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Research article

Perceived crowding and physical distance rules: a national account perspective

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Abstract: Policies concerning the sustainable tourism are fundamentally addressed to the environmental protection and to minimize the anthropogenic impact when exploiting beaches, archeological sites and other tourist attractions. In this paper, we propose a subjective measure, namely the Perceived factor, in order to take into account the more general dimension of the social factor in the assessment of the Tourism Carrying Capacity (TCC) measures. The analysis evaluates the employment impact of the perceived crowding by using data resulting from a survey conducted in the Asinara National Park. In this respect, a macroeconomic analysis is presented by using a SAM scheme developed at a local level, based on four municipalities representing a potential gravitational area of tourists visiting the Asinara National Park. Afterward, a SAM-based model combined with the sustainability measures is proposed to compute the employment loss due to the Perceived factor.

Keywords: tourism impacts; pandemic studies; environmental sustainability; Social Accounting Matrix; regional studies

JEL Codes: R11, D57, Z32

1. Introduction

Policies concerning the sustainable tourism are fundamentally addressed to the environmental protection and to minimize the anthropogenic impact when exploiting beaches, archeological sites and other tourist attractions. During the ’80s, studies on the Tourism Carrying Capacity (TCC) have been widely proposed as a solution to this type of issues. Later on, Cifuentes et al. (1999) introduced a correction factor as a dimension of the Real Carrying Capacity (RCC) in order to take into account the number of the visitors and the groups size. It was a step towards a quantitative assessment of the quality of the visit, considering that in previous works only a qualitative appraisal, survey based, was presented.

More recently, Needham et al. (2008) proposed a complete set of social carrying capacity indicators* In particular they used the concepts of reported encounters, perceived crowding and norms, in order to estimate standards of quality for social carrying capacity indicators. The reported encounters, in the outdoor recreation, is a subjective count of the number of other visitors that an individual remembers seeing in a given location while the perceived crowding is defined as "a subjective negative evaluation that the number of reported encounters or people observed is excessive" (Vaske and Shelby, 2008). However, these two concepts are not immediately translated into responses as to provide concrete solutions for a sustainable and efficient management as they are subjective measures. An approach for addressing this issue and understanding people's behavior is offered by norms, that individuals use for evaluating activities, environments, or management strategies; as in Needham et al. (2014): "Recreationists who encounter more people than their normative tolerance for seeing others usually feel more crowded than those encountering fewer than their norm."

In the same research strand, Silva and Ferreira (2013) developed the concept of Crowding Effect, which represents the degree of congestion, as to explain an inverse relation between the excessive usage of a specific beach and the quality usage from the user's point of view. When measuring the crowding effect, the congestion degree and the visitor density on the beach, different approaches are considered as to verify ex-post the convergence of the resulting indicators. For instance, Marzetti and Mosetti (2004) in accordance with De Ruyck et al. (1997), in order to calculate the visitor density on the beach, suggested to: i) carrying out a survey by questionnaire on the most crowded days of the year in order to obtain information about visitors' perception of crowding on the beach at the survey time; ii) obtaining the number of visitors on the beach in the most crowded days of the year, based on photographs taken on certain days (see also O'Reilly (1986)).

A further extension for this type of evaluation is represented by the usage of big data. Such data collection on reported encounters would guarantee a direct measurement of the real time crowding where the distance between such measure and the results of a survey would give us further elements to quantify the crowding perception, by means for example of beach sensors or aerial imaging and mapping.

In the aftermath of a pandemic, this topic is relevant as allows to distinguish among the subjective perception and the norm translating this evaluation (see also the recommendations proposed by Milanes et al. (2021)). Adopting the dimension of the perceived crowding allows moving into the psychological dimension of safe tourism, a kind of tourism in which the visitor feels safe during the stay.

This study evaluates the employment impact of the crowding perception by using data resulting from a survey conducted in the Asinara National Park, whose results are presented in Corbau et al. (2019) and in Carboni (2018).† Studies on sustainable tourism policies must be local based and adapted to specific areas, taking into account the dimensions evaluated at local level. This proposal is the subject of section 2. Section 3 is then dedicated to the implementation of a National Accounting scheme, useful to design sustainable policies at local level and to the Social Accounting Matrix (SAM)-based model while in section 4 the employment results derived by the adjusted TCC indices are provided. Finally, conclusion are outlined in section 5.

* For other studies related to the Social Carrying Capacity see for instance Marzetti and Mosetti (2004) and Gonson et al. (2018).
† Studies related to the economic assessment of tourism development can be found in Oh (2005) and more recently in Qiu et al. (2019).

2. Sustainable tourism policies during the pandemic

In the late '90s, Cifuentes et al. (1999) refined the TCC approach developed in Cifuentes (1992). The improvements mainly concerned the visitors' perception of a tourist attraction in order to guarantee a visit experience as satisfying as possible. The main novelty was the introduction of a Social Factor within the correction factors, related to the visitors' perception and determined by elements that are conditioned by a certain degree of subjectivity. The perception of the user becomes fundamental for the determination of the TCC; through this factor it can be defined an acceptable space of social limits, considering not only the size of the area but also the privacy, the personal space and the on-site characteristics (Silva and Ferreira, 2013).

To this end, Carboni (2018) proposed a survey (746 questionnaires in the period from July to September 2017), which had as main object to investigate the visitors' satisfaction degree of the Asinara National Park, concerning the environmental quality, the perception of the landscape, the services offered and the perceived level of crowding of the beaches. The information gathered was extremely useful as to determine the quality of the visit, to estimate the unmet needs and the services considered lacking. Moreover, they allow to obtain valuable suggestions for optimizing tourism planning and policies.

In the section of the questionnaire "Perception and evaluation of the visit", the visitor's preferences are investigated regarding the appreciation of the environmental quality, the degree of importance related to the environment and the perceived crowding level. In order to assess the level of anthropogenic presence and the related perception, visitors were asked to answer through the use of pictures, as to concretely verify their crowding perception. Based on their own experience, visitors expressed preferences on the crowding of the Park's beaches. From the sample examined only 2% indicated a high crowding perception, the 20% considered an average crowding level; consequently the 78% perceived low or zero crowding level from the shown pictures.

The results of the aforementioned survey, based on the association between the pictures with different level of crowding and the answers provided in the questionnaires, were used to transform the subjective measure of the crowding perception into a new correction factor of the carrying capacity.

Equation 1 shows a normalized measure related to the Perceived crowding (**Pc**), then translated into an access propensity to the beach (**c**) in Table 1 and finally associated to an available area as a Perceived factor (**Pf**) in Table 2.

$$\mathbf{c = 1 - Pc} \tag{1}$$

When for example, **Pc** is equal to 0.02, the 2% of the sample considers a high crowding of the beach, by using this information we estimates an average propensity to access the beach as follows:

Table 1. Perceived crowding, average propensity and Perceived factor of the beach.

Response item	**Pc**	**c**	**Pf**
High	0.02	0.98	0.98
Medium	0.2	0.8	0.8
Low	0.42	0.58	*0.61*
Null	0.36	0.64	*0.61*

Source: Own elaboration

This also means that when **c** is equal to 0.98, the 98% the people interviewed not considers a high level of crowding and for this reason decides to access the beach. We then summarize the low or no crowding perception with an average value and in the last column we report the Perceived factors, used to adjust the carrying capacity (see also Garau et al. (2021)). Afterward, we associate each **Pc** value to an available area, as follows:

Table 2. Perceived factor and Available area.

Response item	**Pf**	Available area (m^2)
High	0.98	8
Medium	0.80	6
Low or Null	0.61	4

Source: Own elaboration

Our measure is conceived in order to provide a specific correction factor for RCC and ECC, depending on the available area per visitor in the pocket beach of Cala dei Ponzesi. Table 3 resumes the adjusted carrying capacities when taking into account the crowding perception, in this way, the new indices compute the potential reduction of encounters per season. The content of the Table 3 is the following: A = Available area for tourist use; Au = Area required per tourist; Rf = Rotation factor corresponding to the number of visits per day; PCC = Physical carrying capacity; Cf = Correction factor, RCC = Real carrying capacity, Mc = Management capacity; ECC = Effective carrying capacity.

Table 3. Adjusted carrying capacities with the crowding perception factor, seasonal results.

$A(m^2)$	$Au(m^2)$	Rotation factor	PCC	Correction factor	RCC	Management capacity	ECC	Perceived factor	RCC adjusted	ECC adjusted	Δ RCC	Δ ECC
916	8	3	41,907	0.69	29,240	0.43	12,573	0.98	28,655	12,322	−585	−251
		4	55,876		38,987		16,764		38,207	16,429	−780	−335
	6	3	55,876		38,987		16,764	0.80	31,190	13,411	−7,797	−3,353
		4	74,501		51,983		22,353		41,586	17,882	−10,397	−4,471
	4	3	83,814		58,481		25,147	0.61	35,673	15,340	−22,808	−9,807
		4	111,752		77,974		33,529		47,564	20,453	−30,410	−13,076

Source: Carboni (2018) and own elaboration

When looking at an available area of $8m^2$ per visitor and a rotation factor of 3, only slight decreases are observed in the RCC and ECC adjusted, after applying the related Perceived factor; while when the available area required per tourist is reduced to $4m^2$, Δ RCC and Δ ECC decrease dramatically, passing from 58,481 to 35,673 visitors in the first case, and from 25,147 to 15,340 visitors, in the latter.

3. The national accounts perspective

The aim of this section is to propose an accounting framework and a related modeling approach in order to assess the employment impact of the sustainability measures related to the TCC and the perceived crowding. In this respect, a macroeconomic analysis is presented by using a SAM scheme developed at a local level[‡], based on four municipalities representing a potential gravitational area of tourists visiting the Asinara National Park. The accounting scheme presented in this study includes an

[‡] A previous study related to the construction of a SAM for Sardinia can be found in Ferrari et al. (2009).

additional advantage by including more blocks than those normally considered in an Input-output(I-O) framework and, moreover, is built at the municipal level. This makes the Local Social Accounting Matrix (LSAM) an important and rare tool when considering that only recently national statistical offices has started to publish national accounting matrices, while there are currently very few official statistics that offer the same detailed information at the regional level.

This framework is an adaptable tool that presents transactions able to identify interdependencies among Activities, Primary factors and Institutional sectors, being therefore supporting modeling in the task of measuring the employment impact on specific sectors. Moreover, this framework assesses not only the impacts on the main economic variables (as for instance, GDP and output), but it is also able to capture the income distribution variation among the Institutional sectors.

3.1. The LSAM-based Model

The macro-economic analysis is based on the input-output theory established by Leontief (1951), the system of national accounts (SNA) by Stone (1961) and the extended Input-Output model proposed by Miyazawa (1976) and further developed by Pyatt and Round (1979).

By proposing the SAM/SNA framework as a reference scheme, the analysis also considers along with the direct and indirect effects, the induced ones, by taking into account the block of the primary and secondary distribution. The results of the static model will be expressed in terms of employment generated by industry.

As this local framework keep separated commodities and industries, the content of the **S** matrix is introduced as follows:

$$\mathbf{S} = \begin{bmatrix} \mathbf{0} & \mathbf{D} & \mathbf{0} & \mathbf{C} \\ \mathbf{B} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \mathbf{V} & \mathbf{0} & \mathbf{T} \\ \mathbf{0} & \mathbf{0} & \mathbf{Y} & \mathbf{H} \end{bmatrix} \tag{2}$$

where **D** and **B** are, respectively, the use technical coefficients matrix and the share matrix, **C** is the matrix of endogenous final expenditure coefficients, **V** and **T** represent the matrix of endogenous value-added and net taxes on products input shares, **Y** is the matrix of endogenous coefficients distributing income to value-added categories and **H** is the matrix of endogenous coefficients for distributing institution and household income.

We also define the vector $\bar{\mathbf{x}}$ as:

$$\bar{\mathbf{x}} = \begin{bmatrix} \mathbf{q} \\ \mathbf{x} \\ \mathbf{v} \\ \mathbf{y} \end{bmatrix} \tag{3}$$

where **q** is the vector of total sector outputs by commodity, **x** is the vector of total sector outputs by industry, **v** is the vector of total value-added inputs, and **y** is the vector of total household income.

Following Miller and Blair (2009) the main equation of the SAM-based model is:

$$\bar{\mathbf{x}} = \mathbf{S}\bar{\mathbf{x}} + \bar{\mathbf{f}} \tag{4}$$

where

$$\bar{\mathbf{f}} = \begin{bmatrix} \mathbf{f} \\ \mathbf{0} \\ \mathbf{w} \\ \mathbf{h} \end{bmatrix} \tag{5}$$

and **f** is the vector of exogenous demand by commodity, **w** is the vector of value-added inputs and **h** is the vector of household income categories, that are exogenously specified.

Round (1988) observed that most often in construction of SAMs used for modeling, and in particular when calculating the multipliers, the Government, Capital, and "Rest of World" accounts are considered to be exogenous; in our case only Capital and "Rest of Italy and Rest of World" accounts are exogenous specify.

Alternatively, Equation 4, can be express in its reduced form, as follows:

$$\bar{\mathbf{x}} = [\mathbf{I} - \mathbf{S}]^{-1}\bar{\mathbf{f}} \tag{6}$$

Solving the model for the employment, after having defined the vector of employment-to-output ratio, **e**, we finally get:

$$\mathbf{e}\bar{\mathbf{x}} = \mathbf{e}[\mathbf{I} - \mathbf{S}]^{-1}\bar{\mathbf{f}} \tag{7}$$

3.2. The LSAM framework

This section illustrates sources, techniques and estimates used for building the 2014 local accounting scheme at basic prices.[§] The framework refers to four municipalities in the area of interest: Sassari, Alghero, Porto Torres and Stintino (hereinafter referred to as SAPS). The construction of LSAM required gathering all the available information at the municipal level, as the one presented in the ISTAT dataset "Local units and employees" and in the regional statistics, referring to the annual accounts and final balance-sheets of local authorities.

By using as starting point the 2014 SAM of Sardinia (as in Garau et al. (2021)) and local specific dataset (e.g. the number of employees at sectoral level), the regional coefficients have been down-scaled in order to obtain an estimation of both the Supply and Use tables. The number of employees by industry provided a structure of the output by industry. Once the output vector has been estimated, the Supply table is obtained as well as the output by product. At this stage, having the information of both the output by industry and by product, the construction of the Use table along with the block of the value added and the net taxes on products vector, is computed. The information provided by these two blocks allows to obtain an estimation of the municipal GDP. The imports vector is then obtained as a residual, from the difference between final demand and gross value added.

The structure of the regional SAM also provided an estimation of the allocation of primary income (differentiating between value added and net taxes on products) by institutional sector, including the rest of Italy and of World, as well as an estimate of the component of the value added generated by cross border workers that reside in the four municipalities.

Following the same approach also the secondary income distribution and the use of disposable income account have been estimated. In this way, we assumed that the local structure of the current transfers among institutional sectors is the same of the regional one.

[§] Please note that the content of the matrix **S** is derived from the figures presented in more details in Table 4.

The gross savings account were scaled on the basis of the capital formation aggregate, which includes fixed investment, change in inventories and in valuables and the regional gross savings, and later calibrated by institutional sector redistributing the balance between total row and column. Finally, the current external balance has been obtained as a residual.

The accounting framework built for the four municipalities, provides a basic structure that includes: 54 Commodities; 37 Industries; 3 components of Value added (Compensation of employees, Gross Operating Surplus and Other net taxes on production); the vector of Net taxes on products; 6 Institutional sectors (Non-financial corporations, Financial corporations, Government, Households, Non-profit institutions serving households (NPISHs)); 2 components of the capital formation (Gross fixed investments and Change in inventories and in valuables); Rest of Italy and the Rest of World.

Table 4. Aggregated framework of the LSAM, in million euro.

	Commodities	Industries	Value added	Taxes less Subsidies	Institutional Sectors	Capital Formation	Rest of Italy and of World	Total
Commodities		5,323			3,198	792	4,612	**13,925**
Industries	9,401							**9,401**
Value added		3,979					14	**3,993**
Taxes less Subsidies		99			318	34	1	**452**
Institutional Sectors			3,994	447	3,889		180	**8,510**
Capital Formation					861		−35	**826**
Rest of Italy and of World	4,524		−1	5	244			**4,772**
Total	**13,925**	**9,401**	**3,993**	**452**	**8,510**	**826**	**4,772**	

Source: Own elaboration

Table 4 displays the main aggregates by block: output by product and by industry, primary factors, institutional sectors, gross capital formation, Rest of Italy and Rest of World. The first column shows the total amount of goods and services at basic prices distinguishing between the domestic output (9, 401), (that determines **B**), and the imports of goods and services (4, 524). The second column provides the total output by industry given by the flows of intermediate goods required by industries during the production process (5, 323), (that determines **D**), the value added at basic prices (3, 979) and the net taxes on products (99) , (that determine **V**). Third column represents the primary "municipal" income generated by the workers residing in the municipalities that along with the income generated outside the considered area, together with the net taxes on products (in the forth column), contribute to defining the primary distribution of income and constitutes the gross "municipal" income (4, 445), (that determines **Y**).

Consumption expenditure on final goods by institutional sectors (3, 198), (that determines, partially, **C**), and their counterpart of taxes on the products less subsidies (318), (that determines, partially, **T**), are listed in column five, as well as the current and capital transfers between Institutional sectors (3, 889) , (that determines **H**), including the Rest of Italy and Rest of World (244), in the secondary distribution of income, and the gross savings by Institutional sectors (861).

Column six concerns the final demand regarding the Gross Capital Formation, which includes gross fixed investment and changes in inventories and in valuables (792), (that determines, partially, **C**), and their counterpart of net taxes on products (34), (that determines, partially, **T**).

Finally the seventh column displays the exports to the Rest of Italy and Rest of World (4, 612) and their counterpart of net taxes on products (1), the primary income generated by the workers residing in the municipalities but generated outside the considered area (14); all the current and capital transfers between Institutional sectors from the Rest of Italy and the Rest of World (180) and the current external balance (−35).

4. Physical distance rules scenarios

In section 2, we observed how the perception measure can be translated into an indicator, starting from a survey, that can be strictly related to a physical distance concept. In this paragraph we intend to discuss how this factor can be furthermore implemented into a modeling framework and, finally, being of key importance to generate scenarios. We associate an expenditure function to an available area per tourist, in the reference beach (Cala dei Ponzesi), as to link the sustainability concept to an economic variable, by taking into account also the **Pf**. This expenditure is translated into a final demand shock, through the use of a tourism expenditure vector (provided by ISTAT, see for more details Perez (2012)) and combined with an average daily expenditure value per visitor in Sardinia (data provided by Sardegna Statistiche (2018)). Afterward, the economic impact in terms of total output induced by visitors gravitating in the area (SAPS) can be computed as to obtain results in terms of employment loss. In a nutshell, we provide an employment impact assessment of the sustainable use of natural resources. The employment impacts in percentage variation are now reported, as a result of the SAM-based model.

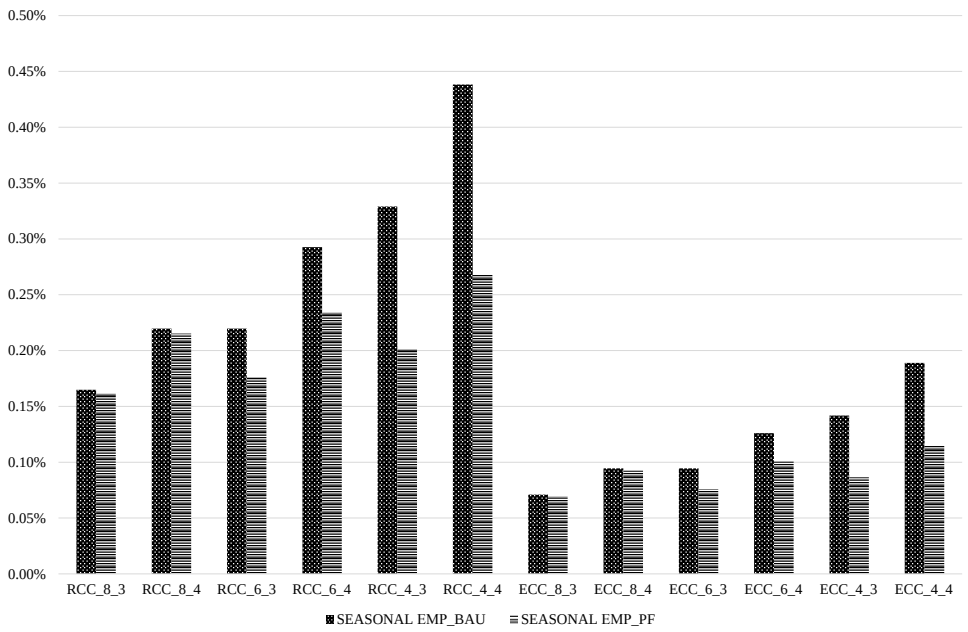

Figure 1. Employment change per TCC - in percentage variation (%), two scenarios.
Source: Own elaboration.

Figure 1 compares two scenarios: the first (defined as business as usual (BAU)) considers the employment variation when dealing only with the correction factors and the latter comprises a further dimension related to the Perceived factor. When the available area becomes smaller, the beach is perceived as more crowded and the **Pf** increases, this leads to a greater reduction of the employment impact. The same rationale stays for the ECC.

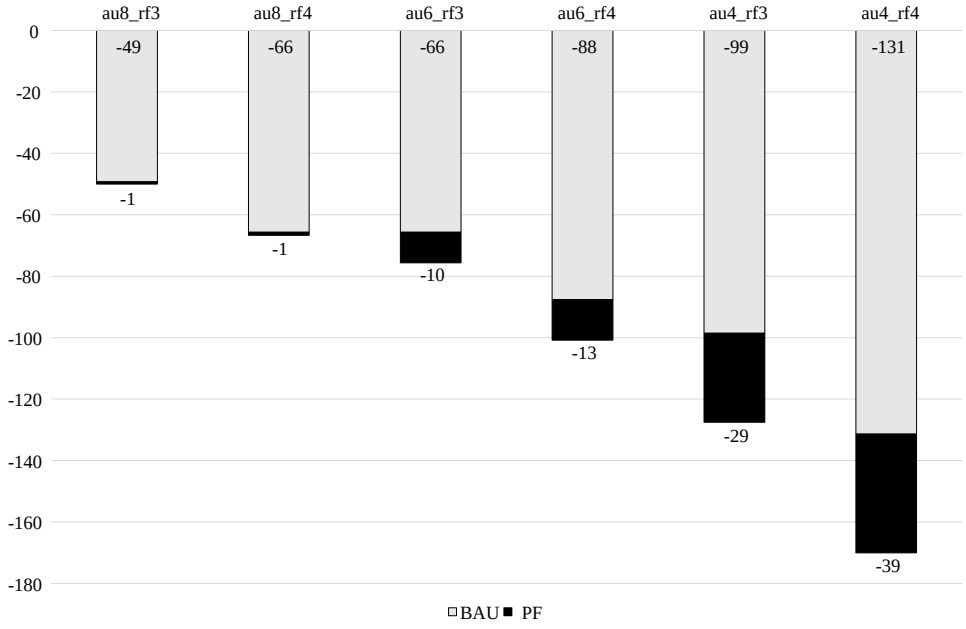

Figure 2. Employment loss (person) determined by the Perceived factor.
Source: Own elaboration.

Figure 2 displays the employment loss (person) associated to the distance between the ECC and an optimal management capacity, i.e. RCC, when considering and not considering the **Pf**. When **Pf** is at its maximum value (corresponding to an available area of $8m^2$) the employment loss is almost marginal (-50, when the *Rf* is 3 and -67, when the *Rf* is 4), while when **Pf** is at the minimum value (corresponding to an available area of $4m^2$) the employment loss is relevant. At this stage, the employment loss is determined by two main factors: the management capacity and the crowding perception. For instance, in the latter case, when the rotation factor is equal to 4, the overall loss is 170 employees, of which 131 due to a suboptimal management capacity and 39 related to the crowding perception.

The policymaker dilemma regarding a sustainable planning, that takes into account the tourist perception, will be easily solved: as the available area is a natural constraint, the only viable solution is improving the management capacity and the coastal planning efficiency. When the beach has a more important naturalistic value (as in the case of a pocket beach like Cala dei Ponzesi) visitors could accept a greater crowding if compensated by better services. Thus, even if the perception factor is lower, an optimal management allow to host more visitors by reducing the distance between RCC and ECC.

5. Conclusions

The National Park of Asinara island has recorded over the years an increasing trend of tourist demand and recreational users that can be in principle divided into “individuals” and “groups” users. This has led to some issues in the visitors management and in the proper use of the on-site characteristics, such as the need for a consistent rationalization process concerning the number of accesses and its regulation, the environmental protection from exploitation, as well as the planning of a process for a “socially shared fruition” (Carboni et al. (2015); Corbau et al. (2019)).

In this study, we propose a subjective measure, the so-called Perceived factor, in order to take into account the more general dimension of the social factor in the assessment of the Tourism Carrying Capacity (TCC) measures. The **Pf** is related to qualitative aspects of the visit. The visitors perception and the quality of the visit is given by different elements that can change in relation to the on-site characteristics, and it is also conditioned by a certain subjectivity, since each individual has a different perception. However, this factor is a fundamental component when visiting protected areas or tourist attractions, as it can significantly influence the tourism and economic development of the site.

In order to evaluate the **Pf**, the questionnaire was focused on visit satisfaction level, related to the management capacity and other natural and environmental aspects. The results of the survey were then analysed to understand which is the satisfaction level of the recreational users and what did not work in their experience, as to propose corrective actions and improve the overall quality of the visit (Corbau et al., 2019).

Table 3 shows the relevance of the **Pf** in affecting the TCC measures, especially when the visitors flow increases and the overcrowding of the beaches is more perceived. In fact, while the first two correction factors (those that allow to pass from PCC to the RCC and from RCC to the ECC) are not affected by the rotation factor or by the available area required per tourist, the Perceived factor considers both of them and it is more relevant when the available area is smaller. The result of the scenarios shows that when applying this factor, the capacity of the beach to accommodate visitors is further reduced by a maximum value of 39%.

It is important to observe that the ECC values can be corrected according to the related management capacity. Certainly, there are elements such as the quality of the beach management, the existence or lack of parking and beach services, which have a major role in creating this reduction and can therefore be adequately counteracted. The overcoming of this critical issue would increase the number of people that can visit the beach until the ECC becomes equal, or almost equal, to the RCC.

Among all the factors that determine a quality level of the visit, it is now important to consider those related to the health security and to the psychological effects on the visitors in the aftermath of a pandemic. At this purpose, the concept of the **Pf**, intended also as a sub-dimension of ECC, can be extended in order to determine the available area able to accomplish the physical distance rules. This approach can be used as to strengthen the idea that an optimal sustainable management is needed as to promote the concept of a *safe* sustainable tourism, respectful of the environment and health. The pandemic has in fact boosted specific trends for a sustainable tourism able to inspire health security.

Furthermore, the results of the study show that despite the small size of Cala dei Ponzesi, one of the most visited beaches of the Asinara island (Corbau et al., 2019), the crowding would not be perceived as a risk factor when the available area is $8m^2$, and therefore the visitors would feel *safe* even in times of COVID-19.

The pandemic and the related distance rules have made more evident the need of a rationalised fruition of tourist attractions strictly related to health security requirements. However, since these elements have become essential, it is inevitable that the improvement of the overall management capacity together with the coastal planning, can become the main lever for a sustainable and safe tourism.

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Conflict of interest

All authors declare no conflicts of interest in this paper.

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