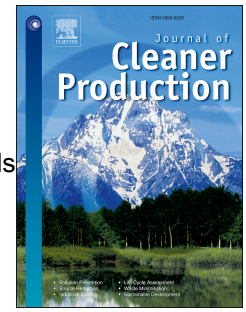

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Sustainability indicators for the economic evaluation of tourism investments on islands

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Sustainability indicators for the economic evaluation of tourism investments on islands

ABSTRACT

The sustainable tourism development is often a key element for the enhancement of island states. The fragility and the environmental, social and economic vulnerability that characterize these territories make the need to integrate the multiple aspects of sustainability into the decision-making processes concerning the definition of plans and programs of investment in the tourism sector increasingly urgent. Thus, the aim of the work is to build a dataset of sustainability indicators classified and weighed according to the subsequent characterization of a multi-criteria evaluation model. This dataset is obtained by defining an analysis procedure aimed at: selecting scientifically valid indicators, readily available by the analysts and easy to interpret by stakeholders; weighing the indicators themselves based on criteria shared in the literature; taking into account the uniqueness of the territorial reference system. The evaluation protocol proposed is substantiated in the subsequent steps of selection, classification, weighting and ranking of sustainability indicators for the analysis of tourism projects on the island. Innovative elements essentially concern weighting operation. In fact, the weight of each indicator is a function of several evaluation criteria and is estimated by using both statistical analysis methods and analytic hierarchy processes.

The output of the study, consisting of the dataset of sustainability indicators, is a prerequisite for the subsequent characterization of a multi-criteria evaluation model able to select investment projects that balance the environmental, economic and social specificities of the island. This can determine greater effectiveness in the allocation processes of both public and private resources.

Keywords: island sustainability; sustainable tourism development; evaluation indicators; frequency analysis; multi-criteria methods; economic evaluation of projects.

Highlights:

- Indicators dataset for the economic evaluation of tourism projects on the islands is proposed
- An innovative methodology to select island sustainability indicators is defined
- The indicators are selected on the basis of scientifically valid criteria
- The indicators weighting is based on statistical analysis and multi-criteria methods

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1. Introduction

For more than thirty years the promotion of sustainable development of the "island system" is a *leitmotiv* of ever-greater interest for scholars. This is because the islands are characterized by a high "vulnerability" both environmental and economic and social (Campling and Rosalie, 2006; Douglas, 2006; Polidoa et al., 2014). Authors such as Kerr (2005) and Kelman et al. (2015) define these territories as bounded systems based on limited economic independence and marked by unique characteristics of biological and cultural diversity, scarce resources and fragile and sensitive ecosystems. Moreover, they are often prone to natural disasters and, due to their small size, they are less resistant to the single catastrophic event (Hein, 2010; Budeanu et al., 2016). Therefore, these are living laboratories for the planet.

Being closed systems, these territories represent manageable units of study, in which people can more easily experience the impacts of their actions on ecosystems (Nagarian 2006, Polido et al., 2014). Which is why the islands, and even more the small islands, can be the object of experiments aimed at verifying the capacity of specific actions to pursue goals and future targets of sustainability. As a result, they need ever-increasing international support (Crossley and Sprague, 2014; Shafiee *et al*., 2019).

In addition to having limited resources, in the island states economic and social activities tend to be concentrated in coastal areas and interconnectivity between the economic, environmental, social, cultural and political spheres is highly pervasive. Consequently, Twining-Ward and Butler (2002) believe that one of the biggest challenges for the islands is the sustainable tourism development that for these territories is not an optional *extra* but a practical necessity.–Therefore, as Kerr (2005) argues, sustainability in island systems is often viewed as paradoxical due to their high dependence on international trade, which is in contrast with the strategies applicable in these territories. Thus, it becomes essential to characterize *ad hoc* approaches that reconcile the multiple aspects of sustainability related to the "island system". This both in economic policies concerning the definition of investment plans and programs, and in the processes of resource allocation to individual projects, particularly aimed at the tourist development of these peculiar territories (Lenzen, 2008; De Mare et al., 2018; Nesticò et al., 2018; Nesticò and Maselli, 2018).

According to the outlined framework, the work aim is to define a dataset of indicators valid for the economic evaluation of tourism projects on an island. To this end, a broader panel of scientifically valid indicators and concretely implementable in the decision-making processes is constructed. Subsequently, from this panel we select specific indicators for the analysis of investments on the island. Therefore, the sustainability indicators thus obtained are classified and weighted in function of the subsequent characterization of a multi-criteria evaluation model.

The path of selection, classification and weighting of sustainability indicators on the one hand is based on the criteria of data accessibility, relevance with respect to the achievement of goals, applicability to the specificities of the study project, quantification capacity. On the other hand, this path is based on the scientifically valid principles of the frequency analysis. However, it is above all in the phase of assigning of the weights to the indicators that the novelty of the study is substantiated. In fact, in practice the attribution of weights derives from the comparison in pairs between elements, where in general a panel of experts assesses the greater importance of one indicator over another based on appropriate rating scales. In order to make this operation more objective, each indicator is weighed here according to several evaluation criteria, using both statistical processing and analytic hierarchy processes.

The paper is structured as follows. Section 2 shows the bibliographic contents that are indispensable for building the dataset of sustainability indicators. Section 3 explains the investigation methodology, which refers to multi-criteria logics. A repeatable study protocol is thus characterized in the selection of parameters for evaluation. Section 4 sets out the resulting dataset of sustainability indicators and the related discussions of the study. The conclusions of the work, the implications of economic policy and the research perspectives are in the last section.

2. Literature review

It is known that the development of an indicators system is as complex as it is critical (Blancas et al., 2011; Tanguay et al., 2013). This is because defining indicators useful to investigate a specific topic, such as that of sustainable tourism, means to make a concept more concrete and operational (Manning, 1999). To this end, namely to select indicators useful to investigate the issue of sustainable tourism on the island, it is necessary to understand which are the sustainability challenges that the island states have to pursue. In this regard, Sheldon (2005) underlines how each island is unique and that uniqueness needs to be nurtured and strengthened through sustainable tourism. He proposes six possible classifications of the islands, essential to clarify which sustainable tourism strategies the decision-makers needs to address:

a. based on climate;
b. in relation to their size and proximity to the mainland;
c. depending on whether they are part of an archipelago;

d. for governance, namely if the island is politically autonomous or is part of the continental government system;
e. depending on whether the resident population is growing or declining;
f. in relation to the socio-cultural homogeneity of the inhabitants, being the islands with homogeneous indigenous populations particularly vulnerable to tourism development.

Thus, according to specific characteristics, in their quest to sustainability island states face divergent challenges:

- economic,
- environmental and
- socio-cultural.

Regarding the *economic issues*, the greatest challenge for the island is the scarcity of resources: the decrease in the value of agricultural and mining products on international markets, the extinction of multiple fish populations, the changes in the nature of the coasts caused by global warming suggest that tourism can become an economic catalyst for the development of island states (Croes, 2004). In fact, it can increase competition, encourage the development of start-ups and trade opening up to increase the quality of life for residents. However, as far as possible the revenue generated by tourism must remain on the island. In this sense, fiscal policies, business subsidies and investment incentives are all useful strategies for strengthening the economy of these territories. According to Nadal et al., (2004), a further challenge of economic sustainability concerns the reduction of seasonal fluctuations in tourist flows through the diversification of products and the market and a better use of tourist infrastructures and superstructures. Another concern is the increase in land prices, which often forces residents to invest in the foreign real estate market. However, this can only stimulate the migration and the dissolution of local culture.

The *environmental issues* that can influence the sustainability of the island, instead, are closely related to the preservation of coastal areas, of native species and, more generally, of ecosystems. In this context, the often-excessive use of island coasts generated by tourism activities can contribute to environmental degradation, in terms of pollution, erosion, damage to biodiversity. Furthermore, the increase in waste related to tourism can generate significant problems related to the limited disposal spaces.

Finally, the *socio-cultural issues* essentially concern indigenous peoples. In fact, the approach of tourists to the inhabitants of the island can often increase phenomena of culture commodification, loss of traditional lifestyles, moral standards, as well as increasing crime phenomena (Sheldon et al., 2005). In this regard, according to Mitchell and Reid (2001), the key element for the sustainable development of tourism is precisely the involvement of the community in the island planning processes.

In light of the above, it is clear that the vulnerability and specificity of island states imply the need to integrate the key principles of sustainability into the political and planning system of these territories (Herbert, 1998; Fortuny et al., 2008; De Mare et al., 2013; Higgins-Desbiolles, 2018,).

This can be done evaluating the complex problem of sustainable tourism development on the base of sustainability indicators. Therefore, from the analysis of the numerous sets of indicators on the topic already proposed by the scholars, a lack of consensus emerges about both goals and targets to be taken into account, and about the aggregation/disaggregation methods of the indicators themselves. Furthermore, among the multiple panels, there are both those that are scientifically rigorous but too complex to be adopted by policy-makers; and those derived from a participatory approach and which risk being determined only for territorial branding purposes (Tanguay et al., 2013; Gillgren et al., 2018; Fuldauer et al., 2019).

With reference to the investment initiatives aimed at the tourist development of the island system, the challenge is to select indicators that are:

– scientifically valid, therefore widely shared in the literature;

- acceptable to stakeholders, therefore concretely applicable in the decision-making process;
- able to take into account the uniqueness of the area in which the intervention takes place.

The literature sources are the main studies on sustainable tourism development indicators on the islands or concerning the sustainability assessment of coastal areas. The expansion of the panel shows that as the number of studies increases (up to 15) the frequency trend of the indicators tends to stabilize.

Table 1 reports the studies selected for the dataset definition. For each study, the number of indicators investigated and the classification for issue are specified. It should be noted that each study considers a significantly variable number of indicators, between 9 and 119, for a total of 131 indicators. The number of issues is also highly variable, ranging from 1 to 52. This confirms the multiplicity of problems that sustainable tourism development processes determine.

The following section details the methodology that we propose to select, classify and weigh the sustainability indicators.

4. Methods for the selection of sustainability indicators and the corresponding weighting

Starting from a generally valid definition, the indicators are those variables that make the phenomenon of interest perceptible, summarizing or simplifying the most important information related to it. In other words, an indicator must communicate, quantify, evaluate and monitor information details concerning a specific topic (Lee and Hsieh, 2016; Neumann et al., 2017; Estêvão et al., 2019). The reference literature suggests different approaches to select sustainability indicators, i.e. those that have to reflect the environmental, economic and social attributes of the entity to which they would be applied (Robert and Tribe, 2008, Ocampo et al., 2018, Pires Eustachio et al., 2019). Some authors point out that the selection of indicators is closely related to their political relevance (Manning, 1999; Miller, 2001; Pickaver et al., 2004; Modica et al., 2017; Foroni et al., 2019).Others, instead, believe that data robustness, adaptability and availability significantly influence the data selection process (Di Ruocco and Nesticò, 2018; Schumacher *et al*., 2018a; Schumacher *et al*., 2018b; Kurniawan et al., 2019). Then, when to be select are the sustainable tourism development indicators, the interconnectivity of the multiple components of the tourism system must also be taken into account (Michailidou *et al*., 2016; Agyeiwaah *et al*., 2017; Asmelash and Kumar, 2019). Tanguay et al. (2016) choose indicators based on frequency, greater compliance with the problem of sustainable tourism development, measurability over time, data availability, consistency with regional policies and the concrete possibility of decision-makers to adopt them. Again, Karnauskaite et al. (2019) identify the evaluation indicators based on the following criteria: scope, relevance, data availability, and quantification capacity. Finally, according to Roberts and Tribe (2008), not only is there no criteria model for selecting indicators, but this selection varies inadvertently depending on the research objective.

In the light of the outlined framework, in this paper the selection, classification, weighting and ranking of sustainability indicators is based on the following evaluation criteria:

a) *goal*, that is, according to the specific objectives of the study;
b) *operation*, therefore choosing indicators that can be concretely implemented by the decision-makers;
c) *relevance*, in order to identify those specifically applicable to the island's tourism enhancement issues;
d) *adaptability*, differentiating between core and optional indicators;
e) *frequency*, with which they are repeated in literature;
f) *data availability*, that is evaluating the accessibility to the same;
g) *quantification capacity*, differentiating between quantitative and qualitative criteria.

So, the evaluative procedure that is defined here is embodied in the following 4 closely interrelated steps:

1. Select indicators from the default dataset;
2. Classification of selected indicators;
3. Weighting of the indicators;
4. Ranking of the indicators.

In the first step, among the indicators of the dataset already defined in section 2, only those strictly coherent with the research purpose are selected, as well as of simple practical implementation, i.e. concretely applicable in decision-making process.

At the second step the selected indicators are classified. The objective of this phase is to identify for each indicator the issue that they investigate as well as the membership of one of the three dimensions of sustainability: environmental, economic and social. Indeed any process, in particular the tourism development on the island, is 'sustainable' if it considers together the three dimensions just mentioned; 'liveable' if it takes into account only the social and environmental dimensions of the development; 'equitable' if it regards the social and economic components; 'feasible' if it covers the environmental and economic dimensions.

In addition, the indicators are classified both with reference to the relevance to the research objective and to their adaptability. In other words, we propose a distinction between *core* indicators, that is always valid, and *optional* indicators whose applicability depends on the specificities of the study project. In the third step the weights of the indicators are estimated on the basis of three criteria:

- frequency,
- data availability and
- quantification capacity.

Instead, we cannot attribute a weight to the two criteria of the relevance and the adaptability.

With reference to the relevance, for example, it would not be consistent to give more importance to indicators that analyze human pressure generated by tourism compared to indicators that assess the environmental impacts. This only because the first specifically investigate issues related to the development of sustainable tourism.

Even with respect to the adaptability, to attach a weight is not possible. In fact, optional indicators even if are not always measurable as a function of the specific territorial characteristics, have the same importance of the core indicators.

With reference to the first criterion, we attribute to the i-*th* indicator a weight $w_{1(i)}$ corresponding to the frequency with which it is repeated in the datasets examined. Given the population composed of N units, corresponding to the 15 datasets on which the discrete variable X is observed, which takes k distinct modes, it is possible to represent the observations in a frequency distribution where:

- x_i represents the i-*th* mode of X, corresponding to the i-*th* indicator;
- n_i consists of the i-*th* absolute frequency and provides the number of times the i-*th* mode occurs in the observed dataset:

$$\sum_{i=1}^{k} n_i = N; \quad 0 \leq n_i \leq N \tag{1}$$

- $f_i = n_i / N$ is the i-*th* relative frequency, i.e. the ratio between the absolute frequency and the number of tests performed. f_i it is measured with a decimal number or percentage (relative frequency × 100)

$$\sum_{i=1}^{k} f_i = 1; \quad 0 \le f_i \le 1 \tag{2}$$

With reference to the second and third criteria, namely the availability of data and the quantification capacity, the weights $w_{2(i)}$ and $w_{3(i)}$ are estimated using the Analytic Hierarchy Process (AHP). It is a well-known method of comparison in pairs, from which the logic is used to estimate the vectors of the weights to be assigned to the indicators. Thus, through comparisons in pairs, the greater or lesser importance of one element is established with respect to another in relation to a specific criterion. Specifically, the evaluation indicators selected and classified in the previous steps are now compared with respect to the availability of data and the quantification capacity.

The result of the comparison is called the dominance coefficient a_{ij} and indicates the greater or lesser importance of the first element *i* with respect to the second *j*. To be able to obtain the values and construct the matrices of the comparisons in pairs, we use the semantic scale of Saaty, which relates the first nine whole numbers with as many judgments that express the possible results of the comparison, as shown in Table 2.

The dominance coefficients define a matrix *A*, called matrix of the comparisons in pairs, positive, invertible, square ($n \times n$) with n number of elements to compare. For its complete definition, it is necessary to supply only the values of the elements placed above (or below) the diagonal:

$$A = \begin{array}{c} \\ C_1 \\ C_2 \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \end{array}$$

The normalization of the matrix allows estimating the vector of the priorities or weights *P(C)* of the criteria with respect to a common attribute. The element $p(C_i)$ of the vector *P(C)* is obtained by normalizing the geometric mean m_i of the i-*th* row of the matrix A compared to the sum of the geometric means of all the m_k rows. In other words, the weight vector is the eigenvector corresponding to the maximum eigenvalue λ_{max} of the matrix *A*:

$$p(C_i) = \frac{m_i}{\sum_{k=1}^{n} m_k} \tag{3}$$

where:

$$m_k = \sqrt[n]{a_{k1} \cdot a_{k2} \cdot \dots \cdot a_{kn}} \tag{4}$$

The eigenvector method also allows verifying the consistency of the judgments expressed by the decision makers. This by estimating a *Coensistency Index* (*CI*), function of the weight vector and of the number *n* of compared criteria. In formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{5}$$

The *CI* consistency index is then compared with the *Random Index* (*RI*) thus obtaining the *Coensistency Ratio* (*CR*):

$$CR = \frac{CI}{RI} \tag{6}$$

The values of *RI* are obtained from the average of the *CI* values of numerous reciprocal matrices of the same order *n*, whose coefficients are randomly generated by a calculator (Ribera et al., 2019).

Specifically, Saaty (1980) states that binary comparisons can be defined as sufficiently coherent with each other if it results:

$CR < 5\%$ for $n = 3$;
$CR < 9\%$ for $n = 4$;
$CR < 10\%$ for $n > 4$.

The fourth and final step of the analysis procedure details the ranking of the evaluation criteria based on the final weight $W_{f(i)}$ relative to each criterion. $W_{f(i)}$ derives from the arithmetic mean of the weights $w_{1(i)}$, $w_{2(i)}$ and $w_{3(i)}$ estimated at step 3 for each i-*th* criterion:

$$W_{f(i)} = \frac{w_{1(i)} + w_{2(i)} + w_{3(i)}}{3} \quad (6)$$

This ranking of sustainability indicators is a prerequisite for the subsequent characterization of a multi-criteria evaluation model applicable to investment initiatives for the promotion of tourism on the island.

Figure 1 outlines the evaluation protocol.

Figure 1. The phases for the ranking of sustainability indicators.

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5. Results and discussions

The calculations are conducted by following the four steps indicated in the previous section.

Step 1. *Selection of indicators from the default dataset.*

Since the analysed sources examine multiple aspects of sustainable tourism development, from the initial dataset we extract only those indicators that, besides being strictly coherent with the research objective that is the economic evaluation of tourism initiatives on the island, are also of concrete applicability in decision-making processes.

Step 2. *Classification of selected indicators.*

Table 3 describes and classifies the 23 indicators selected in the previous step on the base of:

- *issue*. According to the classification of sustainability indicators proposed by the United Nations World Tourism Organization (2004) and SUSTAIN partnership (2012), 12 key issues are identified: economic opportunity, tourism, transportation, change at the coast, biodiversity and natural resources management, land use, energy & climate change, waste management, water resources and pollution, local and cultural identity, sustaining tourist satisfaction;
- *dimension*, understood as a reference of the indicator to one of the three dimensions of sustainability, namely economic (EC), environmental (EN) and social (S). Specifically, the economic dimension is investigated through three indicators: employment by sector (EC_1), economic performance (EC_2) and tourism intensity, in absolute terms (EC_3). On the other hand, there are 17 environmental indicators, 1 of which relates to the tourism issue (EN_1), 2 to that of transport (EN_2, EN_3), 1 evaluates the changes in the coastline (EN_4), 2 analyse the biodiversity and the management of natural resources (EN_5, EN_6), 2 the land use (EN_7, EN_8), 4 the energy and climate change (da EN_9 EN_{12}), 2 the waste management (EN_{13}, EN_{14}), 3 the water resources and pollution (da EN_{15} a EN_{17}).

Finally, with reference to the social dimension, information regarding the tourist pressure on the inhabitants of the island (S_1), cultural and local identity (S_2) and the level of visitor satisfaction (S_3) are examined;

- *relevance* with respect to the objective, thus identifying 9 indicators investigating problems specifically related to the sustainable tourism development. These are 2 indicators that investigate the anthropic pressure generated by tourism (EC_3, EN_1), 1 indicator that assesses the

degree of accessibility to the island (EN3), 1 indicator that measures changes in the coastline (EN_4), 2 indicators that investigate the issue of biodiversity and natural resource management (EN_5, EN_6);

- *adaptability*, distinguishing 17 *core* indicators, valid independently from the specific territory in which the intervention is located, and 4 *optional* indicators that are a function of peculiar territorial characteristics and therefore it is not always possible to evaluate (EN_4, EN_5, EN_6, EN_8).

Step 3. W*eighting of the indicators.*

For the purposes of the subsequent characterization of a multi-criteria evaluation model, the sustainability indicators in Table 4 are weighted according to three criteria: *a)* frequency, *b)* data accessibility, *c)* quantification capacity. In all three cases, the elaborations are carried out regardless of the economic (EC), environmental (EN) and social (S) dimensions of the indicators, or considering their membership in the aforementioned dimensions.

a) A weight $w_{1(i)}$ is estimated for each indicator based on the frequency with which they are repeated in the examined sources. Considering that the selected indicators are present in more than one study through an identical or completely comparable statement, it is of interest to weigh them based on repetition, since this establishes the greater or lesser relevance and reliability in the scientific literature. Based on the frequency analysis we estimate two weights: $w_{1(i)}$ that represents the weight of the i-*th* indicator compared to the entire panel; $w_{1D(i)}$ that coincides with the frequency with which the i-*th* indicator is repeated in the sub-datasets consisting of indicators of the same dimension.

The frequency analysis shows that the most frequent indicators of all are: *area of land and sea protected by statutory designations*; *energy consumption*; *share of renewable energies*; *annual water consumption*. These are present in 10 studies. They follow first *employment by sector*, *greenhouse gas emissions*, *water reused*, *local satisfaction level with tourism*, analysed in 9 sources, and then *economic performance* e *waste disposal method*, indicated in 8 papers. Still in order: *tourism density* and *waste production* in seven works; *Tourism intensity (in absolute terms)*, *tourism intensity (related to locals)* and *level of satisfaction by visitors* in 6 publications. Finally: *transport usage*, *coastal erosion*, *marine habitats and species that have been identified as priorities for conservation*, *forested land area*, *quality of water for human consumption*, are less frequent as appearing 5 times; *degree of accessibility in island territories and in territory initiative*, *area of built-up land* and *green buildings*, present in only three studies.

b) The indicators are also weighted with reference to the accessibility of the data using the Analytic Hierarchy Process (AHP). Given that when it is necessary to choose between several investment initiatives, not all the necessary data are always directly available from the project documents, for each criterion the following considerations apply. It should be noted that each indicator is attributed a possible importance from 1 to 10, passing from extreme difficulty to high ease of data retrieval. This is to make pairwise comparisons immediate and consistent.

The indicators *local satisfaction level with tourism* e *level of satisfaction by visitors* can be evaluated only on the basis of specific questionnaires, so they are the most difficult to evaluate. These are attributed importance equal to 2.

Indicators like *economic performance*, *transport usage*, *energy consumption*, *greenhouse gas emissions*, *share of renewable energies*, *waste production*, *waste disposal method*, *quality of water for human consumption*, *annual water consumption*, *water reused* they can be estimated, depending on the level of the design, or on the basis of design data or more likely are evaluated on the basis of analysis of the reference benchmark. Therefore, these indicators have importance equal to 4. Instead, *employment by sector*, *economic performance*, *tourism intensity (in absolute*

terms), tourism intensity (ratio of tourist to locals), tourism density are more immediately estimable and their importance is 5.

Coastal erosion and *marine habitats and species that have been identified as priorities for conservation*, instead, are directly assessable by analyses *in situ* for which importance equal to 6 is attributed. However, these are function of data that are more difficult to find than those needed to estimate the *area of land and sea protected by statutory designations* and *degree of accessibility in island territories and in territory initiative*, whose importance is equal to 7.

Because depending on preliminary design information, *area of built-up* and *quality of water for human consumption* (importance 6) and *forested land area* and *green buildings* (importance 7) are easy to access.

Also in this case the elaborations are conducted first by comparing in pairs all the 23 indicators of the panel, then only those of the same dimension.

c) Also with reference to the quantification capacity, the implementation of the Analyst Hierarchy Process allows to estimate for each indicator the weights $w_{3(i)}$ and $w_{3D(i)}$. Quantitative indicators are distinguished from those based on qualitative judgments. Since the former are measurable and therefore comparable based on objective data, we give to them a moderate preference for comparisons in pairs with respect to qualitative indicators.

Step 4. *Ranking of the indicators.*

The results derive from the processing related to step 4 of the analysis protocol. Table 4 summarizes for each indicator information related to frequency, data accessibility, and quantification capacity. Table 5 shows both the ranking of the evaluation criteria based on the final weight of each indicator $w_{f(i)}$ compared to the entire panel of 23 indicators and the weight $w_{fD(i)}$ obtained by considering only the indicators of the same dimension. The resulting weights derive from the arithmetic mean of the weights estimated in step 3 and are reported in table 5. The appendices A and B detail the calculation matrices, while the figures 2 and 3 schematize the results.

Figure 2. Bar chart of the indicators weights $w_{f(i)}$.

Figure 3. Bar chart of the indicators weights $w_{fD(i)}$.

The calculations conducted comparing all 23 indicators (Figure 2) show that:

- the weights range from 2.17% to 6.98%;
- indicators with lower weights are *level of satisfaction by visitors* (w_f = 2.17%) and *local satisfaction level with tourism* (w_f = 2.80%), both because they are qualitative indicators and because they can only be estimated on the basis of questionnaires and therefore on data not immediately available;
- the indicators with higher weights are instead, *area of land and sea protected by statutory designations* (w_f = 6.98%), *transport usage* (w_f = 5.92%) and *marine habitats and species that have been identified as priorities for conservation* (w_f = 5.92%). These are in fact frequent quantitative indicators in the scientific literature and whose estimate is based on easily available data;
- the weights of the remaining indicators are included in the range 3.05-4.84%.

With reference to the analysis between indicators of the same dimension (Figure 3), it should be noted that:

- among the economic indicators, the indicator with the highest weight is *employment by sector* (w_f = 37.48 %);

- among the environmental ones, the most relevant are *area of land and sea protected by statutory designations* (w_f = 8.92%), *degree of accessibility in island territories and in territory of the initiative* (w_f = 6.88%) and *area of built-up land* (w_f = 6.78%);
- the most influential social indicator is *tourism intensity (related to locals)* with w_f = 51.76%.

6. Conclusions

For the island the sustainable tourism development is often a challenge so important that it becomes a real practical necessity (Twining-Ward and Butler, 2002). In addition, the environmental, economic and social vulnerability as well as the specificities of the island states entail the need to integrate the key principles of sustainability in politics and in the territorial planning system (Herbert, 1998). In this perspective, the paper proposes a dataset of sustainability indicators for the multi-criteria analysis of tourism projects on island. The dataset is constructed by implementing an innovative methodology specifically designed for the selection, classification and weighing of evaluation indicators.

The research starts with the composition of a panel of 131 indicators concerning the sustainable tourism development on islands and the sustainability assessment of coastal areas. These indicators derive from the international scientific literature, which reveals 15 main bibliographic sources of reference. The dataset thus defined constitutes the information support useful for implementing 4 analysis steps, which conform the evaluation protocol: *selection, classification, weighting and ranking* of sustainability indicators.

The first phase, that is the selection one, consists in extracting from the predefined dataset only indicators strictly coherent with the study purpose, as well as of simple use in the decision-making processes. 23 indicators are selected.

In the second step, the 23 indicators are classified according to: specific reference *issue*; *dimension*, which can be environmental, economic or social; *relevance* with respect to the ability to interpret the phenomenon investigated; *adaptability* to the evaluation of different projects for sustainable tourism on the island.

In the third step we attribute the weights to the indicators. It is at this stage that the main novelty of the evaluation procedure is substantiated. In practice, in fact, the attribution of weights derives from the judgment of experts, who evaluate the greater importance of one element compared to another based on appropriate rating scales. To make this operation more objective, we propose to weigh each indicator according to three criteria: frequency, data accessibility, quantification capacity. Specifically, three weights are attributed to each i-*th* indicator: $w_{1(i)}$ corresponding to the frequency with which the indicator is repeated in the examined dataset; $w_{2(i)}$ based on data accessibility; $w_{3(i)}$ in relation to the ability to quantify the indicator. To estimate $w_{2(i)}$ and $w_{3(i)}$ the Analytic Hierarchy Process is used.

The fourth step returns the final weights and therefore the ranking of the indicators, which allows assigning them more or less importance. The ranking is produced both for all the 23 elements making up the panel and distinguishing the indicators by dimension.

The dataset of sustainability indicators and the information on the relative weights are an important tool to support multi-criteria evaluations, able to guide the allocation processes of public and private resources aimed at the tourist development of the islands. Research perspectives may concern the formalization of a multi-criteria model based on the evaluation indicators specifically selected here. This in order to choose among several investment alternatives those that jointly consider the multiple

aspects of sustainability and therefore able to safeguard fragile and vulnerable systems such as island states. This with relevant economic policy implications.

Refercences

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No.	*Source*	*No. of indicators*	*Classification*
1	What Managers Need to Know – A Practical Guide to the Development and Use of Indicators of Sustainable Tourism, Madrid: World Tourism Organisation, WTO (Manning, Clifford, Dougherty, Ernst, 1996)	11	11 key Sustainable Tourism Development indicators
2	Indicators of Sustainable Tourism in New Zealand: A Local Government Perspective (Dymond, 1997)	11	11 key Sustainable Tourism Development indicators related to 4 issues (Economic, Ecological, Social, Planning)
3	The development of indicators for sustainable tourism: results of a Delphi survey of tourism researchers (Miller, 2001)	9	9 indicators divided into 4 issues: employment, financial, customer satisfaction,

			environmental impact assessment
4	Implementing STD on a Small Island: Development and Use of Sustainable Tourism Development Indicators in Samoa (Twining-Ward, Butler, 2002)	24	24 indicators grouped in 12 key issues and 4 themes (Environment, Economy, Society and Culture, Tourism)
6	European Environment Agency core set of indicators: letter on consultation process on proposal, proposals for a core set of indicators (European Environmental Agency, 2004).	11	11 key Sustainable Tourism Development indicators for western European countries
7	Indicators of Sustainable Development for Tourism Destinations: a Guidebook (United Nations World Tourism Organization, 2004)	29	This set is collected in a Guidebook, which illustrates 12 issues and the 29 related evaluation criteria
8	The Evaluation of Sustainable Tourism Development by Analytic Hierarchy Process and Fuzzy Set Theory: An Empirical Study on the Green Island in Taiwan (Tsaur, Wang, 2007)	28	28 evaluation criteria related to 10 target and 3 issues (Physical-Ecological, Social-Cultural, Political-Economic)
9	Indicators for Tourism Destinations: A Complex Adaptive Systems Approach Using Systemic Indicator Systems (Schianetz, Kavanagh, 2008)	26	26 key indicators for tourism destinations
10	The assessment of sustainable tourism: Application to Spanish coastal destinations (Blancas, Gonzalez, Lozano-Oyola, Perez, 2010)	32	32 indicators referred to 3 pillars (Environmental, Economic, Social)
11	Measuring Coastal Sustainability. A Guide for the Self-Assessment of Sustainability Using Indicators and a Means of Scoring them (SUSTAIN Partnership, 2012)	91	91 indicators, of which 58 core and 33 optional referring to 22 issues and 4 pillars (Economics, Environmental Quality, Social well-being, Governance)
12	Sustainable tourism indicators: selection criteria for policy implementation and scientific recognition (Tanguay, Rajaonson, Therrien, 2013)	27	27 key Sustainable Tourism Development indicators
13	Application and evaluation of an indicator set to measure and promote sustainable development in coastal areas (Schernewski, Schönwald, Kataržyte, 2014)	58	58 indicators classified in 22 issues and 4 pillars (Economics, Environmental Quality, Social well-being, Governance)
13	A green economy indicator framework for tourism destinations (Law, DeLacy, McGrath, 2017)	119	119 indicators across 52 components
14	Assessing coastal management case studies around Europe using an indicator based tool (Karnauskaitė, Schernewski, Schumacher, Grunert, Povilanskas 2018)	45	58 indicators related to 4 pillars (Economics, Environmental Quality, Social well-being, Governance)
15	Indicator-Based Sustainability Assessment Tool to Support Coastal and Marine Management (Karnauskaite, Schernewski, Støttrup, Kataržyte, 2019)	89	89 indicators, of which 50 core and 39 optional referring to 22 issues and 4 pillars (Economics, Environmental Quality, Social well-being, Process)

Table 1. The 15 sources analysed for the dataset definition.

Intensity of dominance	*Definition*
1	Indifference
3	Moderate preference
5	Strong preference
7	Very strong preference
9	Extreme preference
2,4,6,8	Intermediate preference reviews
(1/2, 1/3, …)	Mutual preference judgments

Table 2. Saaty's semantic scale.

Indicator	Definition	Unit of measure	Issue	Dimension	Relevance	Adaptability
Employment by sector	Number of new employees	No.	Economic opportunity	EC_1	NO	Core
Economic performance	Economic Net Present Value (NPV) or Economic Internal Rate of Return (EIRR)	(€, %)	Economic opportunity	EC_2	NO	Core
Tourism intensity (in absolute terms)	Number of annual tourists (in absolute terms)	No.	Tourism	EC_3	YES	Core
Tourism density	Number of tourists per square meter o bed occupancy rate	(No/m^2, %)	Tourism	EN_1	YES	Core
Transport usage	Number or percentage of tourists who reach their destination by public transport	No.	Transportation	EN_2	NO	Core
Degree of accessibility in island territories	Frequency with which means of transport reach the tourist facility or have stops close to it	No of public means per day	Transportation	EN_3	YES	Core
Coastal erosion	% of the investment initiative that would be placed in an area of the coast in a state of erosion or already characterized by artificial interventions of protection/defence of the coast	(%)	Change at the coast	EN_4	YES	Optional
Marine habitats and species that have been identified as priorities for conservation	Number or percentage of endangered marine/terrestrial species passing through the area in question	(No or %)	Biodiversity and Natural Resources Management	EN_5	YES	Optional
Area of land and sea protected by statutory designations	Sea or land area protected by statuary designations (eco-label certifications, blue flags ..)	(m^2 or %)	Biodiversity and Natural Resources Management	EN_6	YES	Optional
Area of built-up land	Covered area	m^2	Land Use	EN_7	NO	Core
Forested land area	Contribution of the project to the increase of forested land areas	m^2	Land Use	EN_8	NO	Optional
Green buildings	Implementation/application/use of green technologies	Qualitative evaluation	Energy & Climate Change	EN_9	NO	Core
Energy consumption	Estimate of energy consumption of the tourist facility	Tonnes of oil equivalent (TOE)	Energy & Climate Change	EN_{10}	NO	Core
Greenhouse gas emissions	Estimate of GHG emissions for each investment alternative	Co^2 tonnes	Energy & Climate Change	EN_{11}	NO	Core
Share of renewable energies	% of energy deriving from renewable sources	%	Energy & Climate Change	EN_{12}	NO	Core
Waste production	Quantity of waste produced in a year (even on the beach)	Tonnes/year	Waste Management	EN_{13}	NO	Core
Waste disposal method	Volume or percentage of recycled waste (also evaluating the presence of any waste treatment systems in the tourist facility)	(m^3, %)	Waste Management	EN_{14}	NO	Core
Quality of water for human consumption	Presence of water treated and compliant with international standards	Yes / NO, qualitative evaluation	Water Resources and Pollution	EN_{15}	NO	Core

Annual water consumption	Volume of water consumed per year	(m^3/year)	Water Resources and Pollution	EN_{16}	NO	Core
Water reused	% of reused water	%	Water Resources and Pollution	EN_{17}	NO	Core
Tourism intensity (related to locals)		No.	Tourism	S_1	YES	Core
Local satisfaction level with tourism	Acceptance of the insertion in the territory of the structure in question by the locals	Questionnaires	Local and Cultural Identity	S_2	YES	Core
Level of satisfaction by visitors	Appreciation of the facility under consideration by tourists	Questionnaires	Sustaining tourist satisfaction	S_3	YES	Core

Table 3. Description and classification of the 23 selected indicators.

Indicator	Dimension	Absolute Frequency	Importance based on accessibility data	Quantification capacity
Employment by sector	EC_1	9	5	Quantitative
Economic performance	EC_2	8	4	Quantitative
Tourism intensity (in absolute terms)	EC_3	6	5	Quantitative
Tourism density	EN_1	7	5	Quantitative
Transport usage	EN_2	5	4	Quantitative
Degree of accessibility in island territories and in territory initiative	EN_3	3	7	Quantitative
Coastal erosion	EN_4	5	6	Quantitative
Marine habitats and species that have been identified as priorities for conservation	EN_5	5	6	Quantitative
Area of land and sea protected by statutory designations	EN_6	10	7	Quantitative
Area of built-up land	EN_7	3	7	Quantitative
Forested land area	EN_8	5	6	Quantitative
Green buildings	EN_9	3	6	Qualitative
Energy consumption	EN_{10}	10	4	Quantitative
Greenhouse gas emissions	EN_{11}	9	4	Quantitative
Share of renewable energies	EN_{12}	10	4	Quantitative
Waste production	EN_{13}	7	4	Quantitative
Waste disposal method	EN_{14}	8	4	Quantitative
Quality of water for human consumption	EN_{15}	5	7	Qualitative
Annual water consumption	EN_{16}	10	4	Quantitative
Water reused	EN_{17}	9	4	Quantitative
Tourism intensity (related to locals)	S_1	6	5	Quantitative
Local satisfaction level with tourism	S_2	9	2	Qualitative
Level of satisfaction by visitors	S_3	6	2	Qualitative

Table 4. Data for the assessment of the three evaluation criteria.

Indicator	Dimension	$w_{1(i)}$	$w_{2(i)}$	$w_{3(i)}$	$w_{f(i)}$	Rank	$w_{1D(i)}$	$w_{2D(i)}$	$w_{3D(i)}$	$w_{fD(i)}$	$Rank_{(D)}$

Employment by sector	EC_1	5.70%	3.79%	5.04%	4.84%	4	39.13%	33.30%	40.00%	37.48%	1
Economic performance	EC_2	5.06%	2.22%	5.04%	4.11%	10	34.78%	33.30%	20.00%	29.36%	3
Tourism Intensity (in absolute terms)	EC3	3.80%	3.79%	5.04%	4.21%	9	26.09%	33.30%	40.00%	33.13%	2
Tourism Density	EN_1	3.80%	3.79%	5.04%	4.21%	9	6.14%	6.40%	4.40%	5.65%	7
Transport usage	EN_2	4.43%	2.22%	5.04%	3.90%	11	4.39%	6.40%	2.60%	4.46%	11
Degree of accessibility in island territories and in territory of the initiative	EN_3	3.16%	9.57%	5.04%	5.92%	2	2.63%	6.40%	11.60%	6.88%	2
Coastal erosion	EN_4	1.90%	6.13%	5.04%	4.36%	7	4.39%	6.40%	7.10%	5.96%	5
Marine habitats and species that have been identified as priorities for conservation	EN_5	3.16%	6.13%	5.04%	4.78%	5	4.39%	6.40%	7.10%	5.96%	5
Area of land and sea protected by statutory designations	EN_6	3.16%	9.57%	5.04%	5.92%	2	8.77%	6.40%	11.60%	8.92%	1
Area of built-up land	EN_7	6.33%	9.57%	5.04%	6.98%	1	2.63%	6.10%	11.60%	6.78%	3
Forested land area	EN_8	1.90%	6.13%	5.04%	4.36%	7	4.39%	6.40%	7.10%	5.96%	5
Green buildings	EN_9	3.16%	6.13%	1.68%	3.66%	12	2.63%	2.20%	7.10%	3.98%	12
Energy consumption	EN_{10}	1.90%	2.22%	5.04%	3.05%	14	8.77%	6.40%	2.60%	5.92%	6
Greenhouse gas emissions	EN_{11}	6.33%	2.22%	5.04%	4.53%	6	7.89%	6.40%	2.60%	5.63%	8
Share of renewable energies	EN_{12}	5.70%	2.22%	5.04%	4.32%	8	8.77%	6.40%	2.60%	5.92%	6
Waste production	EN_{13}	6.33%	2.22%	5.04%	4.53%	6	6.14%	6.40%	2.60%	5.05%	10
Waste disposal method	EN_{14}	4.43%	2.22%	5.04%	3.90%	12	7.02%	6.40%	2.60%	5.34%	9
Quality of water for human consumption	EN_{15}	5.06%	9.57%	1.68%	5.44%	3	4.39%	2.20%	11.60%	6.06%	4
Annual water consumption	EN_{16}	3.16%	2.22%	5.04%	3.47%	13	8.77%	6.40%	2.60%	5.92%	6
Water reused	EN_{17}	6.33%	2.22%	5.04%	4.53%	6	7.89%	6.40%	2.60%	5.63%	8
Tourism intensity (related to locals)	S_1	5.70%	3.79%	2.62%	4.03%	11	28.57%	60.00%	66.70%	51.76%	1
Local satisfaction level with tourism	S_2	5.70%	1.03%	1.68%	2.80%	15	42.86%	20.00%	16.70%	26.52%	2
Level of satisfaction by visitors	S_3	3.80%	1.03%	1.68%	2.17%	16	28.57%	20.00%	16.70%	21.76%	3

Table 5. Ranking of the indicators.