	46.3	12	2.6	12
Madrid	19.3	5	83.5	3	40.5	15	70.5	3
Murcia	5.0	14	30.2	9	51.0	11	3.6	9
Navarre	6.3	13	4.9	16	59.9	8	2.8	11
Rioja, La	10.2	10	0.0	17	91.1	2	1.2	15
Valencia	19.2	6	47.1	6	60.5	7	32.2	4

Source: Table elaborated by the authors from SSETI figures.

Islands are the Spanish destination subjected to the greatest driving forces and pressures from tourism. They are also, however, the leading region in the category of responses to confront the negative effects of tourism on the environment. In this overall ranking, they precede the Canary Islands (which have a weak response to the negative effects of tourism), Catalonia and Madrid. These are the Spanish regions in which the effects of tourism are most marked and the responses of their institutions are most resolute.

Extremadura is the Spanish region with the lowest levels in aggregate indices (especially in driving forces and responses). The responses are null, perhaps because of the low pressure tourism exerts on its territory. With similar low levels can be mentioned the cases of Castilla-La Mancha, Aragon and La Rioja.

From an overall analysis of the resulting indices, one can make two observations:

(1) Because of the method of calculating the aggregate index, there is bound to be one destination with the highest possible value (100) and another with the lowest possible (0).

(2) The method also led to a major jump in the values of the three or four top-ranked destinations and the rest (especially notable in the driving force and response indices), that is, the assignation of values of the aggregate indices to the regions analysed was highly uneven. In certain cases, therefore, it would be impossible to establish a meaningful comparison between autonomous regions.

Table 3. Aggregate indices of driving forces, pressures, state and responses estimated according to the ESI method.

Autonomous regions	Driving forces Value	Driving forces Rank	Pressures Value	Pressures Rank	State Value	State Rank	Responses Value	Responses Rank
Andalusia	52.9	5	71.6	5	49.6	9	43.9	6
Aragon	39.4	11	40.2	10	6.2	17	32.9	7
Asturias	42.3	10	45.3	8	63.6	5	32.4	10
Balearic Islands	98.0	2	86.0	1	74.9	3	96.3	2
Basque Country	27.6	14	54.8	7	26.8	16	48.9	5
Canary Islands	98.3	1	81.2	4	89.5	1	31.7	13
Cantabria	46.5	7	23.4	15	67.4	4	30.1	16
Castilla and León	43.9	8	31.8	12	46.0	10	32.9	8
Castilla-La Mancha	14.9	17	26.2	13	33.5	15	30.8	14
Catalonia	73.6	3	85.5	2	61.5	6	96.4	1
Extremadura	16.8	16	24.4	14	33.7	14	29.8	17
Galicia	24.8	15	34.5	11	38.0	13	31.9	12
Madrid	47.2	6	85.0	3	39.3	12	85.1	3
Murcia	29.3	13	43.5	9	43.3	11	32.8	9
Navarre	32.6	12	20.7	16	53.4	8	32.1	11
Rioja, La	43.0	9	17.7	17	84.0	2	30.6	15
Valencia	53.6	4	60.4	6	54.3	7	61.0	4

Source: Table elaborated by the authors from SSETI figures.

The ESI method

Table 3 lists the results for the same aggregate indices, but now calculated using the ESI method proposed by the WEF. The top rankings again include the Canary Islands and the Balearic Islands. Indeed, the differences between these two regions are slight, except for the 'responses' index which reflects how the regions are coping with the environmental problems deriving from tourism. Catalonia is placed third in the overall ranking, while there are three regions vying for fourth place: Madrid, Valencia and Andalusia.

Again, the use of this different method of estimation did not change Extremadura's overall position at the bottom of the ranking. Castilla-La Mancha, La Rioja and Aragon come above Extremadura in this classification, in similar terms as for the WTTC method.

Finally, one notes that the indices in Table 3 generally are distributed far more evenly than in the WTTC case, with the differences between regions being less marked and no region having either the maximum (100) or minimum (0) levels of the possible range. Consequently, these indices would seem to be better suited to comparing different tourism destinations.

The ST index method

The formulas used to calculate the aggregate indices of driving forces, pressures, state and responses with the ST index method are presented in Table 4. The weights in these formulas are the correlations between each indicator and the factor (or factors) representing the corresponding DPSIR element. These

Table 4. Weighted aggregate indices for the DPSIR model using the ST index method.

	F	%	*FR*
Driving forces:	1	84.63	N
Pressures:	2	79.44	Y
$G_1 = -0.024PR1 + 0.373PR2 - 0.463PR3 + 0.889PR4 + 0.955PR5 + 0.927PR6$			
State:	1	57.01	N
Responses:	1	66.65	N

Note: F, number of extracted factors; % of explained variance; FR, factor rotation.
Source: Table elaborated by the authors.

Table 5. Aggregate indices of driving forces, pressures, state and responses estimated according to the ST INDEX method.

Autonomous	Driving forces		Pressures		State		Responses	
regions	Value	Rank	Value	Rank	Value	Rank	Value	Rank
Andalusia	45.5	4	93.3	6	49.7	9	40.4	6
Aragon	12.8	11	7.4	11	5.0	17	25.6	7
Asturias	15.5	10	8.1	10	70.7	5	25.1	10
Balearic Islands	100.0	1	97.3	4	82.0	3	98.8	1
Basque Country	10.3	12	79.3	7	20.5	16	49.4	5
Canary Islands	100.0	2	99.0	3	92.5	1	24.3	13
Cantabria	20.1	7	4.9	15	74.9	4	22.6	16
Castilla and León	16.7	8	35.2	8	43.5	10	25.6	8
Castilla-La Mancha	5.1	16	4.7	16	27.0	14	23.4	14
Catalonia	85.6	3	99.5	1	68.2	6	95.2	2
Extremadura	5.0	17	4.2	17	27.3	13	22.1	17
Galicia	7.5	15	9.1	9	32.3	12	24.5	12
Madrid	38.1	5	99.3	2	24.5	15	93.7	3
Murcia	8.4	14	5.9	14	39.4	11	25.4	9
Navarre	9.9	13	6.8	13	56.5	8	24.7	11
Rioja, La	15.6	9	6.9	12	89.0	2	23.2	15
Valencia	35.2	6	93.6	5	57.9	7	69.3	4

Source: Table elaborated by the authors from SSETI figures.

correlations are determined from the rotated (or non-rotated, if such is the case) factor matrix.

These formulas, together with the use of Casalmiglia's transformation function (1990) with $\phi = 100$, result in the aggregate indices for Spain's autonomous regions listed in Table 5. These results basically show great similarity to those obtained with the two previous methods. The Balearic Islands and the Canary Islands again are ranked top or near the top in all the DPSIR categories, except for the 'responses' category, for which the Balearic Islands are ranked top, while the Canary Islands are ranked only thirteenth. Overall, Catalonia is in third place, preceding Madrid, Andalusia and Valencia. Extremadura is ranked bottom in three out of the four categories. This region and those of Castilla-La Mancha and Aragon have the lowest values overall of the aggregate indices.

Table 6. Composite correlations ($r_{M,S}$) of the DPSIR model elements in the WTTC, ESI and ST index methods.

	Driving forces	Pressures	State	Responses
WTTC method	0.8173	0.6399	0.3141	0.5075
ESI method	0.8485	0.7102	0.2495	0.6472
ST index method	0.9294	0.7144	0.3361	0.7347

Source: Table elaborated by the authors.

Hence, there appear to be no significant differences in the results of using the three different methods to obtain composite tourism sustainability indices. The question arises, however, as to whether the resulting composite indices are coherent with the 14 SSETI indicators from which they were constructed. In other words, are the aggregate indices obtained from the statistical information of Table 1 equally synthesized?

To reply to this question implies verifying whether or not the distances between tourism destinations in the original raw indicators are maintained in the final composite index. To this end, we calculated composite correlations for the driving forces, pressures, state and responses indices following the WTTC, ESI and ST index methods. The results are listed in Table 6.

One observes that the strongest correlations correspond to the driving forces index, with all three methods giving values above 0.8. One also notes the low values of the state index (from 0.25 in the ESI to 0.33 in the ST index). Indeed, there were only two SSETI indicators in this category and clearly they are insufficient as measures of the state of the environment in Spain's regions as tourism destinations. Hence, there needs to be an improvement in the design of the SSETI indicators, in particular in the state indicators.

The primary objective of the present study was the comparison of the three aggregate index methods on the basis of these composite correlations. In this sense, there are two essential deductions that can be made from the results presented in Table 6:

(1) The ESI composite correlations are stronger than those of the WTTC method, with the exception of the state index. Thus, the statistical transformations proposed by the WEF (logarithmic or potential transformation of asymmetric indicators and winsorization of all indicators) prior to assignment and aggregation would seem to be suited better to obtaining a final robust index than the WTTC relativization of indicators into a range of 0 to 1.

(2) Although the ESI correlations are, in general terms, quite acceptable (apart from the state category, they are all above 0.64), they are weaker than the ST index correlations. The pressure index can be considered equally consistent when the ESI method is applied or the ST index method, since the two correlations are quite similar in value. For the other three categories of the DPSIR model analysed, however, the ST index composite correlations are stronger than the ESI correlations. Thus, while it is convenient to perform statistical transformations prior to indicator aggregation, the use

of different weights in that aggregation is even more effective in obtaining composite indices that are as robust and consistent as possible.

Conclusions

The authors have been investigating this subject actively over recent months and contributing to the debate on it in forums and publications. This communication is the first presentation of specific data derived from an empirical analysis. The results have demonstrated the fruitfulness of the proposed index, since its results show a greater degree of consistency and robustness than the alternative methods tested.

The study has confirmed the importance that was indicated at the beginning of this paper of weighting the different indicators that comprise a composite index of sustainable tourism. The use of different weights ensures that the composite sustainable tourism index fulfils its main purpose of ranking tourism sustainability so that the progress of tourism destinations towards sustainability can be determined and compared. Such a tourism sustainability ranking will encourage destinations to make their own choices concerning sustainability, to set policies and establish support programmes with well-defined targets and monitoring procedures. Also, the decision makers involved will have more information with which to evaluate the performance of these programmes.

The method accepts the four-dimensional character of sustainability (economic, social, environmental and institutional). It uses standard factor analysis to establish all of the partial indicator weights in the construction of the aggregate index. Therefore, it is ensured that those indicators which are more correlated with each dimension have greater weights in the calculation of the aggregate index.

In addition, we proposed a measure of the validity of the aggregate indices given by the three aforementioned methods. This measure quantifies the correlation between the original raw indicators used and the calculated aggregate indices and helps to clarify how adequately those indices have been constructed. This composite correlation was found to be stronger with the ST index method than with the ESI method, and stronger with the latter than with the WTTC method. In particular, the newly proposed index proved to be the most consistent.

Nevertheless, there are still unresolved questions that the authors currently are researching. First, the method takes for granted the availability of data for all the indicators and tourism destinations analysed. On many occasions, however, this is not the case, so that a procedure is needed to deal with missing data. Otherwise, both the indicator and the destination affected by any missing information would have to be excluded from the analysis.

Second, it would be desirable to apply the method to different tourist destinations, even of different countries. At present, this is impossible, however, since there exists no common database of indicators for them all.

Third, the ST index is a static composite index because it provides a snapshot of tourism sustainability referred to a single time period (usually a year). It would be interesting to design tools to enable comparison between different time periods. Attention would have to be focused on whether the weights for different years are different or the same, that is, whether they are stable in time or, on the contrary, are volatile.

And fourth, there is the always-troublesome issue of the sources of the information that the composite index depends on. Although the national statistics agencies of developed countries provide a considerable amount of information, it is not usually available in a systematic and homogeneous form for all the tourism destinations that one wishes to analyse. This makes it necessary to define previously a homogeneous system of indicators responding to the four dimensions (economic, social, environmental and institutional) of sustainability. Then, prior to calculating the ST index, one can determine the four corresponding partial indices of sustainability (S_{EC}, S_{SO}, S_{EN} and S_{IN}, respectively) and thereby have information on the progress of each of the destinations analysed in these four components.

In sum, the present study has demonstrated the validity of the proposed method and that its results have greater consistency than those that were obtained using two other methods that have worldwide acceptance. In future work, our aim is to address the challenges that are noted in discussing the results in order to obtain a consistent ranking of tourism sustainability for every tourism destination that is to be analysed.

Endnotes

1. http://www.unmillenniumproject.org/.
2. http://www.ipcc.ch.
3. For more detailed analysis of the evolution of the concept of sustainability applied to tourism and of factors conditioning its measurement, see, among others, Dourojeanni (1997), Bell and Morse (1999, 2003), Hall (2000), Swarbrooke (2000), Ivars (2001), Ko (2001, 2005), Fullana and Ayuso (2002), Weaver (2005), Pulido (2006) and Bass (2007).
4. SSETI provides no indicators to measure the 'impact' element in the DPSIR model. Consequently, the empirical analysis is limited to the other four elements of the model.

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Appendix 1

WTTC approach

Defining a global tourism competitiveness index begins essentially by standardizing all the indicators used following the methodological approach proposed by the United Nations Development Programme (UNDP). Thus, for indicator j in country i, if x_{ij} designates the value, its normalized value is given by the expression:

$$y_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \tag{A1}$$

The indicators thus range in value from 0 to 1. The value 1 corresponds to countries with the maximum indicator value and the value 0 to countries with the minimum value.

If the relationship between the indicator and the competitiveness measure is inverse (the smaller the indicator's value, the greater the tourism competitiveness), the normalization procedure uses expression (A1), except with the numerator changed to $\max(x_{ij}) - x_{ij}$.

With the normalized indicators, the WTTC method defines an aggregate index for the eight dimensions of the aforementioned competitiveness. This index is a simple sum of the normalized values of each dimension's indicators:

$$S_i^{(k)} = \sum_{j=1}^{m} y_{ij}^{(k)} \tag{A2}$$

where the superindex k ($k = 1,2,\ldots,8$) denotes the eight dimensions and m the number of indicators needed to measure every dimension.

Lastly, in order to facilitate the interpretation and comparison between countries, the aggregate index of each dimension of tourism competitiveness is defined as follows:

$$C_i^{(k)} = \frac{S_i^{(k)} - \min(S_i^{(k)})}{\max(S_i^{(k)}) - \min(S_i^{(k)})} \tag{A3}$$

This methodological approach does not synthesize all the information into a single competitiveness index. Instead, it considers eight separate aggregate indices, each corresponding to one competitive dimension. There needs to be borne in mind two disadvantages:

(1) The $S_i^{(k)}$ index does not use all the available indicators. Many countries are excluded from the overall calculation due to the lack of statistical information on some indicators.
(2) Each $S_i^{(k)}$ index is obtained as a simple sum of the normalized indicators. Hence, the indicators are not weighted in the calculation of the aggregate indices.

In an attempt to secure a weighted composite tourism competitiveness index, Gooroochurn and Sugiyarto (2005) define the following aggregate index for each dimension:

$$I_i^{(k)} = \frac{\sum_{j=1}^{m} y_{ij}}{m} \tag{A4}$$

They then use this to calculate a weighted composite index:

$$z_i = \sum_{k=1}^{8} \omega_k \, I_i^{(k)} \tag{A5}$$

where the weights ω_k are calculated from the estimated coefficients of a confirmatory factor analysis model:

$$\omega_k = \frac{|\hat{\beta}_k|}{\sum_{k=1}^{8} |\hat{\beta}_k|} \tag{A6}$$

The proposal thus weights the eight tourism competitiveness dimensions at the end of the methodological development. There remain unknown, however, the weights of the indicators in constructing each aggregate index $I_i^{(k)}$, since these are obtained as simple unweighted averages of those indicators.

ESI approach

In the ESI approach, all variables are normalized in order to facilitate the comparison among countries and allow variable aggregation in the indicators. Some variables are then transformed before assignation and aggregation. This is done by first calculating their skewness as a check of normality. Variables with a skewness greater than 2 are then transformed using the base-10 logarithm or potential transformations.

The final step in this pre-processing of the variables is their winsorization in order to eliminate the effect of outliers. In particular, for each variable, values exceeding the 97.5 percentile are lowered to the 97.5 percentile, and values beneath the 2.5 percentile are raised to the 2.5 percentile.

Once the winsorized normalized values ($\tilde{z}_{ij}$) of the 76 variables have been obtained, the values of the 21 intermediate indicators are calculated as the equally weighted average of the $\tilde{z}_{ij}$:

$$I_{ir} = \sum_{j=1}^{p} w_j z_{ij} \text{ for } r = 1,2,\ldots,21 \tag{A7}$$

where the weights w_j are the same for the p variables constituting the rth intermediate indicator ($w_2 = w_2 = \ldots = w_p = 1/p$).

Finally, the ESI is obtained as the also equally weighted average of the 21 indicators:

$$\text{ESI}_i = \sum_{r=1}^{21} \omega_r I_{ir} \tag{A8}$$

where the weight, ω_r, of each intermediate indicator is the same for all 21 ($\omega_1 = \omega_2 = \ldots = \omega_{21} = 1/21$).

The indices calculated using expression (A8) are transformed into percentiles of the normal distribution in order to facilitate comparison among countries.

One observes, therefore, that ESI employs identical weights at the levels of both the variables and the indicators. This is because of the global (worldwide) character of ESI, notwithstanding the justification for the use of different weights in the case of an analysis of a single nation (or even a smaller territorial area), 'Our argument for equal indicator weights is based on the premise that no objective mechanism exists to determine the relative importance of the different aspects of environmental sustainability. At the country level, the indicators would almost certainly be weighted differently, but we cannot determine a globally applicable differential set of weights that would allow a fair comparison between countries' (World Economic Forum, 2005, p 66).

Appendix 2

Given the underlying character of each of the sustainability dimensions, the factor variables considered in the ST index represent the underlying measure of those dimensions. Thus, after the computation of the factor loadings, the aggregate index of the kth sustainability dimension for the case where a single factor explains a high proportion of the original indicator variances is calculated as:

$$I_k = \alpha_{11} Y_1 + \alpha_{21} Y_2 + \ldots + \alpha_{n_k 1} Y_{n_k} \tag{B1}$$

where n_k is the number of indicators used to measure this kth dimension, Y_j (for $j = 1,2,\ldots,n_k$) is the normalized value of indicator X_j and α_{j1} is the correlation (or factor loading) between the normalized indicator Y_j and the single factor. From expression (B1), it follows that the stronger the relation between an indicator and the underlying dimension quantifiable by the indicator (the kth dimension of sustainability), the greater its weight in the calculation of index I_k.

At other times, it is necessary to consider more than a single factor to explain a high proportion of the Y_j variances. The optimal factorial solution is then usually the rotated one, where two or more extracted factors are transformed (by an orthogonal rotation) to make every indicator strongly correlated to just one of the rotated factors. Thus, if $m \geq 2$ rotated factors are considered, and with β_{jr} (for $j = 1,2,\ldots,n_k$; $r = 1,2,\ldots,m$) designating the correlation between the normalized indicator Y_j and the rotated factor G_r, one obtains the following intermediate factors:

$$\begin{aligned}
\theta_1 &= \beta_{11} Y_1 + \beta_{21} Y_2 + \ldots + \beta_{n_k 1} Y_{n_k} \\
\theta_2 &= \beta_{12} Y_1 + \beta_{22} Y_2 + \ldots + \beta_{n_k 2} Y_{n_k} \\
&\ldots \\
\theta_m &= \beta_{1m} Y_1 + \beta_{2m} Y_2 + \ldots + \beta_{n_k m} Y_{n_k}
\end{aligned} \tag{B2}$$

Since the eigenvalues are in decreasing order, θ_1 explains a greater percentage of the Y_j variances than θ_2; θ_2 explains a greater percentage of the variances than θ_3, and so on. This means that the composite index corresponding to the kth tourism sustainability dimension is obtained as a weighted sum (with decreasing weights) of the intermediate indicators of expression (B2) thus:

$$I_k = \omega_1\theta_1 + \omega_2\theta_2 + \omega_3\theta_3 + \ldots + \omega_m\theta_m \quad \text{(B3)}$$

where $\omega_1 \geq \omega_2 \geq \ldots \geq \omega_m$ are given by:

$$\omega_i = \frac{\lambda_i^*}{\sum_{i=1}^{m}\lambda_i^*}\ ;\ \text{for } i = 1,2,\ldots,m \quad \text{(B4)}$$

and λ_i^* $(i = 1,2,\ldots,m)$ is the eigenvalue associated with the factor G_i.

The resulting index I_k is not usually easy to interpret, whether there is a single factor (expression (B1)) or multiple factors (expression (B2)). In order to facilitate the interpretation, the authors propose transforming I_k into a 0 to ϕ range, using Casalmiglia's transformation function (Casalmiglia, 1990):

$$S_k = f(I_k) = \begin{cases} 1 + \dfrac{\phi - 1}{2}\exp(I_k) & \text{if } I_k < 0 \\[2ex] \phi - \dfrac{\phi - 1}{2}\exp(-I_k) & \text{if } I_k \geq 0 \end{cases} \quad \text{(B5)}$$

Now it can be argued that the closer the transformed value of S_k is to ϕ for a given tourism destination, the greater that destination's (economic, social, environmental or institutional) sustainability. And, of course, the closer S_k approaches 0, the lower the sustainability.

Finally, to obtain a single composite tourism sustainability index, we consider Gooroochurn and Sugiyarto's method (2005) to be the most appropriate. Thus, the ST index is a weighted sum of the partial composite indices S_{EC}, S_{SO}, S_{EN} and S_{IN} (representing the sustainability dimensions: economic, social, environmental and institutional). The weights are obtained from the estimated coefficients of a confirmatory factor analysis model as follows:

$$ST_i = \omega_1 S_{ECi} + \omega_2 S_{SOi} + \omega_3 S_{ENi} + \omega_4 S_{INi} \quad \text{(B6)}$$

where

$$\omega_k = \frac{|\hat{\beta}_k|}{\sum_{k=1}^{4}|\hat{\beta}_k|}\ ,\ \text{if } k = 1,2,3,4 \text{ and } \sum_{k=1}^{4}\omega_4 = 1$$