

Ocean and Coastal Management

Carrying capacity as tool for beach economic value assessment (case studies of Italian beaches)

--Manuscript Draft--

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Abstract:	This study developed a new integrated assessment method for sandy beaches, using three recreational Italian beaches as case study, with the purpose of obtaining their economic value. The method was based on a geomorphological assessment of the beaches and a carrying capacity evaluation; an economic analysis through the elicitation of the willingness to pay (WTP); a social assessment of beachgoers' attitude and opinion. For the selected beaches, which differed for typology, location, shape, level of urbanization and tourism, we identified the available surfaces for recreational uses through the observation of satellite images. WTP results indicate that respondents would be willing to pay a contribution from 9 to 15 € per season. WTP is principally positive correlated with some variables like beach frequentation, residence in the localities, available services on the beach. The value of the selected beaches was calculated multiplying the sustainable carrying capacity of each site with their related maximum WTP. It was found that the values of the beaches varied from more than 50 M€/season at a popular urban beach to 1M€/season at a remote natural beach. The comparison of beach valuation and investments made by managers of the beaches show a gap. Therefore, the huge non-market value of these beaches might need decision-makers to guarantee continuous beach restoration measures.
Suggested Reviewers:	Anna Montini anna.montini@unibo.it Anna Montini is Professor in Economics and Lecturer in Environmental Economics. She is a member of the Italian Association of Environmental and Resource Economists. Extensive experience in environmental economics and in the conception, implementation and design of statistical quantitative instruments (surveys and questionnaires). Her main research interests are environmental economics and policy, environmental-economic performance at the geographical/spatial level, tourism-environment relations Allan Williams allan.williams@sm.uwtsd.ac.uk Allan Williams is a full Professor at University of Wales, with a wide range of interests. He has a strong interest in: Management of beaches and the coast, Coastal scenery, Litter, Willingness to pay. He published more than 200 papers on the previously mentioned topics. Michael Getzner

	michael.getzner@tuwien.ac.at Michael Getzner is author of 217 records (2001 - 2019) on: Public Finance Infrastructure Economics and Policy Ecological Economics, Environmental and Resource Economics Regional Economics Energy Economics. He specifically studies WTP approaches for environmental application both on coastal sites and inland sites. Enzo Pranzini enzo.pranzini@unifi.it Enzo Pranzini, Full Professor of the University of Florence and President of the National Group for Coastal Environment Research, is Director of Studi costieri scientific journal. For over 40 years he has been dealing with problems related to erosion and defence of the coasts. On this theme he was responsible for several National and European projects, and for the research in over sixty projects developed by the University of Florence. E.P. is the author of more than 250 scientific publications
Response to Reviewers:	

From PhD. Ilaria Rodella,
University of Padova
via Martiri della libertà,8 -35122- PD (Italy)

Ferrara, 22 January 2020

Dear Editor,

thank you for your mail concerning our manuscript entitled "*Carrying capacity as tool for beach economic value assessment (case studies of Italian beaches)*" by Ilaria Rodella, Fabio Madau, Massimiliano Mazzanti, Corinne Corbau, Donatella Carboni, Umberto Simeoni, Luigi Parente for possible publication in "Ocean and Coastal Management".

The manuscript has been completely revised according to all useful comments provided by the Reviewers.

We accepted the suggested stylistic amendments, reworded sentences that were unclear and had the entire text revised. We accordingly reorganized several parts of the text and provided further clarification to some points of the manuscript, especially in Introduction.

Please find attached a point-by-point response to reviewer's concerns. We hope that you find our responses satisfactory and that the manuscript is now acceptable for publication.

Yours sincerely,

Ilaria Rodella and co-workers

REVISION NOTES

Comments from the editor:

GENERAL COMMENT: I have completed my evaluation of your manuscript. The reviewers recommend reconsideration of your manuscript following minor revision and modification. I invite you to resubmit your manuscript after addressing the comments below. Please resubmit your revised manuscript by Jan 22, 2020.

When revising your manuscript, please consider all issues mentioned in the reviewers' comments carefully: please outline every change made in response to their comments and provide suitable rebuttals for any comments not addressed. Please note that your revised submission may need to be re-reviewed.

REVIEWER #1:

1. In fig.1, a small world map should be added to show the situation of the study area.

According to the reviewer's suggestion, we added a world map and a Europe map to Figure 1

REVIEWER #2:

Carrying capacity as tool for beach economic value assessment (case studies of Italian beaches)

The ms deals with an integral analysis of the carrying capacity of three Italian beaches with different characteristics. The authors made a very detailed a thorough analysis with integral surveys of the beach users.

In my view the article is rather restricted to compare the study to what happens to countries similar to Italy like Spain, but they do not thoroughly compare with similar studies done elsewhere. There may be remarkable differences due to income capacity, local conditions that could be compared before defining a model of carrying capacity.

I fail to see the international appeal of the article. Most of the cites are based in examples from Europe, a couple from Colombia and one from Brazil. There are many other studies, for instance in China, and South America that have followed the same concepts, even published in OCM, but you fail to take them into account.

According to the reviewer's suggestion, we added a more exhaustive and inclusive literature review of international carrying capacity applications, also citing OCM manuscript. In fact, we've cited case studies in Africa (Lucrezi et al., 2016), in China (Liu et al., 2020; Wei et al., 2014; Zheng et al., 2019), in USA (King and McGregor, 2012), in Portugal (Daniel A Zacarias et al., 2011), in Argentina (Huamantincos Cisneros et al., 2016; Revollo Sarmiento, 2012) and others.

(from line 44 to 60) *The definition of the CC of recreational areas has become an essential tool, as it "enables the preservation of the high quality (eco-systemic, ecological, environmental and social quality) and quantity (traducing in beach width and sand amount) of coastal resources*

whilst meeting not only the current needs but also securing long term economic and ecological benefits for future generations” (UNEP/MAP, 1997). In this context, CC assessment is a technique used in beach management, being applied in different ways and in distinct socio-ecological settings. *Moreover, much stress has been placed in the last decades on the importance of strategic beach zoning (both spatial and temporal) (Valdemoro and Jiménez, 2006), which have not yet been implemented over large geographical scales for sandy beaches (Lucrezi et al., 2016), also considering the functional beach width for recreational purposes (Cabezas-Rabadán et al., 2019). Strategic zoning is able to encompass the interspersed of natural and unaffected beach with areas suitable for recreation, thus it is essential both in the case of urban and natural beaches.*

Several techniques were developed to calculate the CC and to individuate the real beach zonation during the summer season. For instance, some studies used on-site information and video processing to provide significant real-time data (Huamantínco Cisneros et al., 2016), also combined with surveys requested to tourists; other studies directly counted the number of users on the beach (King and McGregor, 2012; Pessoa et al., 2013; Polette et al., 2003; Roca et al., 2008); mathematical algorithms were developed for counting and locating people on the beach based on image reprojection and model of occupation of space by users (López-Dóriga et al., 2019; Rsevollo Sarmiento, 2012); other studies used the analysis of satellite images and the application of CC estimation methodologies (Corbau et al., 2019; Ilaria Rodella et al., 2017; D A Zacarias et al., 2011). More comprehensive studies also included a variety of environmental, economic and social indicators for the assessment of the environmental CC of the coastal zones (Liu et al., 2020; Zheng et al., 2019).

Concerning the income capacity, this is not a concept theoretically founded in microeconomics (and macro). In any case, income is a wtp check variable. As far as beach income level, every littoral has a different income level, this is true in general, even if we consider beaches very closed to each other like Lido di Spina (FE) and Cervia (RA). Considering different economic development around the world, a research may compare several country's GDPs before asking a wtp. However, we consider beaches in the same country, because this research mainly aim to develop an integrate tool for the assessment of beach value (and to demonstrate different values for different beach types considering their physical features and users behavioural attitude).

what do you mean by 0 m width?? either you have (so width is > 0 m) or you do not have beach

With 0 m we intended to remark that some stretches of Lido di Venezia are completely eroded. However, we agree with the reviewer's comment and re-wrote the sentence as follow: *“Lido di Venezia is a barrier island 11.8 km long with width reaches up to 200 m (Table 1), with the lowest values in the central part of the barrier island, with gentle beach slope (0.25 % - 0.53 %) (Consorzio Venezia Nuova, 2000).”*

indicate the number of people surveyed. What is the rate of people that were asked to fill the survey vs those that actually did the survey? Another important issue is do you question about the social conditions of the respondents: were the high, middle or low income people. Possible differences in answers can be obtained depending of their income level

The rate of people that actually did the survey was 81% of the complete data set - because the non-answered interviews and the “protest votes” were not considered (Carson, 2012). We described this result and the first and second bid responses from line 246 to 255.

As concerned with the second question, the WTP elicited is inherently related to the individual income, as reported in Table 2. In other terms, we assumed that WTP is a function of individual income and, as a consequence, income represents a structural cap of WTP. Therefore, income is not adopted into the variables in the multinomial CV model because it is inherently included in the model. For this reason, we did not involve individual income in the multi-variated model.

According to the reviewer’s comment, we modified the manuscript as follows:

(lines 59-71) “Table 2 reports the model on the dichotomous choice of this study, based on (Hanemann, 1989, 1984) model. According to the model, individual utility derives from both environmental good characteristics and own income. Micro-economically speaking, this is an indirect utility function that contains income, the theoretical structure by which we can properly define WTP as an economic concept rooted in theory. The indirect utility is derived from the utility maximization of a bundle of goods subject to income constraints. The demand functions depending on income and prices are substituted back to convey a function that is coherent with the elicitation of WTP as an income-related measure. In other terms, it is assumed that WTP, among the others, is a function of individual income and, as a consequence, income represents a structural cap of WTP. Therefore, income is not adopted into the variables in the multinomial CV model because it is inherently included in the model. In that context, the maximum WTP is theoretically and then empirically the monetary distance between utility in the status quo and utility in the enhanced scenario (here the constitution of the fund for improved beach management).”

REVIEWER #3: 1.

1.1. Recommendation

Major Revision

2. Comments to Author:

The manuscript is well written and the subject is really focus in the scope of this journal. The results are quite good and the comparison between the WTP and the carrying capacity of different kind of beaches it is really interesting.

Thank you very much. We appreciate the positive comments and endeavor in our edits to address your concerns. Much of the paper has been reorganized to deal with the important issues that you noted.

2.1. Major comments:

This paper presents a fundamental problem when presenting WTP data in some of the chosen lido. Many of these lidos have private access to the beach and it is necessary to pay in order to enter them (you can go free through the intertidal zone). As you can see in many of them, simply on the internet, it has well-stipulated rates for different services and that would allow to include the real cost per day of many users. In this sense, the

WTP of users of this type of beaches (or sections) is not comparable with those who go to free beaches and much less in the case of Sardinia beach, where payment is not necessary and there are practically no services. It would be interesting to have a clear comparison of the differentiated results according to this type of beach: free or with a balneari establishment.

Thanks for the useful comment. In our study, we applied a WTP analysis in order to assess the user's willingness to pay to preserve the beach. Therefore, we asked users their possible payment to ensure beach conservation. This value is unrelated to the real cost that users paid for services/recreational activities and beach access in the case of private beaches. Therefore, in our opinion, the comparison of wtp and service costs is not useful because of the different purposes of the analysis and economic methods. In fact, our approach aims to obtain an economic value following a sustainable and conservative purpose also according to carrying capacity final aim. On the contrary, the evaluation of services costs is commonly adopted by Travel Cost Method (TCM) and Hedonic Prices (HPs), which follow a recreational use of the coast. However, we compared the wtp with the daily expenses on the beach in order to facilitate the assessment of recreational and environmental behaviors.

In the revised version of our manuscript, we added a detailed description of this aspect both in methods and in discussion sections.

(lines 31-32): "It must be underlined that WTP is not related to other possible payments supported by tourists. In other terms, it represents a specific and possibly additional payment aimed to ensure beach conservation".

(lines 552-593): In fact, CVM and other economic methods like Travel Cost Method (TCM) and Hedonic Prices (HPs) are based on comparability of values (Martinez-Alier et al., 1998), which implies that ecosystem services can be measured by reducing their values to a single monetary unit. However, beaches have many attributes contributing both to ecosystem service and to environmental quality, and some of them may not be easily and/or meaningfully translated into a monetary scale (Ariza et al., 2012). In the absence of other attempts to assess beach value, this study serves as a guide for further research on the topic, but to address the management needs, other value dimensions of beach need to be studied (Stålhammar and Pedersen, 2017), like processes related to beach bio-physical condition (e.g. water- sand pollution, the effect of human changes to the physical condition of the beach), gains and losses of sediments in relation to protection of coastal facilities, ect.. Non-WTP does not necessarily imply that people do not value the beach – they may be valued instead in nonmonetary terms, including underlying intrinsic values concerning the existence, inspiration or aesthetic enjoyment (Chan et al., 2012; Jacobs et al., 2016). These values can be accounted for using nonmonetary valuation techniques, e.g. sociocultural valuation and integrated valuation methods (Gómez-Baggethun et al., 2014), which can be integrated with monetary assessments to achieve sustainable management (Norton et al., 1998).

Secondly, it was not specified in the survey how ecosystem service provided by each beach would change following the better management of the littoral. Survey respondents had to make a decision based on assumptions, which is difficult to do without a certain degree of

familiarity with the ecosystem service concept and appropriate information about possible beach changes (Blomquist and Whitehead, 1998). Therefore, CVM may present problems derived from an absence of preferences on some characteristics of ecosystems (Diamond and Hausman, 1994), even if it takes into account the bequest and option values. Bequest values refer to the value of the satisfaction obtained from preserving a natural environment for future generations. Option values refer to the wtp for retaining an option to use a beach that would be difficult or impossible to replace and for which no close substitute is available (Ariza et al., 2012).

Thirdly, some respondents may feel that it is unethical to place a monetary value on public goods such as wildlife or environmental quality, while others may argue that these goods should be provided “free of charge” (Lindsay et al., 1992; Rodella et al., 2019). In fact, people fail to give value to the use of an ecosystem like a beach although this is important for its preservation, while they are more confident in the evaluation of services and recreational activities, especially in Italy. This aspect derives from the fact that most of the Italian beaches have private access and it is necessary to pay for using their facilities, like sunbeds, umbrellas, equipment, ect. This implies that users believe that they already pay enough for staying at the beach thus they hesitate to find a value for contributing to beach sustainability. Moreover, this attitude is exacerbated by local users, which assume that beach facilities and maintenance must be covered by the payment of local taxes (Rodella et al., 2019a). Nevertheless, our findings could be useful to compare the WTP (seasonal payment) and the daily expense on the beach, in order to evaluate if the users’ environmental behavior is higher than the recreational behavior. Considering the same temporal extension for each value, so the user that stay 1 day at the beach (23,5% at Lido di Venezia, 13,8% at Lidi di Comacchio and 25% at Fiume Santo; Table 5), we can assume that the environmental attitude is higher than the recreational one for Lido di Venezia and Fiume Santo. Indeed, WTPs of both sites are higher than the daily expenses (wtp of 15,53€ and daily expense of 12,29€ at Lido di Venezia; wtp of 11.87€ and daily expense of 4.57€ at Fiume Santo). This result is probably due to the particular cultural and historical value of the Venetian littoral and the environmental and landscape value of Porto Torres-Stintino coast. On the contrary, users of Lidi di Comacchio showed less environmental behavior (wtp of 9.86€ lower than daily expenses 15,32€), probably related to the poor landscape and scenery value of these beaches and their unattractive urbanization (Rodella and Corbau, 2020).

In conclusion, our approach aims to obtain an economic value following a sustainable and conservative purpose also according to carrying capacity final aim. This implies that economic methods like CVM and others focus on the characteristics valued by humans, thus aspects not easily to perceived may be ignored.

On the other hand, in terms of the maintenance costs of the beaches, the investments made by these balneari establishments and the cleaning costs have not been included (or I could not see). On the other hand, investments made on the coast cannot be accounted for those made in the last two years, it has to be done in longer term. For example, the cost of the large amount of jetties and breakwaters that appear distributed in

the central area of the Lido di Venezia (them can be observed in the aerial images) is not even mentioned in the work. It is obviously the it was not a recent investment, but it has to be taken into account.

-Line 713 to 714: Authors did not include as a possible contributor the different business around the tourist activities (hotels, balneari, restaurant, etc...). In my opinion, they have to be important stakeholders

Thanks for the useful comment. Our analysis is solely addressed to elicit the willingness to pay by part of tourists for promoting beach conservation actions. This sensitivity is, according to the question formulated, related to the specific beach where the respondent is, therefore the willingness reflects the actual status of the beach. It means that it represents a way for financing possible or additional actions – with respect to the investments made – aimed to safeguard beach conservation. In this sense, we compared the amount derived from a possible payment by part of tourists with the investments amount recently made by public authorities. We focused attention only to recent investments. We supposed that investments made decades ago have a residual economic value close to zero. Furthermore, a recent – public or private - investment better reflect the needs of the single beach as it stands today or in last year (before the investments), also in terms of conservation (that is the focus of the paper). In this sense, the analysis appears as a cost-opportunity exercise comparing the recent investments made for conservation by part of public and/or private subjects with the willingness to pay today by part of tourists for conserving the beaches. Obviously – as underlined in the manuscript – this analysis would give us an indication and shows evident limits (first of all the possible lack of data concerning the entire volume of investments made).

Furthermore, maximum WTP, as a monetary compensation in exchange of an increase in utility, - in this case enhanced beach conservation- is the welfare economic proxy of the social benefit, the price/value one is attaching to a specific / contingent (variation of a) good. That value is necessary to (i) estimate empirical demand functions for goods which do not provide market prices / behavioral tracks, (ii) provide figures for Cost Benefit Analysis (CBA). In a CBA analysis the estimated total WTP (average WTP*population of reference) minus the costs to produce the change (beach conservation here) convey a net benefit or cost figure. Having said that, the cost figures one has to compare to WTP in a CVM study are those linked to the analysed 'project'. In the case we consider, other costs (beach fees, etc..) are not relevant to analyse the welfare change under analysis. Other costs may be used in the overall assessment of the beach financial value in the status quo, but not for the examination of proposed changes.

Taken into account these considerations, we've modified the manuscript from line 644 to 654.

Finally, the carrying capacity data is only used to calculate the possible benefits that can be reported based on the number of users, but it is not analysed if it corresponds to the number of users that really exist. In this sense it is also missing in the discussion that part of the dry beach is not used during the summer due to the excessive heat that usually exists in the Mediterranean area.

A simple way to calculate the aggregate benefit of beach resource protection is to multiply the estimated WTP per trip or per person resulted from the DB model. This estimation is commonly applied in economic estimation of benefit using WTP approach (Piriapada and Wang, 2014; Saengsupavanich, 2019;

Saengsupavanich et al., 2008). The answer about the comparison of CC with the real data of user on a beach is reported below.

(lines 474-486) *Concerning the available surfaces identified in the satellite images and the relative beach zonations, some consideration could be taken into consideration. First of all, the dimensions of each area depend on the actual beach width, and in case of administrative concession of a part of the beach ("Bagno" or "Lido" in Italy) the spatial distribution of users across the beach is almost uniform, and with the exception of very wide beaches, the entire subaerial beach surface is exploited (I. Rodella et al., 2017a; Valdemoro and Jiménez, 2006). Secondly, in relatively wide beaches the safe zone, which acts as a buffer area between the resting zone and the service zone, is presented. Similar zoning has been adopted by (Polette et al., 2003) in a carrying capacity analysis on Brazilian beaches. Thirdly, on the Mediterranean coast, resting area is usually restricted to 20-25 meters (Valdemoro and Jiménez, 2006) closer to the waterline due to the hot on the rest of the beach. Users justify this behavior by citing the fact that sand gets very hot on sunny days, and walking across large areas of the beach is uncomfortable. In view of these considerations, we can consider our CC estimation as the maximum number of users that can stay at a beach. This number has been reduced with the application of the corrective factors (Error! Reference source not found.). Corrective factors were used to obtain the RCC acting on the...*

2.2. Minor comments:

Study site

-Line 99: Authors do not show data about the size of beach in 2010, they have to show more recent data.

According to reviewer's suggestion we add more recent data about beach size and erosion, from line 131 to 134.

-Line 109: the assumption about the cause of erosion is not supported by any cite.

According to reviewer's suggestion, we add some useful references like Aguzzi et al. (2016) and Armaroli et al., (2012).

-Line 113: when authors speak about lake I supposed they referred to the lagoon.

Done, we avoid the mistake.

-There is not any data of range of tides or medium wave energy. Also, it could be interesting climate information (temperature, wind, precipitation).

According to reviewer's suggestion, we add some climate information for each site:

Lido di Venezia:

Lido di Comacchio: The average annual temperature in Lido di Comacchio is 13.4 °C for the period 1991-2015. During the summer season (June-September) temperatures vary from 19.9 to 23.1 °C. The average annual rainfall is 661 mm. (Arpa

Emilia Romagna, 2018a). The area is microtidal with a range between 80 and 90 cm (spring tides) and 30–40 cm (neap tides). The wave climate is of low energy (60% of Hs below 1.0 m; IDROSER, 1996). Storm directions are from E–NE (Bora wind) and SE (Scirocco wind). Armaroli et al. (2012) reported that critical storm thresholds for damages along the coast are: 1) $H_s \geq 2$ m and WL (surge + tide) ≥ 0.7 m for urbanised zones; 2) $H_s \geq 3.3$ and WL (surge + tide) ≥ 0.8 m for natural areas with dunes. Besides, beach erosion is worsened due to a strong human control and exploitation of water courses (Preciso et al., 2012).

Fiume Santo: From a climatic point of view, Asinara island acts as a barrier, reducing the energy of waves originated by the mistral and northeasterly winds by up to 60% and 20%, respectively. Inside the Gulf of Asinara, winds from the west and northwest (270° to 330°, the ponente, and the mistral) and east and northeast (40° to 90°, the levanter and the grecale) were the most frequent and strongest. During winds with intensities lower than 4 m/s, currents are locally tide-driven (min-max tide excursion of 0.1–0.3 m). During strong events, a stable increase in sea level of about 0.2–0.3 m generally occurs, with peaks of 0.4 m throughout the period of storm surges and with wave heights up to 3–4 m (Devoti et al., 2010). The average precipitation value of Porto Torres station for the period 1922–1992 is 511.6 mm, while the mean temperature value is 21° (from June to September the mean temperature ranged from 21° to 23.9°; Sardegna Clima, 2019).

In general, this part has to be more homogenous, for example, Sardinia region it is only a landscape description and very poor in front of Lidi di Venezia

According to reviewer's suggestion we add more information about the Sardinia study site, as reported from line 162 to 189.

Materials and methods

-Line 137: is there any information in the enquire about the place where tourist stay during their holydays?

Unfortunately, we did not ask about the accommodation during the holiday, so this information is not available

-Line 143: what did the author mean with "well-trained" staff?

Data were collected by researchers and PhD students on coastal geomorphology, therefore we decided to indicate the term well-trained staff. In the revised version of the manuscript, we avoid the term.

-Line 147: What kind of statistical analysis were done? This has to be pretty clear in the methodology not only the software tool.

According to the reviewer's suggestion, we add more details about statistical applied analysis from line 16 to 24

-Line 181 to 186 and table 2 are results.

According to the reviewer's suggestion, we moved both lines and Table 2 in the result section

-Line 227: It is not clear how they use the Bing images, also the data of number of users did not appear in results. One idea would be compare this data with the carrying capacity

The comparison of the estimated carrying capacity with the number of users observed in the satellite images was not carried out in this study. This type of analysis is very interesting if the main purpose of the paper is the evaluation of crowding phenomena, as already estimated in a previous study by some authors of this paper (I. Rodella et al., 2017). However, in this study we did not focus on crowding but to the elaboration of an integrate method for beach value assessment. Therefore, carrying capacity was used only as sustainable parameter, even if its value in some cases is very similar to the real number of users on the beach (especially for eroded beaches with restricted active and safe zones). In fact, in coastal stretches characterized by resting zones that occupy almost the entire available surface of the beach, CC is almost equal to the users' reference number (Rodella et al., 2017). Furthermore, the satellite images used in this study did not allow a correct counting of people on the beach due to their resolution.

-Line 239: Where are the Bing aerial photos? One example at list in the figures could be interesting

We used the Microsoft's Bing Map Services. We accessed Bing imagery (aerial photos) in QGIS using GDAL's WMS capability coupled with virtual files and OpenLayers plugin. The reference projection that matches the Maps Made Easy GeoTiff is the EPSG:3857(OTF) corresponding to the coordinate reference system WGS 84/Pseudo Mercator. The maximum magnification is around the 1: 2,500 scale.

We added these information on the manuscript from line 238 to 240. Moreover we add the Bing information on Figure 4, 5 and 6.

-Line 281: (Arpa Veneto, 2018)

Done, we modified the reference

-Line 292 to 300: Methodologies and period used to measure erosion trends are not comparable. At least they must use the same years or periods.

According to the reviewer's suggestion, we adopted only one method for the analysis of shoreline evolution using the available "National coastal webportal" (Italian Ministry of Environment, 2012) for the reference period of 1960-2012

Line 318: Why did authors decide use a reduction of 5%?

This factor represents the maximum area (5%) of presence of waste (considering a buffer of few meters around the waste) observed during field surveys, according to the reduction factor applied by Corbau et al., 2019

Results

-Line 354: Why did authors not ask for the age in Fiume Santo? Is this important?

Unfortunately, there was a material mistake during the survey at Fiume Santo and the age question did not include in the questionnaire

-Line 357: There are two secondary school.

According to reviewer's suggestion, we modify the word with primary school

-Table 5: Last column it is not total it is average

According to reviewer's suggestion, we modify the last column of the table

-Line 374: Which both?

We deleted the mistake

-Figure 3: This figure does not show anything apart from the data explained in the text. It is not important.

According to the reviewer's suggestion, we deleted Figure 3 from the paper

-Line 408-9: It is the table foot.

We avoided the table foot

-Line 418: Ok that in Fiume Santo beach typology is not important but the authors could compare with other results.

Beach typology variable (Free beach = 0 vs Beach establishment = 1) was considered for the multivariate model of Lido di Venezia and Lido di Comacchio, because these stretches of coast effectively encompassed both types of beaches. On the contrary, Fiume Santo is totally categorized as free beach, thus the multivariate regression applying a binary variable did not allow an useful result. Moreover, the use of redundant variables like this for the example of Fiume Santo would affect the statistical significance of all remaining variables.

-Figure 4 and 5 I could not see zones, it is better to change the colours and divide in two figures. In the southern sector there is not zones, why?

We modified all figures using better colors. In the south part of Lido di Venezia the zonation was carried out only in the available surface without included dune areas

-Figure 4 did not show the evolution of the coast. The same for figure 6

We decided to use as shoreline evolution the "National coastal webportal" (Italian Ministry of Environment, 2012) for the reference period of 1960-2012, therefore we deleted the coastal lines from figure 5

-Figure 6 a is not necessary

We deleted the Figure 6 a

-Figures 4, 5 and 6 Which is the source?

Bing aerial photo 2018, DigitalGlobe, Microsoft Corporation. We added this information on each figure

-Line 486: How many years did they use in the analysis of Lido di Venezia?

This information is reported in method section from line 177 to 179: A rain time series of 18 years (2000–2017) recorded by the weather station at Istituto Cavanis by the (Arpa Veneto, 2018) was used to estimate the number of rainy days during the summer period (from June to September) at Lido di Venezia.

- Table 14: Units?

We added the unit into each column (m)

- Line 502: Why did authors decide use 0.95?

This factor represents the maximum area (5%) of presence of waste (considering a buffer of few meters around the waste) observed during field surveys, according to the reduction factor applied by Corbau et al., 2019

- Line 507: using only a 10% of reducing factor for a beach with a closed area due to biological pollution is so low.

We decided to a 10% of reduction because the 100 m area interested by biological water pollution, was not included in the water area in front of Fiume Santo beach. In fact, the polluted area is located at about 2,700 m on the East from the case study area. We added this information at line 451

- Figure 8 a and b showed more or less the same

Figure 8 a and b shows respectively the daily beach values (a) and the seasonal beach values (b) based on ECC1 and ECC2 for the selected case studies. Therefore, the graphs show similar trends with different scale/magnitude. We decided to include this figure because of the high number of tables into the paper.

Discussion

-Line 556: Data about the family income use to be problematic, people use to do not say the real data. Usually some of papers use the academic levels.

In discussion we reported a general description of the users, “ users interviewed had holiday with family, their income was generally low, they judged the beach width and space per person adequate but with bad recreational activities, they well-known the erosion phenomenon”. In this study we found this general result for users at each site, while educational level varied among sites thus we did not taken into consideration. We agree with your useful comment about the uncertainty of the income answers. Therefore, we add this point at lines 506-507.

-Line 559: Canary Island is also Spain

Thank you for the suggestion, we modified the sentence in line 508

-Line 593: Author did not compare with the real data of number of user that they spoke in methodology. It could be interesting

As explain above, the comparison of the estimated carrying capacity with the number of users observed in the satellite images was not carried out in this study. In fact, in this study we did not focus on crowding but to the elaboration of an integrate method for beach value assessment. Furthermore, the proposed comparison was already presented by Rodella et al., 2017.

-Line 598 to 608: Difference with the national average WTP are not really significance.

According to reviewer's suggestion, we deleted lines from 470 to 476

-Line 629 to 632: Authors have to include in the discussion that in Italy you have to pay to go inside many beaches.

According to the previous comment, we modified the discussion from line 552 to 593 adding more information about wtp and services costs

-Line 651: I could not see this in the results.

Lido di Nazioni presented an erosional trend, as reported in Table 15 (erosion fc_2 of 0.3680) and in Figure 5. For this reason we add this details in line 651 and the useful reference of Marasmi

-Line 660: Usually the upper part of a free beach (without balneari) it is not use during summer because the hot. This explanation appears in several paper about carrying capacity

ILARIA:

-Line 669: This information has to be in study site

We moved the information to the study area, according to your comment

-Line 674: I could not understand this asseveration, of course it will need to comply to the municipality provisions

According to reviewer's comment, we deleted this obvious sentence

-Line 681: What about the cleaning cost?

Cleaning costs were not taken into account as direct investment of local administrations for beach conservation. We considered in this category only requalification/maintenance activities, like nourishments and harbor dredging (as indirect source of sediments). Costs like beach fees, cleaning costs and different business around the tourist activities like hotels, restaurant, etc., are not relevant to analyse the welfare change under the analysis. In fact, these costs may be used in the overall assessment of the beach financial value in the status quo, but not for the examination of proposed changes as conservation scenarios of the frequented beach.

-Line 687: Dredging it is not beach maintenance

Thank you for your comment. Dredging is not a direct beach maintenance activity but we decided to include it in the local investment amount because of it is very often source of sand for beach nourishments. In this sense, investments made for dredging could be also consider as investments for beach preservation. Nevertheless, the marine sediments dredged in harbors or near large industrial and urban areas usually show high levels of contamination, thus their reuse must complain with legislation (i.e. Italian Legislative Decree 152/2006, the Nitrates Directive (Council Directive 91/676/EEC; European Community 1991), and the Water Framework Directive (Directive 2000/60/EC; European Community 2000).

-Line 697-700: Sardinia is a transition European region, what is about European founding?

In Sardinia, the total funding for the Environment Protection & Resource Efficiency (period 2014-2020) was 164,103,000€ (<https://cohesiondata.ec.europa.eu/programmes/2014IT16RFOP015>), of which only 28% was effectively spent during the reference period. Moreover, most of this amount corresponding to the implementation of other type of environmental project or instance, for the improvement of water supply, inland flood protection measures and forest fire protection.

However, we decided to include the aspect of European Funding in the manuscript according to your useful comment.

-Line 725: Authors forgot also the important role of the beaches as natural protection against flooding

We cited this role in the paper at line 725

Conclusions

-Line 739: I am not agree, people express the WTP because in many Italian beaches they have to pay, just for stay. This is complete different in other European countries.

Up to 57% of users of this study agreed to pay for beach preservation, therefore more than half number of interwieved demonstrated an environmental attitude. Nevertheless, this result does not exclude a second reason that induce the answer that could be the habitual frequentation of a beach, the recreative function of the beach, the property of holiday house near the littoral ect. (we add this assumption in conclusion section)

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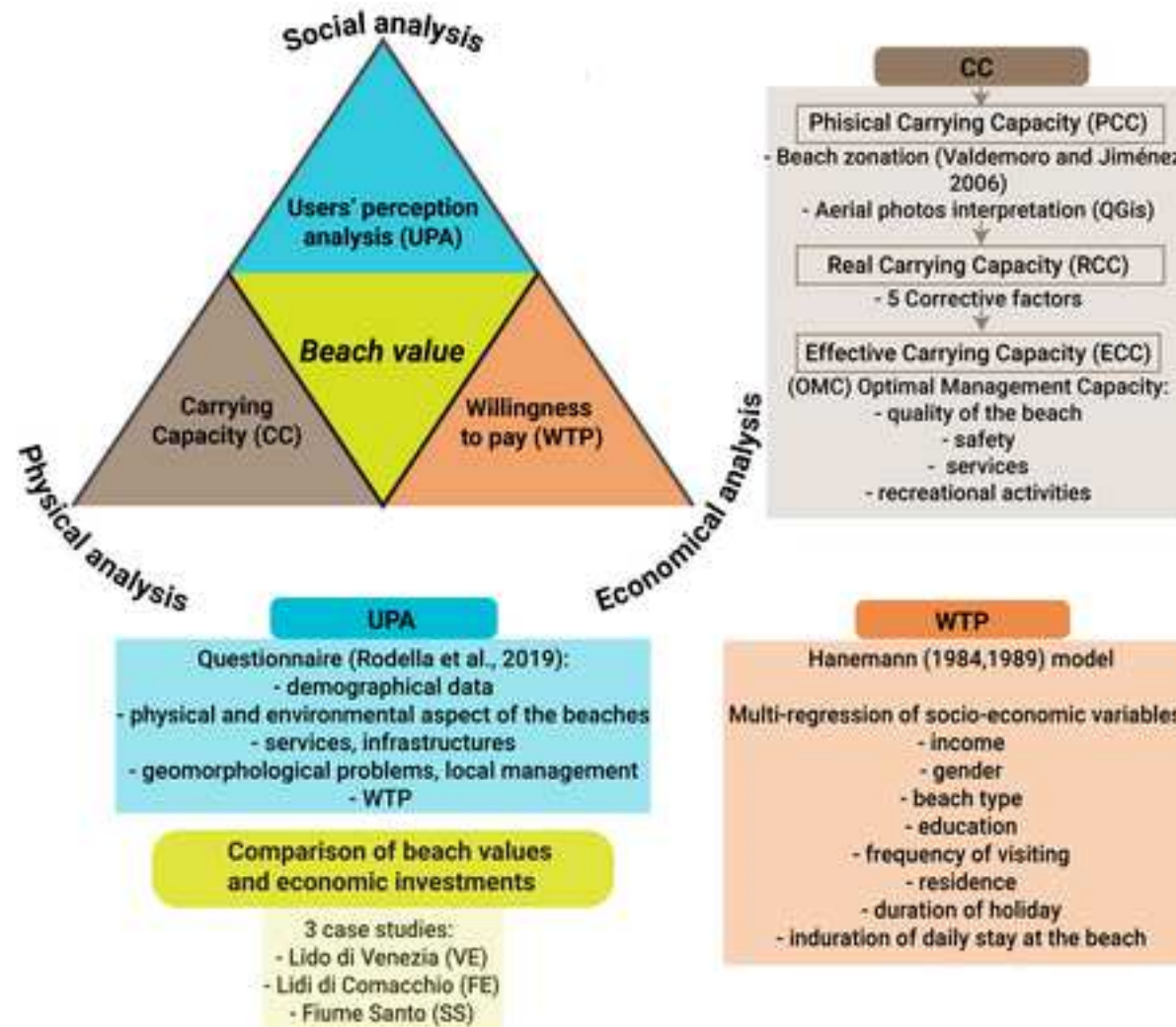
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Highlights:

- results indicate a considerable WTP of beach users;
- WTP is correlated to beach typologies and beach frequentation;
- carrying capacity can be used for beach evaluation;
- corrective factors and optimal management index affected the carrying capacity;
- beach values are very high in comparison to investments carried out on the littorals



Carrying capacity as tool for beach economic value assessment (case studies of Italian beaches)

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Carrying capacity as tool for beach economic value assessment (case studies of Italian beaches)

Graphical abstract

Abstract

This study developed a new integrated assessment method for sandy beaches, using three recreational Italian beaches as case study, with the purpose of obtaining their economic value. The method was based on a geomorphological assessment of the beaches and a carrying capacity evaluation; an economic analysis through the elicitation of the willingness to pay (WTP); a social assessment of beachgoers' attitude and opinion. For the selected beaches, which differed for typology, location, shape, level of urbanization and tourism, we identified the available surfaces for recreational uses through the observation of satellite images. WTP results indicate that respondents would be willing to pay a contribution from 9 to 15 € per season. WTP is principally positive correlated with some variables like beach frequentation, residence in the localities, available services on the beach. The value of the selected beaches was calculated multiplying the sustainable carrying capacity of each site with their related maximum WTP. It was found that the values of the beaches varied from more than 50 M€/season at a popular urban beach to 1M€/season at a remote natural beach. The comparison of beach valuation and investments made by managers of the beaches show a gap. Therefore, the huge non-market value of these beaches might need decision-makers to guarantee continuous beach restoration measures.

Keywords: carrying capacity, users' perception, willingness to pay, beach management, economic value

Highlights:

- results indicate a considerable WTP of beach users;
- WTP is correlated to beach typologies and beach frequentation;
- carrying capacity can be used for beach evaluation;
- corrective factors and optimal management index affected the carrying capacity;
- beach values are very high in comparison to investments carried out on the littorals

1 Introduction

Beaches are important resources for tourism and their values are difficult to assess since only some ecosystem services are established by the market thus their estimation requires the use of non-market valuation techniques. Therefore, quantifying and valuing environmental goods and ecosystem services by an economic point of view is often problematic (Pearce et al., 2006a) and requires an inter-disciplinary perspective from economics to other complement disciplines (Hanley and Spash, 1994). Non-market valuation methods consist in the elicitation of the economic value according to consumer/citizen preferences, which can be revealed (e.g. Hedonic pricing, travel costs methods) by observing market or behavioral 'tracks', or stated (Carson et al., 1996) when choices are not observed or observable as in most valuation ex-ante scenarios, by society in terms of (maximum) Willingness to Pay (WTP) or willingness to accept (WTA, e.g. compensating for a loss of welfare). Maximum WTP is the most used monetary measure, in essence, compensation to obtain higher utility or welfare, from an individual perspective, out of increased consumption of private and/or public goods. In other words, WTP is a given quantity of money for supporting social costs aimed to preserve and/or enhance the 'good' a given project aims at increasing. Specifically, the Contingent Valuation Method (CVM) has been the most applied approach to assess the economic value of a beach (Logar and van den Bergh, 2012; Pearce et al., 2006b; Peng and Oleson, 2017). CVM relies on a direct questionnaire approach, asking a random sample of the population to state their hypothetical maximum WTP for preserving a good (Carson et al., 2000; Mitchell and Carson, 1989). It is the only way (together with the multi-attribute choice modeling method; (Hanley et al., 2001; Mazzanti, 2002) to get knowledge on economic values when 'prices' are not available or observable (Carson, 2012). Precisely, WTP has been used in several study areas in the world to evaluate the beach user interest to beach management (Alberini et al., 2004; Blakemore et al., 2002; Saengsupavanich, 2019; Zhai and Suzuki, 2008) to defence beaches from erosion (Almansa et al., 2012; Lindsay et al., 1992; Logar and van den Bergh, 2012; Marzetti et al., 2016; Matthews et al., 2017) also in view of Integrated Coastal Zone Management – ICZM (Marzetti et al., 2016). The CVM assumption is that individuals have preferences that can be elicited by creating a hypothetical market and that conclusions can be drawn about how the utility change of a product or service is perceived by individuals (Alves et al., 2015). Environmental and behavioral economics, as well as psychological studies, point to the ethical and cognitive issues the method presents (Hanley, 1996). All in all, stated preferences methods remain the only way to **monetize** extra market goods (Portney, 1994).

Since beaches are not only considered as public domain bringing social benefits but also as income sources, there are economic benefits to be derived from their recreational use. For these reasons the recreational use of the beach, also considered as the **number** of tourist attendances at the beach, may be used as an instrument through a WTP approach to obtain the economic value of the beaches (Saengsupavanich, 2019).

35 The number of visitors that a beach can support is commonly translated in carrying capacity term (CC).
36 Carrying capacity in tourism has its origins in the 1960s (Coccossis and Mexa, 2004) and, over the past six
37 decades, the growing interest in coastal tourism has led to the elaboration of the CC conceptual approach
38 to sustenance the development of beach management plans (Sousa et al., 2017). The definition of the CC of
39 recreational areas has become an essential tool, as it “enables the preservation of the high quality (eco-
40 systemic, ecological, environmental and social quality) and quantity (traducing in beach width and sand
41 amount) of coastal resources whilst meeting not only the current needs but also securing long term
42 economic and ecological benefits for future generations” (UNEP/MAP, 1997). In this context, CC
43 assessment is a technique used in beach management, being applied in different ways and in distinct socio-
44 ecological settings. Moreover, much stress has been placed in the last decades on the importance of
45 strategic beach zoning (both spatial and temporal) (Valdemoro and Jiménez, 2006), which have not yet
46 been implemented over large geographical scales for sandy beaches (Lucrezi et al., 2016), also considering
47 the functional beach width for recreational purposes (Cabezas-Rabadán et al., 2019). Strategic zoning is
48 able to encompass the interspersión of natural and unaffected beach with areas suitable for recreation,
49 thus it is essential both in the case of urban and natural beaches. Several techniques were developed to
50 calculate the CC and to individuate the real beach zonation during the summer season. For instance, some
51 studies used on-site information and video processing to provide significant real-time data (Huamantínco
52 Cisneros et al., 2016), also combined with surveys requested to tourists; other studies directly counted the
53 number of users on the beach (King and McGregor, 2012; Pessoa et al., 2013; Polette et al., 2003; Roca et
54 al., 2008); mathematical algorithms were developed for counting and locating people on the beach based
55 on image reprojection and model of occupation of space by users (López-Dóriga et al., 2019; Revollo
56 Sarmiento, 2012); other studies used the analysis of satellite images and the application of CC estimation
57 methodologies (Corbau et al., 2019; Rodella et al., 2017; Zacarias et al., 2011). More comprehensive studies
58 also included a variety of environmental, economic and social indicators for the assessment of the
59 environmental CC of the coastal zones (Liu et al., 2020; Zheng et al., 2019). However, literature in this field
60 shows a gap of information specifically concerning the final aim of beach carrying capacity assessment, i.e.
61 the use of this “magic number” as a real tool for littoral sustainability and not only an index or number.
62 Moreover, carrying capacity is closely related to management options of a beach and, in other words, both
63 to its intrinsic value and to manage investments¹. In this paper, an approach is presented aiming to

¹ As far as management and planning is concerned, Carrying capacity (Hanley N. (2000), “Macroeconomic Measures of Sustainability”, *Journal of Economic Surveys*, vol.14, n.1, pp.1-30, Mazzanti, 2002) is linked to the maximisation of the objective ‘user / tourism attendances). It is worth noting that this is not a maximum revenue / profit equilibrium. WTP information, namely knowledge on the demand curve (WTP empirical distribution), allows setting, in case of necessity,

integrate coastal management and environmental economics. Thereby, four objectives were set. The first objective is to analyze the users' preferences and to estimate their WTP through the analysis of questionnaires surveys. In this analysis, WTP is used as an indicator of beach user engagement in regard to beach management. This includes a range of aspects of the beach management comprising the Integrated Coastal Zone Management – ICZM, beach preservation against coastal erosion, coastal defence systems knowledge and the optimum space available for each beach user.

The second objective is to assess the beach user profile according to the WTP, considering as independent variables a set of physical and socio-demographic attributes. The physical attributes allow to classify each beach based on their typology while socio-demographic attributes (e.g. gender, educational level, beach frequentation) **understanding** the correlation between users and WTP. Consequently, it is possible to identify the key variables that characterize them in eliciting willingness to contribute to supporting possible measures able to defend and enhance the beaches.

The third objective is to determine the economic value of different beaches based on their sustainable carrying capacity. For this reason, the CC is assessed in the littorals both as a sustainable beach parameter and to obtain their economic values.

The last objective involves comparing the obtained economic values and public investments of the local Administration for managing the beaches. Such comparison allows estimating the probable funding needed to adequately promote a range of measures including protection of the coastal zone, preservation of natural environment and improvements in beach management.

2 Study Area

The study sites were: Lido di Venezia locates in Veneto region, Lidi di Comacchio in Emilia – Romagna region and Fiume Santo-Porto Torres in Sardinia (Figure 1). These littorals were chosen because of their different geographical locations, physical settings, beach types and tourist frequentations (in terms of national and foreign tourist arrivals and presences).

2.1 Lido di Venezia (Veneto)

Lido di Venezia is a barrier island 11.8 km long with width **reaches up to** 200 m (Table 1), with the lowest values in the central part of the barrier island, with gentle beach slope (0.25 % - 0.53 %) (Consorzio Venezia

an objective of maximum revenue, which is surely associated with a lower number of users but expressing higher WTP. Working on the revenue curve, this increases revenues and reduce users, with possible economic and environmental benefits. Finally, price diversification management strategies can better reconcile efficiency (revenue generation) and equity (access) in a multi goals type of strategy.

91 Nuova, 2000). The annual mean temperature was 13.2° C, while the total precipitation level was 721.2
 92 during 68 days in 2019 (Arpa Veneto, 2020). The most frequent storm conditions in the northern Adriatic
 93 Sea are characterized by Scirocco wind in autumn and spring, blowing from South-East, and Bora wind in
 94 winter, blowing from North-East, both often exceeding 15 m/s (Met et al., 2019). Wind-waves are on
 95 average less than 0.5 m (Dal Cin and Simeoni, 1994), however, Scirocco and Bora storms can increase the
 96 wave sizes significantly (up to ~5 m) (Cavaleri et al., 1996). The tide is microtidal with an average range of
 97 20 cm increasing to 100 cm during spring tides (Polli, 1970). Tidal gauge (data from the Punta della Salute
 98 (PS) monitoring station), show a mean SL rise of about 6 mm/year over the last 30 years (Met et al., 2019).
 99 Lido di Venezia is an isolated physiographic unit and it receives few sediments from solid coastal transport
 100 due to the presence of jetties at the lagoon inlets known as Lido inlet (to the north) and Malamocco inlet
 101 (to the south). Such jetties have an impact on the barrier island morphology, as they reduce the input of
 102 sediment and facilitate erosive phenomena. The littoral is divided into three parts as follows (Figure 1 a):
 103 - the northern stretch of coast (about 5,000 m long) is characterized by a high anthropization pattern
 104 with beach establishments and hotels. This littoral showed an alternation of accretion (in the northern
 105 stretch of coast of about 2,700 m with a medium shoreline accretion of about 2.4 m/yr from 1998 to 2010
 106 (Fontolan et al., 2014) and erosion (in the followed 2,200 m). Remnant dunes are present near the
 107 “Ospedale al Mare”. Groins have been placed from the ‘70s- ‘80s in order to reduce the beach erosion.);
 108 - the northern stretch of coast (about 5,000 m long) is strongly influenced by anthropic factors such
 109 as land-use changes including construction on large scales of beach establishments and hotels. This littoral
 110 shows a variable spatial redistribution of sediments. Specifically, the northern sector (about 2,700 m of
 111 coast) experiences deposition (medium shoreline accretion of about 2.4 m/yr from 1998 to 2010 while the
 112 southern sector (in the remaining 2,200 m) is subject to erosion processes. In an attempt to prevent beach
 113 erosion, groins have been built out from the ‘70s. Although after the 1950s, coastal dunes have been
 114 heavily subjected to urbanization and other human-induced change (Bezzi and Fontolan, 2003), a dune
 115 ecosystem is preserved in the area “ex Ospedale al Mare”;
 116 - the central stretch of coast (4,600 m long) is entirely occupied by rigid hydraulic structures
 117 including revetments locally known as “murazzi”, groins and submerged barriers extending for
 118 approximately 4.6km. The emerged beach is very narrow and measures from 1-2 m to about 20 m in 2019
 119 close to groins in the updrift sides;
 120 - the southern stretch of coast (about 2,400 m long) is designed as Site of Community Importance
 121 (S.C.I. IT3250023, 166 hectares; Table 1) for its high environmental value. Rigid coastal defences are absent
 122 and urbanization is low. The mean emerged beach measured 206 m in 2019 and the average shoreline
 123 variation rate in the period 1998-2010 was 2.6 m/yr (Fontolan et al., 2014). A recent study of Ruol and
 124 Pinato (2016), instead, reported a mean variation rate of -0.2 m corresponding to a loss of -1875.1 m2/

125 year during the period 2007-2012, focused on the southernmost littoral (for an extension of about 1,500 m
126 from the Malamocco mouth).

127 2.2 Lidi di Comacchio (Emilia-Romagna region)

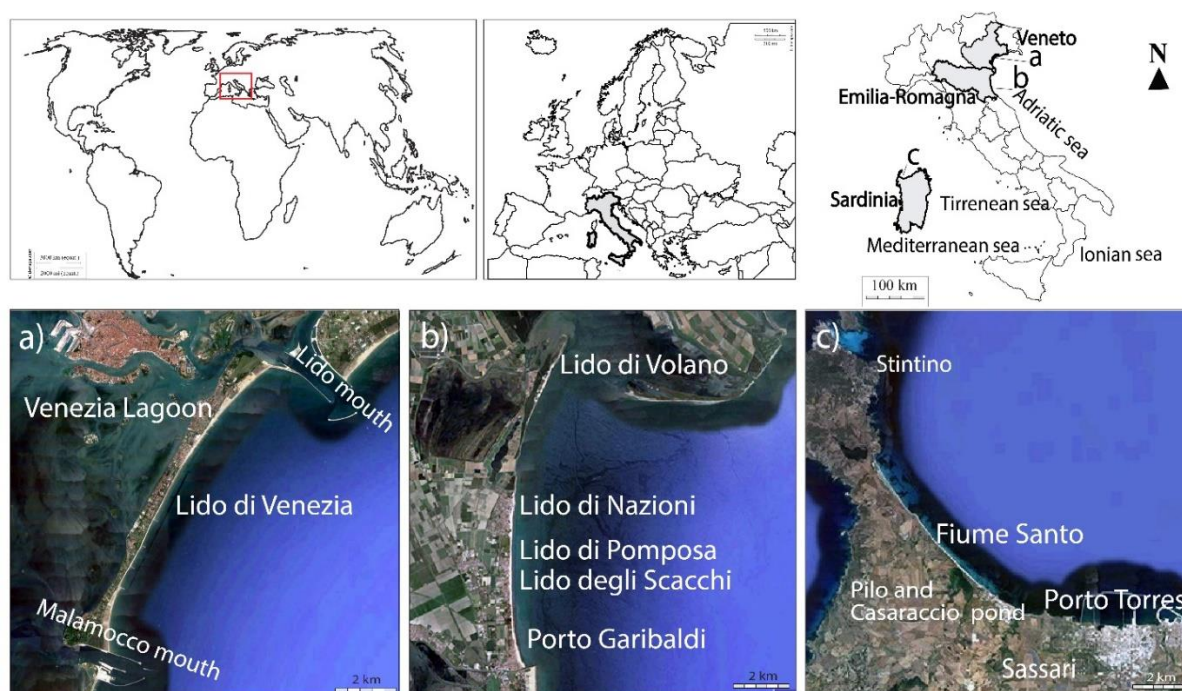
128 The Lidi di Comacchio North coastline is 9 km-long and goes from Lido di Nazioni to Porto Garibaldi and
129 includes four coastal villages: Lido di Nazioni, Lido di Pomposa, Lido degli Scacchi and Porto Garibaldi, for a
130 total of 58 beach resorts (Figure 1 b). The coastal areas consist of low sandy beaches derived from ancient
131 swampy and alluvial deposits (Martinelli et al., 2011), generally below MSL (minimum values of -2/-3 m;
132 Perini et al., 2010). The seabed slope is generally very gentle, about 0.4° (Bondesan et al., 1995). The width
133 of the emerged beach is variable and ranges from 20 m to 60 m from Lido di Nazioni to Lido di Pomposa
134 and from 60 to more than 100 m from Lido degli Scacchi to Porto Garibaldi (Martinelli et al., 2010). The
135 average annual temperature in Lidi di Comacchio is 13.4 °C for the period 1991-2015. During the summer
136 season (June-September) temperatures vary from 19.9 to 23.1 °C. The average annual rainfall is 661
137 mm. (Arpa Emilia Romagna, 2018a). This stretch of coast is eroding due to upstream structures, storm
138 surges and tides (Aguzzi et al., 2016). The area is microtidal with a range between 80 and 90 cm (spring
139 tides) and 30–40 cm (neap tides). The wave climate is of low energy (60% of Hs below 1.0 m; IDROSER,
140 1996). Storm directions are from E–NE (Bora wind) and SE (Scirocco wind). Storm waves with a one-year
141 return period, with directions NE–E–SE, have wave heights around 3 m and periods of 7.5 s (IDROSER,
142 1996). The analysis of extreme waves indicates that the exceeding frequency for high waves (Hs > 5.8 m)
143 only occurs for Bora and Levante being nevertheless very limited (around 2% for both sectors, Martinelli et
144 al., 2010). As a consequence, most of these beaches are characterized from the '70s by hard defence
145 systems that are groins, revetments, breakwaters and the dykes of Porto Garibaldi touristic harbor that
146 altered the natural morphodynamic characteristics of the beach. Despite the strong anthropic alteration,
147 natural elements still characterize the landscapes reclaimed areas occupied by wetlands and rivers.

148 2.3 Fiume Santo – Porto Torres beach (Sardinia region)

149 Fiume Santo beach is located in the northern part of Sardinia region in the Sassari Municipality (Figure 1 c)
150 and is extended for about 2 km from Porto Torres Municipality up to the promontory of the old “Tonnara di
151 Stintino”. The beach is constituted by sandy Holocene deposits of 3-4 meters above sea level,
152 corresponding a succession of two or three ancient parallel dunes (Sassari Municipality, 2016). This beach
153 constitutes a natural zone inside a huge area anthropized by a thermoelectric industry of the nearby Porto
154 Torres coast. Due to the industrial pollution, this stretch of coast is precluded from bathing water, because
155 is located in a “concession zone for industrial use” in front of the thermoelectric centre of Fiume Santo
156 (Bathing Ordinance 54/45 of the Porto Torres Port Authority; Sassari Municipality (2016).

157 Therefore, thermoelectric plants are the dominant feature of the landscape. Nevertheless, the particular
 158 beauty of the sea and the natural conditions of the beach guarantee its frequentation principally by local
 159 tourists. The beach consists of a very mature siliceous gravel formed during the Plio – Pleistocene and
 160 separates the Pilo and Casaraccio pond from the sea (Figure 1 c). Fiume Santo beach is also a historical
 161 beach because of the presence of numerous fossil evidence of the Roman period both in emerged and
 162 submerged beach (Ginesu and Ozer, 2000). From a climatic point of view, Asinara island acts as a barrier,
 163 reducing the energy of waves originated by the mistral and northeasterly winds by up to 60% and 20%,
 164 respectively. Inside the Gulf of Asinara, winds from the west and northwest (270° to 330°, the ponente, and
 165 the mistral) and east and northeast (40° to 90°, the levanter and the grecale) were the most frequent and
 166 strongest. During winds with intensities lower than 4 m/s, currents are locally tide-driven (min-max tide
 167 excursion of 0.1–0.3 m). During strong events, a stable increase in sea level of about 0.2–0.3 m generally
 168 occurs, with peaks of 0.4 m throughout the period of storm surges and with wave heights up to 3–4 m
 169 (Devoti et al., 2010). The average precipitation value of Porto Torres station for the period 1922-1992 is
 170 511.6 mm, while the mean temperature value is 21° (from June to September the mean temperature
 171 ranged from 21° to 23.9°; Sardegna Clima, 2019).

172 This coastal sector presents a high environmental value due to the S.C.I. areas "Platamona pond and
 173 juniper" and "Pilo and Casaraccio pond" and the SPA "Stagno di Pilo, Casaraccio and Saline di Stintino". The
 174 whole beach is free because of the absence of beach establishments and permanent facilities in this area.
 175 Furthermore, the parking space is not adequate for tourist demand mostly during the weekend (Carboni et
 176 al., 2017).



177
 178 **Figure 1: Location map of national WTP surveys. Images report the study areas of: a) Lido di Venezia; b) Lidi di**
 179 **Comacchio north; c) Fiume Santo**

Table 1: The main beach characteristics

Beach name	Beach shape	Beach type (Rodella et al., 2019a)	Beach width (m) (Bing-2018)	Beach extension (m) (Bing-2018)	Presence of erosion ²	Coastal defence systems and harbours (Bing 2018)	Dunes (Williams and Micallef, 2009)	Protected zones ³	Touristic arrivals (person/day) - 2017	Touristic Presences (person) - 2017
LIDO DI VENEZIA (VE)	Linear	Urban	up to 200	11,800 (of which only 7,400 m are of sandy beach)	Yes, in some stretches of coast	Groins, breakwaters and revetments	Several	S.C.I. IT3250023 - S.P.A. IT3250023 Lido di Venezia: biotopi litoranei	185,000 ⁴	559,000
LIDO DI NAZIONI - COMACCHIO (FE)	Linear	Urban	from 5 to 65	2,910	Yes, in the whole littoral	Groins, breakwaters and revetments	Remnants	S.C.I. IT4060007 - Bosco di Volano S.C.I. IT4060004 - Valle Bertuzzi, Valle Porticino-Cannevié	313,457 ⁵	2,433,211
LIDO DI POMPOSA - COMACCHIO (FE)	Linear	Urban	from 20 to 55	2,230	Yes, in the whole littoral	Breakwaters	Remnants			
LIDO DEGLI SCACCHI - COMACCHIO (FE)	Linear	Urban	from 20 to 56	2,500	Yes, in the whole littoral	Breakwaters	Foredunes			
PORTO GARIBALDI - COMACCHIO (FE)	Linear	Urban	from 40 to 120	1,480	Yes, in some stretches of coast	Groins, breakwaters and dykes	Remnants			
FIUME SANTO (SS)	Linear	Natural	15-20	1,490	Yes, in some stretches of coast	Revetments	Several	EUPAP174 - Santuario per i Mammiferi Marini (M.P.A.)	16,009 ⁶	34,397

² http://www.pcn.minambiente.it/viewer/index.php?services=Progetto_coste_2017

³ http://www.pcn.minambiente.it/viewer/index.php?services=Progetto_coste_2017

⁴ Città di Venezia, 2017. Annuario del Turismo 2017, <https://www.comune.venezia.it/sites/comune.venezia.it/files/immagini/Turismo/ANNUARIO%202017%20Ver%202.8.1%20cover.pdf> (accessed 14.02.19)

⁵ Regione Emilia Romagna, 2017. Statistica turismo Ferrara (https://statistica.regione.emilia-romagna.it/turismo/dati-preliminari/copy_of_analisi-territoriale-della-domanda-turistica/analisi-territoriale-della-domanda-turistica/dettaglio-provinciale/ferrara/FERRARA%20-Gennaio-Dicembre%202017.xlsx) (accessed 14.02.19).

⁶ Regione autonoma di Sardegna, 2017. Movimenti turistici in Sardegna 2017 per comune, Comune di Porto Torres fonte <http://dati.regione.sardegna.it/dataset/movimenti-turistici-in-sardegna-2017-per-comune/> (accessed 14.02.19)

3 Materials and methods

3.1 Beach users' perception, questionnaire and sampling

A questionnaire was developed similarly to those used by (Rodella et al., 2017) and (Rodella et al., 2019b) in order to enquire about:

- tourists' characteristics such as gender, age, educational level, residence, beach frequency and reason for beach choice;
- perception about the physical and environmental aspects of the beach they visited, available services and infrastructures;
- geomorphological problems, local management, the available surface per user, the coastal defence system and the willingness to pay for beach management.

Data were collected from June to September 2015. The time for data collection was between 9:30 am and 6:30 pm. Only people over 16 years old were randomly selected and interviewed. They were informed that the data from the survey would not be used for any specific policy but instead for academic research to measure the economic value of beaches.

Statistical and descriptive analyses of users' perception surveys were performed using the Statistical Package for Social Sciences (SPSS) version 20. The analysis considered separately the totality of answers provided for each question. The observed variables were analyzed considering their types, as numeric or scalar, ordinal and nominal. Taking those aspects into account, the results were mostly presented showing the relative observed frequency (%). Contingency tables were built considering the interaction between beaches and user's characteristics and preferences. The daily expense on the beach numeric variable is displayed using descriptive statistics (minimum-maximum value and standard deviation). The users' age was transformed from a scalar to an ordinal variable, grouping and recoding age as reported in Table 5. All remaining variables were nominal (e.g. reason for beach choice) or ordinal (e.g. income) and were directly analyzed on their frequencies without re-classification.

3.2 Contingent Valuation and the experimental design

During the interview, we provided to elicit tourist's maximum WTP for preserving and enhancing the defined beaches. This was elicited by a CVM application on the entire selected sample.

29 3.2.1 The model

30 The model was based on those used by (Rodella et al., 2019a). The method involved survey respondents
31 with WTP being asked two close-ended questions with bid offers, the second bid offer being dependent on
32 whether the first bid was accepted or not (Hanemann, 1989, 1984).

33 We implemented a dichotomous choice model, where a Yes/No answer was considered, therefore
34 participants responded if they would be willing to pay the selected amount or not for the beach
35 management.

36 The WTP question is the following:

37 *“In case a financial fund is constituted in order to ensure the appropriate management of beach, would you*
38 *pay X € (for person) each season in this territory?”*

39 It must be underlined that WTP is not related to other possible payments supported by tourists. In other
40 terms, it represents a specific and possibly additional payment aimed to ensure beach conservation. The
41 project change under scrutiny is thus the constitution of a new fund which supports enhanced beach
42 management, using a financial scheme of ‘voluntary provision of public/mixed goods, outside the boundary
43 of strict state intervention. Based on the pilot groups and literature review, the sets of bids (X) used in this
44 study are as follows: 2 €, 5 €, 10 €, 20 €. Each survey contained one randomly selected amount, which was
45 evenly distributed over the surveys.

46 In the double-bounded approach (DB), respondents are asked two rounds of questions, the second of which
47 depends on their response to the first one. A respondent is presented with the first bid amount *BID*, and if
48 it is accepted a higher bid is offered in the follow-up question. Alternatively, if the first bid amount gets
49 rejected, a lower bid follows in the second round. We used (DB) dichotomous choice because has a higher
50 statistical efficiency than a single-bounded DC, as reported by (Chang and Yoon, 2017).

51 Specifically, in case of an affirmative answer to the question, we asked individual willingness to pay a
52 twofold value than the asked first bid; in case of a negative answer, we asked willingness to pay the half.
53 The conditional WTP for each participant is based on the expectation that the payment amount required
54 for preserving a beach is somewhere between the lower and the upper bid of an individual. The CVM
55 literature review suggests that when using double-bounded dichotomous choice, the first bid ‘anchors’ the
56 second by creating a psychological perception that the ‘objective’ value to be estimated is close to the
57 value of the first bid, leading to starting-point bias (Veronesi et al., 2011).

58 3.3.2 The WTP estimation

59 Table reports the model on the dichotomous choice of this study, based on (Hanemann, 1989, 1984)
60 model. According to the model, individual utility derives from both environmental good characteristics and
61 own income. Micro-economically speaking, this is an indirect utility function that contains income, the
62 theoretical structure by which we can properly define WTP as an economic concept rooted in theory. The

indirect utility is derived from the utility maximization of a bundle of goods subject to income constraints. The demand functions depending on income and prices are substituted back to convey a function that is coherent with the elicitation of WTP as an income-related measure. In other terms, it is assumed that WTP, among the others, is a function of individual income and, as a consequence, income represents a structural cap of WTP. Therefore, income is not adopted into the variables in the multinomial CV model because it is inherently included in the model. In that context, the maximum WTP is theoretically and then empirically the monetary distance between utility in the status quo and utility in the enhanced scenario (here the constitution of the fund for improved beach management).

Table 2: The model assumption for WTP estimation

Model Assumption	Equation
Utility-function $U(j, Y, s)$, where j is a dichotomous variable associated to the use of a given beach ($j = 1$, use of the good; $j = 0$, non-use of the good), Y is the individual income, s is the socio-economic characteristics vector, e_j is the stochastic error term	$u(j, Y, s) = v(j, Y, s) + e_j \quad (j = 0, 1) \quad (1)$
An interviewer would respond YES to the provided question only in case of Eq. 2, where x_i is the formulated BID.	$v(1, Y - x_i, s) + e_1 \geq v(0, Y, s) + e_0 \quad (2)$
The probability distribution of the answer corresponds to Eq. 3. $\eta = e_1 - e_0$, $F_\eta(\bullet)$ is the distribution function of η and the term Δv is equal to the difference	$\text{Prob}(\text{YES} x_i) = \text{Prob}[v(1, Y - x_i, s) + e_1 \geq v(0, Y, s) + e_0] \quad (3)$ $\text{Prob}(\text{YES} x_i) = F_\eta(\Delta v) \quad (4)$ $\Delta v = v(1, Y - x_i, s) - v(0, Y, s) \quad (5)$
Assuming that $x_i \leq \text{WTP}$, the probability of accepting the proposed BID is Eq. 6, where $G_{\text{WTP}}(\bullet)$ is the accumulated distribution function of the random WTP	$\text{Prob}(\text{YES} x_i) = \text{Prob}(\text{WTP} \geq x_i) = 1 - G_{\text{WTP}}(x_i) \quad (6)$
Comparing Eq. 4 with Eq. 6, it derives a relationship between WTP and utility: Eq. 7	$G_{\text{WTP}}(x_i) = F_\eta(\Delta v) \quad (7)$
In order to estimate WTP, we handle $F_\eta(\Delta v)$ as a logistic distribution function and, as a consequence, we adopt a logit model for describing the probability function Eq. 8, whereas we assume a linear model of the income, where utility is given by Eq. 9, where α_j is the constant term and β represents the marginal utility of income.	$\text{Prob}(\text{YES} x_i) = F_\eta(\Delta v) = \frac{1}{1 + e^{-\Delta v}} \quad (8)$ $U_i = \alpha_j - \beta Y \quad (9)$

If $\alpha = \alpha_j - \alpha_0$, it follows Eq. 10	$\Delta v = \alpha + \beta x_i$ (10)
Matching (Eq.10) and (Eq. 8) we obtain the logit-linear model that can be estimated by Maximum Log-likelihood Estimation (MLE)	$\text{Prob}(\text{YES} x_i) = \frac{1}{1+e^{-(\alpha-\beta x_i)}} \quad (11)$
McFadden and Leonard (1992) and Cooper and Loomis (1992) recommended to estimating the median WTP – better trend indicator than the average value – from the univariate model (including only the BID as variable) and by applying the Eq. 12	$\text{WTP median} = \alpha / -\beta \quad (12)$

The multi-variates model was applied in order to estimate the role of socio-economic variables in conditioning WTP, in addition to income. The explicative variables are reported in **Error! Reference source not found..**

Table 3: Description of variables used in the multi-variates model

Variable	Abbreviation	Description		
Free beach	FB	Free beach = 0	Beach establishment = 1	
Gender	G	Male = 0	Female = 1	
Frequency of visiting	F	No habitually = 0	Sometimes = 1	Habitually = 2
Education	E	Secondary school = 0	College = 1	Academic degree = 2
Residence	R	Resident = 0	No Resident = 1	
Duration of holiday	D	1 day = 0	from 2 to 7 days = 1	More than 7 days = 2
Induration of daily stay at the beach	H	less than 2 hours = 0	from 2 to 6 hours = 1	More than 6 hours = 1

We expected that WTP should be affected by some features. The beach type was expressed by a variable that takes into account two different types: free beaches and beach establishments. The two options represent alternative ways to distribute the total social economic value among producers and consumers. The economic value might be greater under both scenarios if the beach quality is higher. On the socio-economic characteristics of tourists, we involved: gender, level of education, residence nearby the observed beach, frequency of visits, the duration both of holiday and of stay at the beach per day. Data arisen from the questionnaire on WTP were elaborated using the statistical software Gretl®. Estimated findings concern the application of the follow-up model. As testing procedure, we adopted the Generalized likelihood-ratio test, which allows us to evaluate a restricted model with respect to the adopted

89 model (Bohrnstedt and Knoke, 1994). Specifically, the Generalized likelihood-ratio test was run to estimate
90 the suitability of the proposed model with respect to the restricted model without the constant term.

91 3.3 Carrying capacity and economic value of the beaches

92 The economic value was estimated for: Lido di Venezia (Figure 1 a), Lidi di Comacchio (beaches of Lido di
93 Nazioni, Lido di Pomposa, Lido degli Scacchi and Porto Garibaldi; Figure 1 b) and Fiume Santo (beach; Figure
94 1 c). The economic value was calculated multiplying the WTP value with the Effective Carrying Capacity
95 (ECC) of the selected beaches. This simple way to calculate the aggregate benefit of beach resource
96 protection is to multiply the estimated WTP per trip or per person resulted from the DB model. This
97 estimation is commonly applied in economic estimation of benefit using WTP approach (Piriapada and
98 Wang, 2014; Saengsupavanich, 2019; Saengsupavanich et al., 2008). The maximum daily and seasonal
99 economic values are estimated considering the maximum number of tourists present on the beach during a
100 season of 4 months. Therefore, we considered tourists that frequent the beach for one day with a turnover
101 of 122 days (the days of the entire season). The method of (Cifuentes, 1992) was applied to the data
102 collected from Bing aerial images of the years 2018 to determine the maximum number of users that an
103 area can accommodate according to their sustainable conditions.

104 3.3.1 The Physical Carrying Capacity – PCC

105 PCC (Eq. 13) is the maximum number of tourists who can physically fit into a specific area over a
106 determined period:

$$107 \text{ PCC} = A/a \times R_f \quad (13)$$

108 Where: PCC = Physical Carrying Capacity; A=Available area for tourist use; a = is the area occupied by 1
109 tourist (m²); Rf = Rotation factor corresponding to the number of visits per day.

110 The total area (A) of the three coastal localities was measured on the Bing aerial photo of 2018 (Microsoft
111 Corporation, Digital Globe, CNES Distribution Airbus DS 2019, 1:10.000 scale) within QGis with Openlayers
112 plugin The reference projection of the aerial photos was the EPSG:3857(OTF) corresponding to the
113 coordinate reference system WGS 84/Pseudo Mercator. The method was applied considering the following
114 dimensional parameters:

- 115 1. width and length of the beach

116 At Lido di Venezia beach we measured the northern and the southern zones for a total of 7,400 m
117 because in the central zone the emerged beach is mostly absent (Table 1). At Lidi di Comacchio
118 North we considered the littoral from Lido di Nazioni to Porto Garibaldi, for a length of 7,590 m.
119 Beach width varied from 15 m northward to 140 m southward, with an average of about 70 m
120 (Table 1). At Fiume Santo we considered a littoral of about 1 km extended from the “Stagno di

121 Pilo" connecting channel to the sea at North to the entrance of the power plant to the South.
 122 The beach width was an average of 22 m (Table 1).

123 2. service zone, safe zone, resting zone, active zone as formulated by (Valdemoro and Jiménez, 2006)
 124 and the safe/active zone corresponding to free beaches;

125 3. free transit area of the beach, was 5 meters for Lido di Venezia, Porto Garibaldi and Fiume Santo
 126 beaches and 3 meters for Lido degli Scacchi, Lido di Pomposa and Lido di Nazioni, according to the
 127 Municipalities Bathing Ordinances (Capitaneria di Porto di Porto Torres, 2016; Municipality of Comacchio,
 128 2017; Venice, 2018). In this study we considered as free transit area a reduction of 5% of active zone for
 129 each beach;

130 4. the net area excluding transit and service zones.

131 According to the existing literature (Rodella et al., 2017; Zacarias et al., 2011) which indicated an area
 132 occupied per tourist (a) ranging from 5 to 10 m² per tourist, two values of a have been used: 5 and 8m².
 133 Therefore, two PCCs were calculated:

- 134 • PCC 1: the net area of each beach was divided by 8 m²/user;
- 135 • PCC 2: the net area of each beach was divided by 5 m²/user, according to several authors (Andric,
 136 1997; Botero and Hurtado, 2009; De Ruyck et al., 1997; Piqueras, 1999; Polette et al., 2003).

137 **3.3.2 The Real Carrying Capacity – RCC**

138 RCC is the maximum lawful number of tourists, once the Correction factors (CF) derived from the particular
 139 characteristics of the site have been applied to the PCC. The RCC is determined using the following
 140 equation (Eq. 14):

$$141 \text{ RCC} = \text{PCC} \times (\text{Cf}_1 \times \text{Cf}_2 \times \text{Cf}_3 \times \dots \text{Cf}_n) \quad (14)$$

142 The correction factors are calculated using the following formula (Eq. 15):

$$143 \text{ Cfx} = 1 - \text{Lmx}/\text{Tmx} \quad (15)$$

144 Where: Cfx=Correction factors of variable x; Lmx=Limiting magnitude of variable x; Tmx=Total magnitude of
 145 variable x.

146 In this study, only five correction factors were used and are: precipitation, erosion, beach access, waste,
 147 water quality.

148

- 149 • *Precipitation (Cf1):*
 150 this factor largely influences the seaside activities.

151 A rain time series of 18 years (2000–2017) recorded by the weather station at Istituto Cavanis by the (Arpa
 152 Veneto, 2018) was used to estimate the number of rainy days during the summer period (from June to
 153 September) at Lido di Venezia. A rain time series of 8 years (2004–2016) was instead used for Lidi di

154 Comacchio considering the urban station of Ferrara (Arpa Emilia-Romagna, 2018). Fiume Santo beach was
 155 analyzed using the Porto Torres raining services for the time series of 1998-2009 (Sardegna Clima, 2011).
 156

- 157 • *Erosion (Cf2):*
 158 Cf2 (Eq.), is determined using the equation:
 159
$$Cf2 = 1 - (\text{length of eroded littoral} / \text{length of total littoral}) \quad (16)$$

 160 The length of the littoral considered is the length of equipped resorts and free beaches.
 161 At all sites Cf2 was analyzed using the “National coastal webportal” (Italian Ministry of Environment, 2012)
 162 for the reference period of 1960-2012.
- 163 • *Beach access (Cf3):*
 164 Cf3 (Eq. 17), is obtained by considering the optimal beach width for the users in view of the results of UPA
 165 (Rodella et al., 2017).
 166
$$Cf3 = 1 - \{[(wm * 1.15) + (wm * 1.1) + (wm * 1)] / wtg\} \quad (17)$$

 167 where ‘wm’ represents the width (m) of each coastal stretch considered, and ‘wt’ the sum total widths of
 168 the whole coast.
 169 The weight corresponding to beach width ranges are reported in Table 6 as indicated by Rodella et al.
 170 (2017). At Fiume Santo, Cf3 has been valued to be equal to 0.90 because, even if this is a rural beach (Table
 171 1), its access is guaranteed by several access corridors through the dune’ system.
- 172
- 173 • *Waste (Cf4):*
 174 this factor has been estimated to be equal to 0.95 at Lido di Venezia and Lidi di Comacchio and 0.90 at
 175 Fiume Santo. This factor represents the maximum area (5-10%) of presence of waste (considering a buffer
 176 of a few meters around the waste) observed during field surveys, according to the reduction factor applied
 177 by Corbau et al. (2019). Fiume Santo, presented a high amount of sewage evidence (algae, wood besides
 178 anthropic waste) due to its natural features and the almost absence of cleaning services. Therefore, for this
 179 beach, we chose to use a Cf4 of 0.90 (reduction of 10%).
 180
- 181 • *Water quality (Cf5):*
 182 this corrective factor is related to the evaluation of water quality conducted by regional agencies in Italy.
 183 Water quality is annually assessed measuring the concentration of cyanobacterial proliferation,
 184 macroalgae, and phytoplankton (*Ostreopsis ovata*), other pollutants, which can be evaluated through
 185 visual inspection, such as wastewater and/or liquid waste, bituminous residues, glass, plastic, rubber, etc.
 186 (art. 9 of Leg. Decree 116/08 Italian Health Minister). We analyzed the Municipalities Bathing Ordinances

for each beach that indicated the possibility/prohibition oh bathing operation during the summer
(Municipality of Comacchio, 2018; Region, 2018; Venice, 2018).

3.3.3 The Effective Carrying Capacity – ECC

ECC is the optimum number of visitors that a site can support considering the RCC and management capacity availability (Eq. 18).

$$ECC = RCC \times OMC \quad (18)$$

where RCC is the Real Carrying Capacity and OMC is the Optimal Management Capacity index (Corbau et al., 2019; Rodella et al., 2017; Zacarias et al., 2011).

OMC was determined using the percentages of good and adequate parameters of “quality and cleanliness of the beach”, “safety”, “recreational activities” and “services” assessed from the UPA and evaluation (Eq. 19) used in (Rodella et al., 2017).

$$OMC = [(quality\ and\ cleanliness\ of\ the\ beach\ \%) * (safety\ \%) * (recreational\ activities\ \%) * (services\ \%)]/4 \quad (19)$$

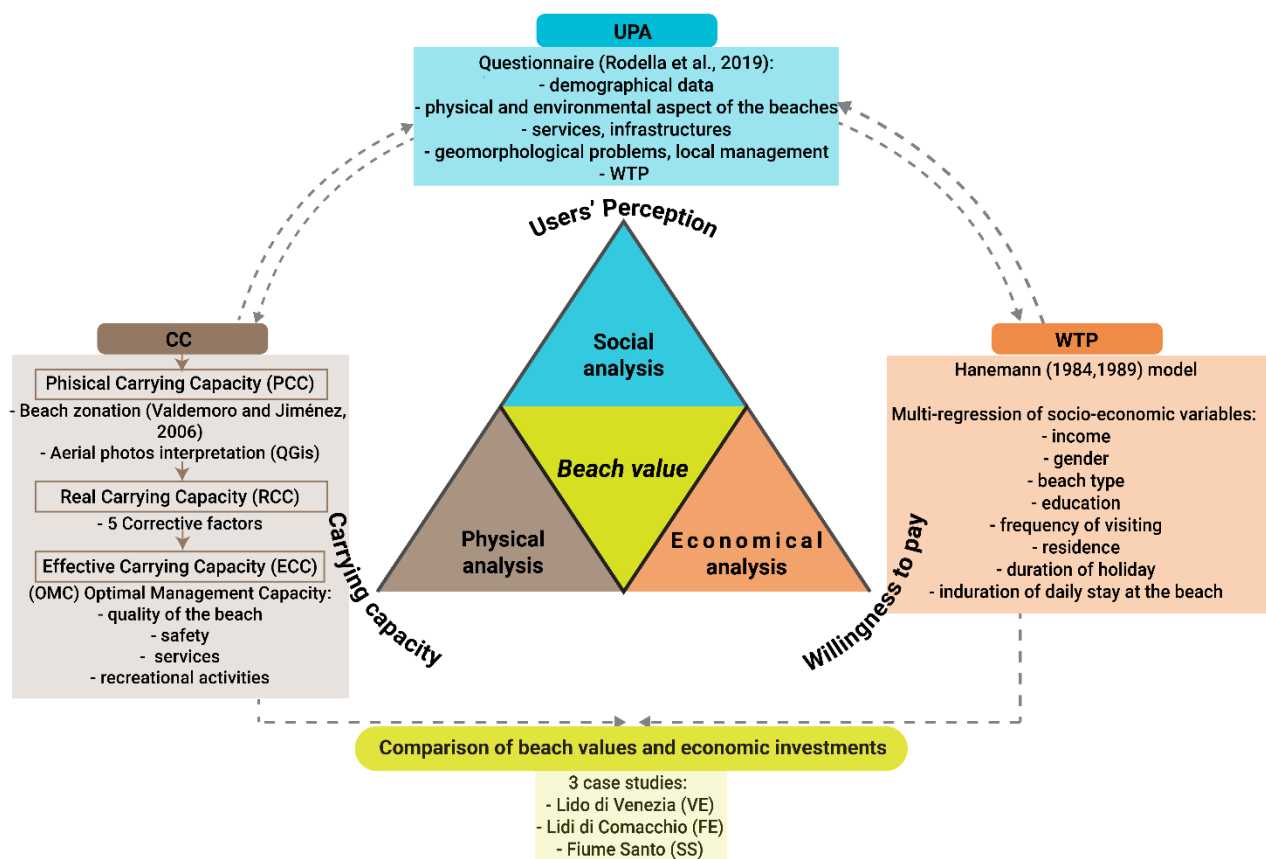


Figure 2: Methodology structure

204 4 Results

205 4.1 Users' perception

206 A total of 204 questionnaires were collected in Lido di Venezia, 145 in Lidi di Comacchio and 104 in Fiume
 207 Santo - Porto Torres for an amount of 453 surveys in 2015.

208 Table 3 highlights the main results of users' profiles for each study area. Gender balance was an average of
 209 39.7% of males and 57.8% of females, even if there was a prevalence of females in Fiume Santo (65.4%) and
 210 male at Lidi di Comacchio (49%) compared to other sites. The respondents were predominantly between
 211 26-40 years at Lido di Venezia (34.8%) and 41 to 65 years at Lidi di Comacchio (36.2%; Table). At Fiume
 212 Santo, users' age was not investigated. Family with children was the main tourism type recorded at all
 213 study sites (an average of 45.9%) followed by holidays with friends (26.5%). The prevalent educational level
 214 was a secondary school (43.3%), followed by an academic degree (30.5%) and a primary school (24.3%;
 215 Table). The interviewees were predominantly not residents (62%). Only the Fiume Santo case study
 216 showed a prevalence of resident users (55.8%). While the prevalent average annual income was lower than
 217 20.000 € (36.4%), 22.1% of respondents declared an income ranging between 20,000 and 31,000 € (Table).
 218 Daily expenses for each user on the beach showed a higher value for Lidi di Comacchio beachgoers (mean
 219 value of 15.32 €/person/day; Table), followed by Lido di Venezia (12.29 €/person/day) and Fiume Santo
 220 (4.57 €/person/day). The main reason for choosing the holiday destination was primarily sea and beach at
 221 Lido di Venezia (44.6%; Table 4) and Fiume Santo (67.3%). On the other hand, at Lidi di Comacchio a
 222 considerable percentage of users chose that area to "have a holiday home" (33.8%) and for the "proximity
 223 to residence" (37.9%; Table). Other factors, like relax/quiet (6.6%), economic reasons (2.2%) and play
 224 sport/amusement (2.2%) played a role also. The "nature and landscape" was the less popular reason
 225 considered when choosing the beach destination (on average 1.1% of the total respondents)

226
 227 **Table 4: General information about users' profile (St.Dev.: Standard Deviation; Min: Minimum; Max: Maximum)**

QUESTIONS		Lido di Venezia (%)	Lidi di Comacchio (%)	Fiume Santo (%)	Average (%)
SEX	Male	36.8	49.0	32.7	39.7
	Female	58.8	51.0	65.4	57.8
	no answer	4.4	0.0	1.9	2.4
AGE	<25	27.9	33.3	-	30.1
	26-40	34.8	24.8	-	30.7
	41-65	31.9	36.2	-	33.6
	>65	5.4	5.7	-	5.5
	no answer	0	1	-	0
EDUCATIONAL LEVEL	Junior high school diploma	15.2	33.1	29.8	24.3
	Secondary school	37.8	46.2	50.0	43.3
	Academic degree	44.1	20.7	17.3	30.5
	no answer	2.9	0.00	2.9	2.0

RESIDENCE	Resident	43.6	14.5	55.8	37.1
	Not resident	55.4	84.8	43.3	62.0
	no answer	1.0	0.7	1.0	0.9
COMPANY	Alone	3.9	7.6	1.9	4.6
	In couple	26.5	13.1	22.1	21.2
	Family (with children)	40.7	51.7	48.1	45.9
	Friends	27.9	24.8	26.0	26.5
	Other	1.0	2.1	1.0	1.3
INCOME	< 20,000 €	44.6	20.0	43.3	36.4
	20,000-31,000 €	24.0	22.1	18.3	22.1
	31,000-41,000 €	10.8	11.0	11.5	11.0
	>41,000 €	11.8	13.1	4.8	10.6
	no answer	8.8	33.8	22.1	19.9
DAILY EXPENSE ON THE BEACH	Mean	12.29	15.32	4.57	-
	St.Dev.	18.388	17.278	7.978	-
	Min	0	0	0	-
	Max	200	150	40	-
MOTIVATION FOR THE VISIT	Sea/beach	44.6	11.0	67.3	39.1
	nature and landscape	1.0	0.00	2.9	1.1
	cultural heritage (handicraft/folklore/cooking)	7.8	0.7	0.0	3.8
	economic reasons	1.5	2.8	2.9	2.2
	play sport/amusement	0.0	6.2	1.0	2.2
	relax/quiet	6.4	6.9	6.7	6.6
	have a holiday home	5.4	33.8	1.0	13.5
	near to residence	33.3	37.9	16.3	30.9
	other	0.0	0.7	1.9	0.7
DURATION OF STAY IN THE RESORT (DAY)	1	23.5	13.8	25.0	20.8
	from 2 to 7	20.1	9.7	21.2	17.0
	from 7 to 15	10.3	17.9	9.6	12.6
	more than 15	41.7	57.9	39.4	46.4
	No answer	4.4	0.7	4.8	3.3
INDURATION OF DAILY STAY ON THE BEACH (HOUR)	Less than 2	15.7	7.6	7.7	11.3
	From 2 to 6	50.7	53.8	58.7	53.4
	More than 6	31.4	37.2	29.8	32.9
	No answer	2.5	1.4	3.8	2.4

228

229 Quality and cleaning of the beach were considered good or sufficient (56.9% and 31.9% respectively). The
230 beach width was generally adequate for 78.8% of users, excessive for 11.7% and insufficient for 4% (Table).
231 An elevated number of visitors were observed during the weekends with an average of 41.9%. The
232 crowding perception can be related to the available space per person judgment. In fact, the space per
233 person on the beach was generally adequate (mean 54.7%) especially at Lido di Venezia (60.3%) even if
234 13.8% of users in Lidi di Comacchio judged the space insufficiently. The recreational activities were poor for
235 45.5% of users, sufficient for 30.2% and good for 17.9% of users and an average of almost 50% of users was
236 unsatisfied with the services provided.
237

Table 5: Motivation for the visit and beach appreciation and assessment

QUESTIONS		Lido di Venezia (%)	Lidi di Comacchio (%)	Fiume Santo (%)	Average (%)
QUALITY AND CLEANING OF THE BEACH	good	56.9	39.3	36.5	46.6
	sufficient	31.9	41.4	43.3	37.5
	low	8.8	18.6	16.3	13.7
	no answer	2.5	0.7	3.8	2.2
WIDTH OF THE BEACH	excessive	16.2	4.8	12.5	11.7
	adequate	76.5	84.8	75.0	78.8
	insufficient	2.5	8.3	1.0	4.0
	no answer	4.9	2.1	11.5	5.5
AVAILABLE SPACE PER PERSON ON THE BEACH	adequate	60.3	51.0	49.0	54.7
	sufficient	28.4	33.8	36.5	32.0
	insufficient	4.9	13.8	2.9	7.3
	No answer	6.4	1.4	11.5	6.0
CROWDING	high	11.3	3.4	9.6	8.4
	high only on the week end	32.4	49.7	50.0	41.9
	medium	38.2	35.2	28.8	35.1
	low	14.7	9.0	2.9	10.2
	no answer	3.4	2.8	8.7	4.4
SAFETY	good	53.4	53.1	9.6	43.3
	sufficient	32.8	37.9	10.6	29.4
	low	7.8	7.6	70.2	22.1
	no answer	5.9	1.4	9.6	5.3
RECREATIONAL ACTIVITIES	good	18.6	26.9	3.8	17.9
	sufficient	32.8	44.8	4.8	30.2
	low	40.2	26.9	81.7	45.5
	no answer	8.3	1.4	9.6	6.4
SERVICES/EQUIPMENTS	adequate	56.3	4.8	4.8	8.4
	excessive	12.7	70.3	6.7	49.4
	low	24.0	22.8	77.9	36.0
	no answer	2.1	2.1	10.6	6.2

239

240 The problem of coastal erosion was comprehended by an average of 83.9% of users (Table) and it was
 241 considered important by 88.1% of them. Only 24.5% of interviewed people know about mixed
 242 interventions, 49.2% knew something about breakwaters (particularly at Lidi di Comacchio, 71.7% of users)
 243 and 21.4% about nourishment (Table 6). Submerged barriers were poorly known (an average of 53.6% of
 244 negative responses). The majority of the respondents were not familiar with the ICZM (not known by more
 245 than 80% of users; Table).

246

247

Table 6: Physical, environmental and management factors

QUESTIONS		Lido di Venezia (%)	Lidi Di Comacchio (%)	Fiume Santo (%)	Average (%)
KNOWLEDGE OF BEACH EROSION	Yes	83.8	85.5	81.7	83.9
	No	13.2	12.4	15.4	13.5
	No answer	2.9	2.1	2.9	2.6

BEACH EROSION IMPORTANT ISSUE	Yes	87.7	91.0	84.6	88.1
	No	12.3	9.0	15.4	11.9
	No answer	0	0	0	0
KNOWLEDGE OF ICZM	Yes	15.2	11.7	19.2	15.2
	No	80.9	84.8	67.3	80.9
	No answer	3.9	3.4	13.5	3.9
KNOWLEDGE OF NOURISHMENT	Yes	26.0	15.9	20.2	21.4
	No	66.2	68.3	57.7	64.9
	No answer	7.8	15.9	22.1	13.7
NEED OF NOURISHMENT	Yes	26.5	40.7	19.2	29.4
	No	16.7	11.0	26.0	17.0
	No answer	56.9	48.3	54.8	53.6

248

249 4.2 Willingness to pay

250 **Error! Reference source not found.** summarises the responses of participants to the bids offers. Data
251 collected amounts to n = 358 (yes and no answers) about 81% of the complete data set - because the non-
252 answered interviews and the “protest votes” were not considered (Carson, 2000). Eighty responses were
253 lost during the bidding process as a result of uncompleted answers. Among the 438 respondents who have
254 done the bidding process, 243 (55.5%) accepted the first bid offer and 195 (44.5%) rejected it.
255 Subsequently, there were 104 (24%) ‘yes/yes’; 102 (23%) ‘yes/no’; 38 (9%) ‘no/yes’; and 390 (26%) ‘no/no’
256 responses to the second bid offer.

257

258 **Table 7: Summary of first and second bid responses**

First BID	Second BID			
	Yes	No	No answer	Total
Yes	104 (24%)	102 (23%)	37 (8.4%)	243 (55.5%)
No	38 (9%)	390 (26%)	43 (9.8%)	195 (44.5%)
Total	142 (32%)	216 (49%)	80 (18.3%)	438 (100.0%)

259

260 For each case study, a consistent number of the interviewed were willing to pay a positive amount of
261 money (more than 57% at Lido di Venezia; 52.2% Lidi di Comacchio; 56.3% at Fiume Santo). The percentage
262 of “yes” decreased at all beaches using the follow-up second BID (29.9% at Lido di Venezia; 29% at Lidi di
263 Comacchio; 37.5% at Fiume Santo).

264 The test on regression suggests that the preferred model would include the constant term, which absorbs
265 substantial heterogeneity in a cross-section environment. Signs of estimated parameters are consistent
266 with economic theory and the related expected, therefore we are able to estimate the median WTP of

267 15.53 € on the sample of Lido di Venezia (Table), median WTP of 9.86 € at Lidi di Comacchio and the (Table
268 10) and of 11.87 € at Fiume Santo (Table 12).

269

270 **Table 8: Estimation of the dichotomous logit model (single bounded) for urban beach of Lido di Venezia (number of**
271 **records =199) (S.E.: Standard Error; z: z-Statistic; D.F.: Degree of Freedom)**

Variables		Coeff.	S.E.	z	p-value
Constant	α	0.798	0.251	3.17	0.001***
BID	β	-0.052	0.021	-2.48	0.013**
Regression test					
LL value	LL' value*	χ^2	D.F.	$\chi^2 (0.95)$	
-132.67	-135.81	6.28	1	3.84	0.000
Median WTP = € 15.53					

272 LL value: Log-Likelihood value; LL' value: Log-Likelihood value for the restricted hypothesis (related to the alternative model,
273 without the constant term); χ^2 : chi-square; $\chi^2 (0.95)$: significative chi-square at 0.05. * Alternative model without the constant term
274

275 Results from the application of the multivariate model, which is a sort of 'construct validity equation', are
276 reported in Table , Table 3 and Table 5. The Generalized likelihood-ratio test suggests that the preferred
277 model includes the constant, so the proposed model was statistically significant on the whole. However,
278 only few explanatory variables were found to be statistically significant. Concerning beach typologies, we
279 found that WTP tends to increase in case of presence of beach establishments (or equipped beaches) at
280 Lido di Venezia (Table) whereas it is expected to decrease at Lidi di Comacchio where users were willing to
281 pay more for free beaches (Table 11). However, in the latter case, this relationship was found not
282 statistically significant. At Fiume Santo the variable related to beach typology was not considered because
283 the littoral is completely natural and free. We also found that WTP would increase for the 'place of
284 residence' factor at Lido di Venezia and Lidi di Comacchio, where residents were willing to pay more than
285 tourists (Table and Table 3), a counter-intuitive result that nevertheless shows the importance for policy
286 and management to unveil the latent specific features of demand case by case. On the contrary, WTP is
287 higher for not-residents at Fiume Santo (Table 5). The only result arisen from the Lido of Venezia shows,
288 however, a significant statistical value. At all sites, particularly at Fiume Santo, WTP has a tendency to
289 increase for tourists and non-habitual people that probably visit the beaches for the first time (Table , Table
290 3, Table 5). The level of education, gender, beach frequency, and holiday duration do not appear
291 statistically significant in each model (Table , Table 3, Table 5).

292

293 **Table 9: Estimation of the dichotomous multinomial logit model for Lido di Venezia (number of records=199) (S.E.:**
294 **Standard Error; z: z-Statistic; D.F.: Degree of Freedom).**

Variables		Coefficient	S.E.	z	p-value
BID	β	-0.048	0.021	-2.241	0.025**
Free	FB	1.580	0.651	2.427	0.015**
Gender	G	-0.171	0.310	-0.552	0.583

Frequency	F	-0.142	0.280	-0.508	0.611
Education	E	0.003	0.215	0.015	0.988
Residence	R	-0.772	0.397	1.943	0.052*
Days	D	0.033	0.155	0.214	0.830
Hours	H	-0.161	0.239	-0.675	0.499
Regression test					
LL value	LL' value*	χ^2	D.F.	$\chi^2 (0.95)$	p-value
-129.824	-130.159	0.67	1	3.84	0.000

LL value: Log-Likelihood value; LL' value: Log-Likelihood value for the restricted hypothesis (related to the alternative model, without the constant term); χ^2 : chi-square; $\chi^2 (0.95)$: significative chi-square at 0.05. * Alternative model without the constant term

Table 20: Estimation of the dichotomous logit model (single bounded) for urban beach of Lidi di Comacchio (number of records = 145) (S.E.: Standard Error; z: z-Statistic; D.F.: Degree of Freedom)

Variables		Coeff.	S.E.	z	p-value
Constant	α	1.016	0.286	3.55	0.000***
BID	β	-0.103	0.026	-3.89	0.000***
Regression test					
LL value	LL' value*	χ^2	D.F.	$\chi^2 (0.95)$	p-value
-92.070	-100.080	16.02	1	3.84	0.000
Median WTP = € 9.86					

LL value: Log-Likelihood value; LL' value: Log-Likelihood value for the restricted hypothesis (related to the alternative model, without the constant term); χ^2 : chi-square; $\chi^2 (0.95)$: significative chi-square at 0.05. * Alternative model without the constant term

Table 3: Estimation of the dichotomous multinomial logit model for Lidi di Comacchio (number of records= 145) (S.E.: Standard Error; z: z-Statistic; D.F.: Degree of Freedom).

Variables		Coefficient	S.E.	z	p-value
Constant	α	2.296	1.114	2.061	0.039**
BID	β	-0.097	0.028	-3.449	0.001***
Free	FB	-0.382	0.677	-0.564	0.573
Gender	G	0.077	0.359	0.214	0.830
Frequency	F	-0.263	0.322	-0.817	0.413
Education	E	-0.228	0.265	-0.862	0.388
Residence	R	-0.152	0.526	-0.290	0.771
Days	D	-0.005	0.173	-0.028	0.977
Hours	H	-0.175	0.306	-0.574	0.565
Regression test					
LL value	LL' value*	χ^2	D.F.	$\chi^2 (0.95)$	p-value
-90.9304	-93.877	5.894	1	3.84	0.000

LL value: Log-Likelihood value; LL' value: Log-Likelihood value for the restricted hypothesis (related to the alternative model, without the constant term); χ^2 : chi-square; $\chi^2 (0.95)$: significative chi-square at 0.05. * Alternative model without the constant term

Table 4: Estimation of the dichotomous logit model (single bounded) for natural beach of Fiume Santo – Porto Torres number of records =104) (S.E.: Standard Error; z: z-Statistic; D.F.: Degree of Freedom)

Variables		Coeff.	S.E.	z	p-value
Constant	α	1,163	0,393	2,96	0.000***
BID	β	-0,098	0,036	-2,66	0.000***

Regression test					
LL value	LL' value*	χ^2	D.F.	$\chi^2 (0.95)$	
-67,270	-71,140	7,74	1		0.000
Median WTP = € 11.87					

LL value: Log-Likelihood value; LL' value: Log-Likelihood value for the restricted hypothesis (related to the alternative model, without the constant term); χ^2 : chi-square; $\chi^2 (0.95)$: significative chi-square at 0.05. * Alternative model without the constant term

Table 5: Estimation of the dichotomous multinomial logit model for Fiume Santo (number of records= 104) (S.E.: Standard Error; z: z-Statistic; D.F.: Degree of Freedom).

Variables		Coefficient	S.E.	z	p-value
Constant	α	2.811	1.027	2.736	0.006***
BID	β	-0.101	0.039	-2.571	0.010**
Gender	G	-0.330	0.489	-0.675	0.499
Frequency	F	-0.908	0.427	-2.127	0.033**
Education	E	0.269	0.325	0.827	0.408
Residence	R	0.168	0.469	0.359	0.719
Days	D	0.047	0.179	0.266	0.789
Hours	H	-0.379	0.370	-1.023	0.306
Regression test					
LL value	LL' value*	χ^2	D.F.	$\chi^2 (0.95)$	p-value
-63.01	-65.990	5.96	1	3.84	0.000

LL value: Log-Likelihood value; LL' value: Log-Likelihood value for the restricted hypothesis (related to the alternative model, without the constant term); χ^2 : chi-square; $\chi^2 (0.95)$: significative chi-square at 0.05. * Alternative model without the constant term

4.3 Carrying capacity and estimation of economic values of the beaches

4.3.1 Beach zonation and PCC

Beach zonation is reported for each case study in maps with the determination of available surfaces for each zone. Results show that Lido di Venezia and Lidi di Comacchio had total available areas (without service zones and transit areas) of about 565,700 m² and 506,100 m² respectively (Figure 3, Figure 4, Figure 5). Fiume Santo compared to the other beaches, showed a smaller net surface of about 26,600 m² (Figure 5).

Table 8 shows the PCC 1 and 2 results for the case studies. PCC of Lido di Venezia was similar to Lidi di Comacchio, both for PCC 1 and PCC 2. In fact, they were respectively 141,425 users/day at Lido di Venezia and 126,538 users/day at Lidi di Comacchio considering PCC 1, while were about 226,200 and 202,400 users/day for PCC 2. PCC at Fiume Santo values varied from about 6,500 users/day (PCC 1) to about 10,400 users/day (PCC 2).

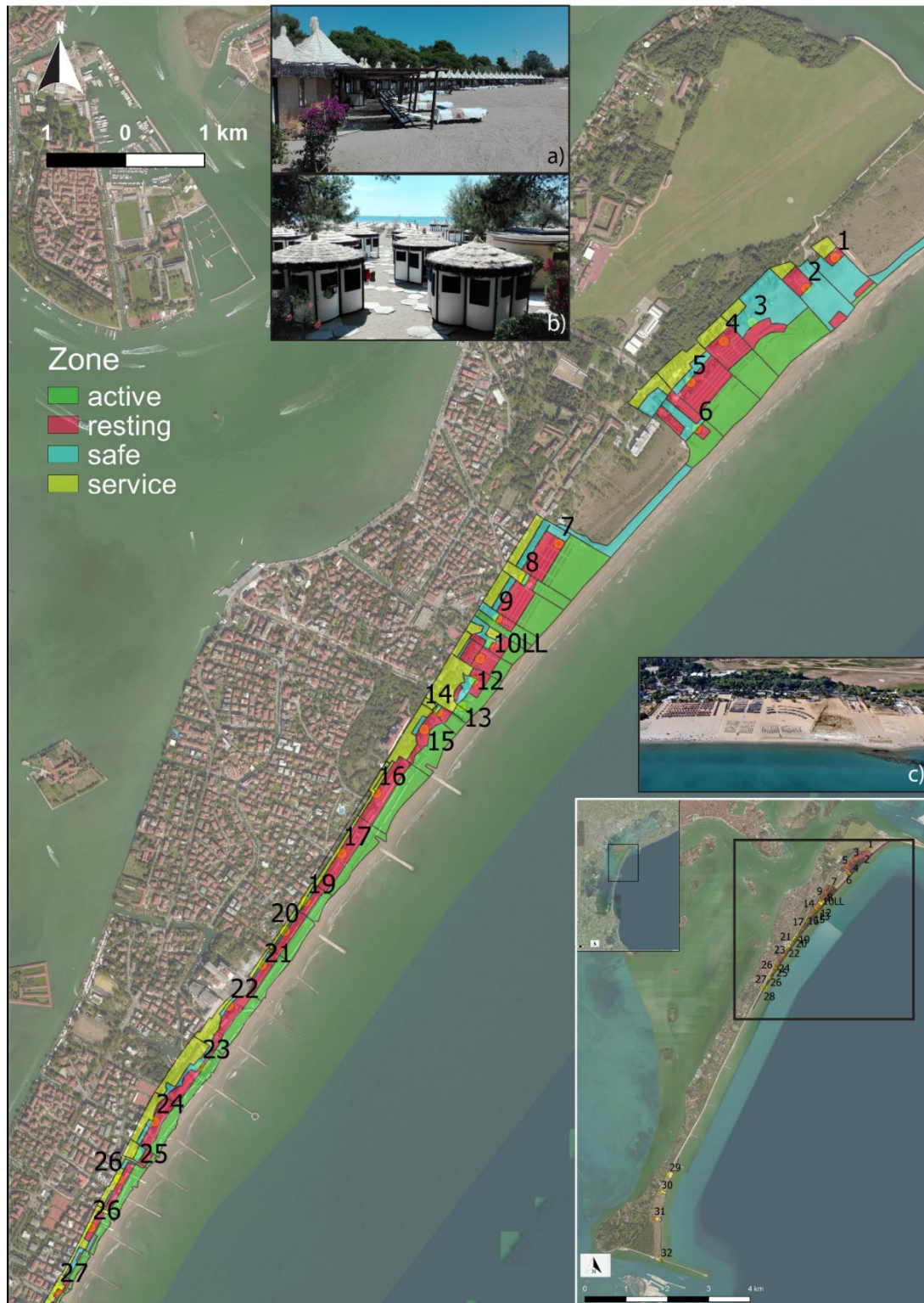


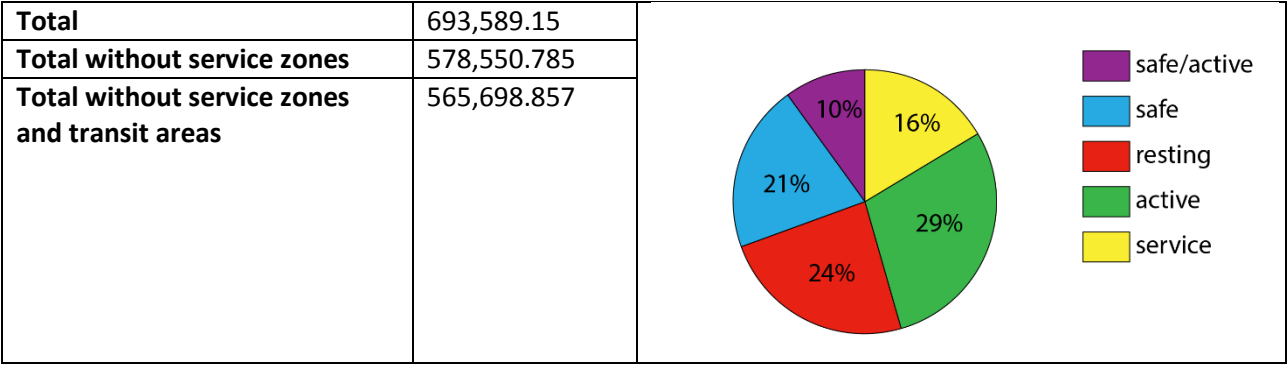
Figure 3: Beach zonation of Lido di Venezia. a) and b) typical beach umbrellas used at Lido di Venezia north (photos taken on June, 15th 2018); c) Google Earth 2018 aerial view of some beach establishments at Lido di Venezia north in which are observing different beach zonations; The base maps are Bing aerial photos of the year 2018, (DigitalGlobe, Microsoft Corporation)



Figure 3: Beach zonation of Lido di Venezia south. d) and e) free beach and beach establishment at Lido di Venezia south (photos were taken on June, 15th 2018); f) Google Earth 2018 aerial view of Site of Community Importance (S.C.I. IT3250023). The base maps are Bing aerial photos of the year 2018, (DigitalGlobe, Microsoft Corporation)

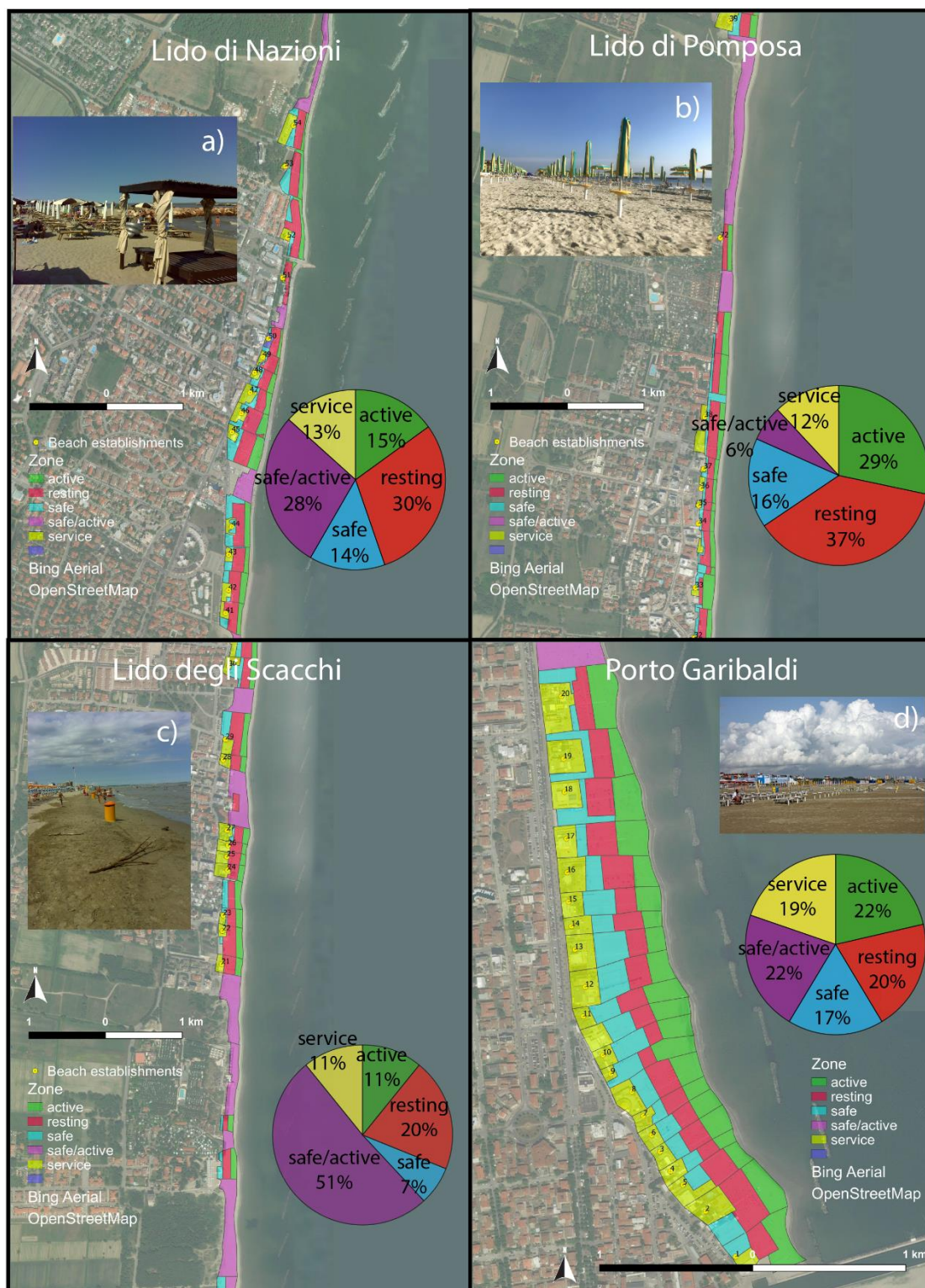
Table 14: Beach zonation results at Lido di Venezia for the reference year 2018

Zone	Surface (m ²)	
service	115,038.372	
active	201,339.406	
resting	166,344.871	
safe	142,315.44	
safe/active	68,551.068	



344

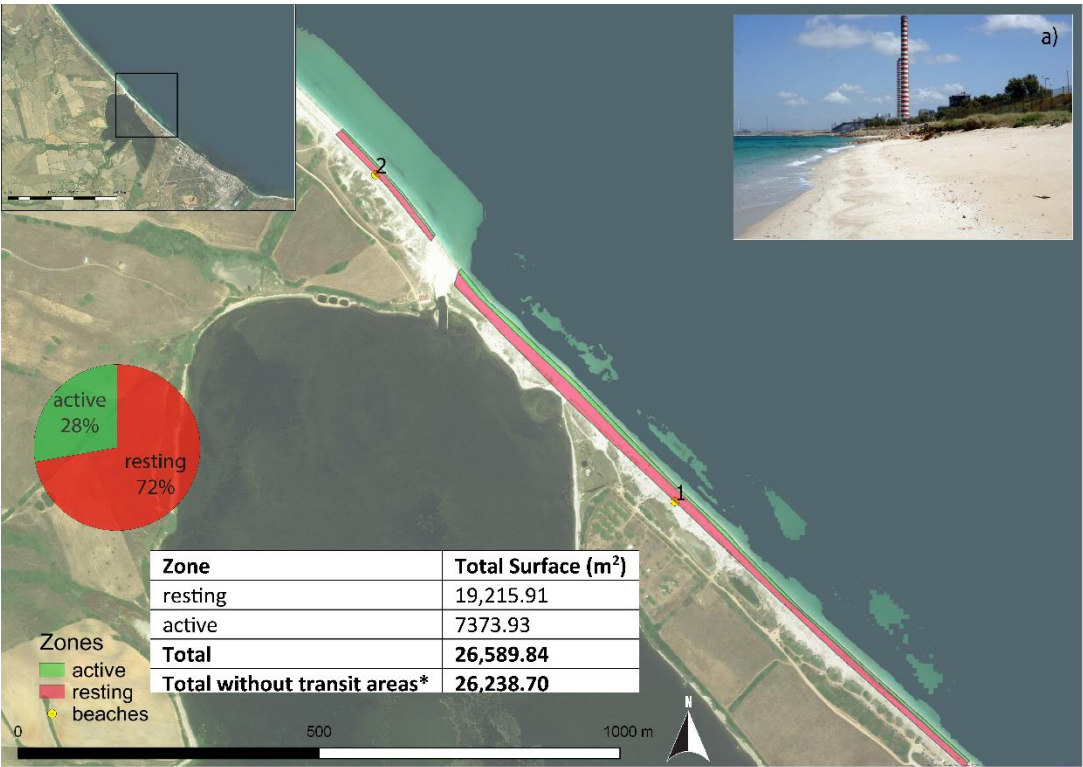
345



Zone	Lido di Nazioni	Lido di Pomposa	Lido degli Scacchi	Porto Garibaldi	Total Surface (m ²)	Percentage(%)
active	27428.15	24571.42	16211.52	41441.24	109652.34	18.06
resting	54621.35	32276.89	29267.70	38429.70	154595.67	25.47
safe	24739.52	14017.90	10271.38	33052.35	82081.16	13.52
safe/active	51568.99	5400.00	74511.40	41817.39	173297.80	28.55
service	24036.35	10251.25	15718.84	37417.17	87423.62	14.40
Total	182,394.38	86,517.48	145,980.86	192,157.88	607,050.61	100
Total without service zones	158,358.03	76,266.23	130,262.01	154,740.70	519,626.98	85.60
Total without service zones and transit areas*	154,596.26	74,839.02	150,776.01	125,941.88	506,153.17	83.37

* transit areas: reduction of 5% of active zone and safe/active zone

347 **Figure 4: Beach zonation at Lidi di Comacchio; a) beach establishment at Lido di Nazioni (photo was taken on August**
 348 **10th 2016); b) resting zone at Lido di Pomposa (photo was taken on June, 2016); c) active zone of Lido degli Scacchi**
 349 **(photo was taken on August, 2017); d) beach establishment at Porto Garibaldi (photo was taken on August, 2018).**
 350 **The base maps are Bing aerial photos of the year 2018, (DigitalGlobe, Microsoft Corporation)**



351 **Figure 5: Beach zonation at Fiume Santo (* transit areas: reduction of 5% of active zone and safe/active zone); a)**
 352 **beach of Fiume Santo (photo was taken on July, 19th 2017). The base maps are Bing aerial photos of the year 2018,**
 353 **(DigitalGlobe, Microsoft Corporation)**
 354

355
 356 **4.3.2 RCC**

357 **4.3.2.1. Precipitation (CF1)**

358 For CF1, the mean number of raining days during the summer period (June to September corresponding to
 359 122 days) is 6 days at Lido di Venezia, and consequently, Cf1 is equal to 0.8032. At Lidi di Comacchio we
 360 considered the period 2004-2016 years (corresponding to 8 years and 976 summers' days) and the related
 361 raining days (324). CF1 for Fiume Santo beach is 0.8927 and it was calculated considering 157 raining days
 362 of 1464 summers' days (reference period 1998-2009).

363 **4.3.2.2. Erosion (CF2)**

364 CF2, which represents the percentage of eroded littoral (Eq.16), ranges from 0.3680 to 1 (Table 7).
 365 The results show that Lido di Nazioni presents the lowest CF2 and therefore is highly eroded, while Fiume
 366 Santo and Porto Garibaldi have the highest FC2 since low erosion or stability has been observed.

4.3.2.3. Beach access (CF3)

CF3 (Table 6) is directly related to the width of the beach (Eq. 17). The results indicate that Lido di Pomposa has the highest beach access factor (0.9640), while PG presents the lowest value (0.2399).

Table 6: CF3 (Beach access)

LEVEL	WIDTH (m)	Lido di Venezia (m)	Lido di Nazioni (m)	Lido di Pomposa (m)	Lido degli Scacchi (m)	Porto Garibaldi (m)	Fiume Santo (m)	MULTIPLYING FACTOR
5	30-50	950	840	1510	655	230		NO
4	51-75	1900	350	620	1120	120		NO
3	76-89	200	200	80	635	5		NO
2	<30	2000	735	20				1
1	>90	2350	65		90	1125		1
TOTAL (m)		7400	2190	2230	2500	1480		
CF3		0.4122	0.6347	0.9910	0.9640	0.2399	0.90	

4.3.2.4. Waste (CF4):

As reported in the method section, CF4 was assessed as 0.95 for each locality.

4.3.2.5. Water quality (CF5)

At Lido di Venezia and Lidi di Comacchio during 2018, the water quality was optimal for bathing activities therefore CF5 was equal to 1 (Table 7). At Fiume Santo in 2018 a part of the beach was interdicted from bathing activities due to the poor water quality (induced by a high concentration of enterococchi and escherichia coli)⁷. Therefore, CF5 of Fiume Santo is 0.90 (Table 7), considering a prohibited zone of 100 m closed to the bathing operations near the case study beach (about 2,700 m on the East-side from the case study area).

Table 7 reports the correction factor results used to calculate the RCC.

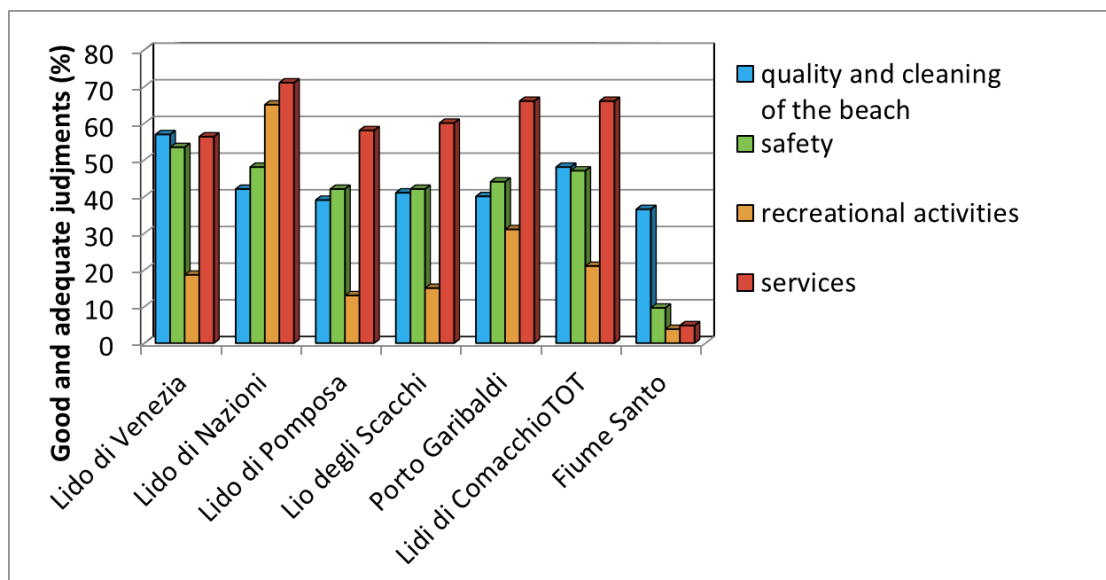
Table 7: Corrective factors (CF1: precipitation factor; CF2: erosion factor; CF3: beach access; CF4: waste; CF5: water quality)

Site	CF1	CF2	CF3	CF4	CF5
Lido di Venezia	0.8032	0.8164	0.4122	0.95	1
Lido di Nazioni	0.6680	0.3680	0.6347	0.95	1
Lido di Pomposa	0.6680	0.8309	0.9910	0.95	1
Lido degli Scacchi	0.6680	0.9900	0.9640	0.95	1
Porto Garibaldi	0.6680	1.0000	0.2399	0.95	1
Lidi di Comacchio (TOT)	0.6680	0.7972	0.7074	0.95	1
Fiume Santo	0.8927	1	0.90	0.95	0.90

⁷ http://www.sardeгнаambiente.it/documenti/39_322_20180420104911.pdf

388 4.3.3 ECC

389 For the application of Eq. 19 we extrapolated the percentages of each parameter for the case studies
 390 (Figure 6).



392
 393 **Figure 6: OMC parameters for each coastal locality**

394 OMC indexes assessed using (Eq. 19) were:

- 395 - Lido di Venezia: 46.3%
- 396 - Lido di Nazioni: 56.5%
- 397 - Lido di Pomposa: 38.0%
- 398 - Lido degli Scacchi: 39.5%
- 399 - Porto Garibaldi: 45.25%
- 400 - Lido di Comacchio Tot.: 45.5%
- 401 - Fiume Santo: 13.67%

402
 403 Table 8 shows the results of PCC, RCC, and ECC for the available net surface of each coastal site.

404
 405 **Table 8: PCC1 considers 8m² per person while PCC2 5 m² per person with a rotation factor of 2 (daily open period of**
 406 **12 hours/average time of occupancy of the beach of 6 hours). RCC1 and RCC2 calculated applying corrective factors**
 407 **and ECC1 and ECC2 applying OMC index.**

Coastal area	Available net surface (m ²)	PCC 1 (users /day)	PCC 2 (users /day)	RCC 1 (users /day)	RCC 2 (users /day)	ECC 1 (users /day)	ECC 2 (users /day)	ECC 1 (users /season) *	ECC 2 (users /season) *
Lido di Venezia	565,699	141,425	226,280	36,310	58,095	16,811	26,898	2,050,979	3,281,566
Lido di Nazioni	154,596	38,649	61,838	5,729	9,167	3,237	3,483	394,919	424,975

Lido di Pomposa	74,839	18,710	29,936	9,777	15,644	3,715	5,945	453,283	725,253
Lido degli Scacchi	150,776	37,694	60,310	22,829	36,526	9,017	14,428	1,100,124	1,760,198
Porto Garibaldi	125,942	31,486	50,377	4,793	7,668	2,169	3,470	264,579	423,327
Total (Lidi di Comacchio North)	506,153	126,538	202,461	45,288	72,460	20,606	32,969	2,513,910	4,022,255
Fiume Santo	26,239	6,560	10,496	4,506	7,210	616	986	75,178	120,284

*considering 4 months of the summer season, equal to 122 days

The daily beach value 1 calculated considering the ECC 1 ranged from about € 7,300 at Fiume Santo to more than €133,300 at Lido di Venezia. The daily beach value 2 varied between 11,700 and 211,700 € (Figure 7).

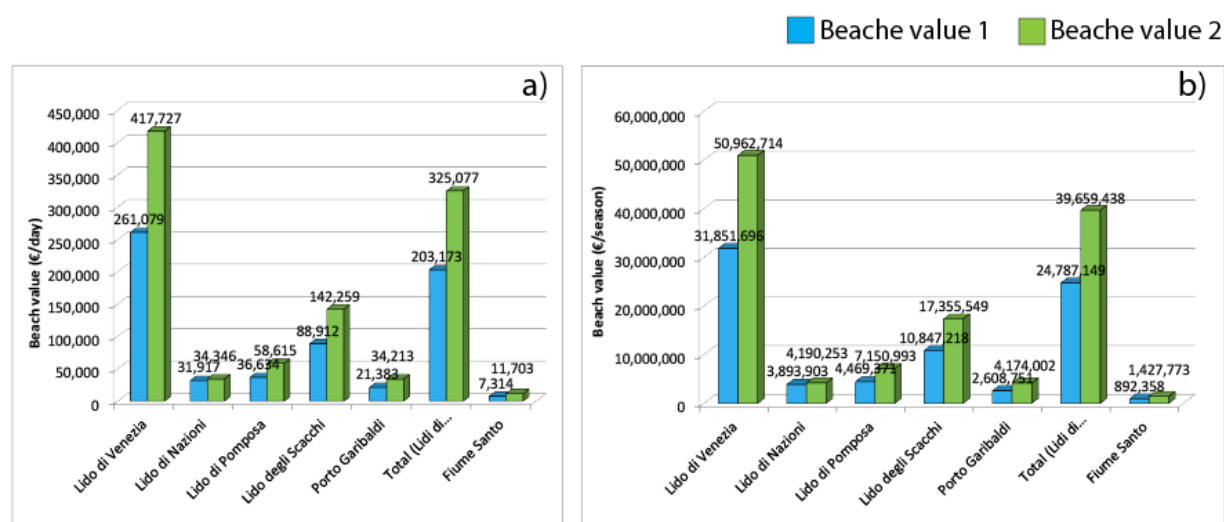


Figure 7: Daily beach values (a); seasonal beach values (b) based on ECC1 and ECC2 for the selected case studies

5 Discussion

5.1 Users' perception

Surveying preferences and opinions of beach users is an application that could yield important information for coastal and beach managers (Dahm, 2003; Koutrakis et al., 2011). However, results of user preferences should be interpreted with caution since they are greatly conditioned by variables such as: demographic characteristics (Dolnicar et al., 2008), proximity of urban area to the beach, climate condition and external conditions of the beach such as transports and the presence of additional activities (Ariza et al., 2012), socio-economic factors (Breton et al., 1996; De Ruyck et al., 1995; Morgan et al., 1993), beach and water quality (Pereira et al., 2003; Vaz et al., 2009; Daniel A Zacarias et al., 2011), landscape (Koutrakis et al.,

2011; Morgan, 1999; Villares et al., 2006), services and recreational activities (Roca et al., 2008; Shivilani et al., 2003), safety (Botero et al., 2013; Williams and Barugh, 2014) and others. Nevertheless, in this study, there are some demographic characteristics and preferences that were common in users of the selected case studies, even if the beach types and touristic frameworks were very different. The common characteristics of each site were: users interviewed had holiday with family, their income was generally low (even if some studies reported an uncertainty of this parameter; Alves et al, 2014), they judged the beach width and space per person adequate but with bad recreational activities, they well-known the erosion phenomenon. These last parameters highlight the importance given to the environment and beach preservation, as confirm by studies in Spain (Peña-Alonso et al., 2018; Roca et al., 2009). The knowledge of erosion notion confirmed the results obtained by Koutrakis et al. (2011) in Riccione beach – Emilia Romagna (70%), Tarquinia beach - Lazio (87%) and in less measure in Riviera del Beigua beach - Liguria (43.3%). Furthermore, 88.1% of the users interviewed considered erosion as a relevant problem (Table). The knowledge of this issue was probably due to habitually frequentation of eroded beaches like Lido di Venezia and Lidi di Comacchio (Table 1) and also because the erosion issue affected about 1,400 km of coast in Italy with Regions having more than 50% of their beaches eroding (Pranzini, 2017; Tavolo Nazionale sull'Erosione Costiera, 2016). Despite the generally frequentation of eroded beaches, the majority of users were clearly uninformed about the nourishment practice (Table), as reported also by (Simeoni et al., 2017). Such results prevalent depend to specifically beach conditions and its physical state. Nourishment was not a common intervention for users probably because is a more recent practice than hard systems. Indeed, the first large nourishment in Italy was carried out in 1971-72 for the creation of Begeggi beach (Vado Ligure, Liguria; Pranzini, 2017). Furthermore, the majority of users (about 53%) did not answer to nourishment need for the beach preservation. This result is in relative agree with previous questionnaire surveys carried out in Italian beaches. Koutrakis et al. (2011), indeed, found that nourishment was not the preferred defence system in comparison of hard defence structures in Emilia-Romagna, Liguria and Lazio Regions. Nevertheless, authors reported that 55 - 80% of respondents believed that the cost for defending the beach from erosion (about 1 M€/km) was justified. In this study, the level of awareness about ICZM is very low (about 15%; Table). This result is quite ambiguous because it probably derived both to the implementation state of ICZM in Italian and more in general in Mediterranean costs and to the environmental attitudes of beach users. ICZM is an iterative process that requires a system of governance with a certain degree of inclusiveness, particularly beyond the state sphere, local and private stakeholders (Tabet and Fanning, 2012). Beach visitors are private stakeholders and their participation in ICZM may reduce local conflicts and make decision-making about coastal management more appropriate in order to provide sustainable beach services (Marzetti et al., 2016). Therefore, our results suggest that more attention should be paid to information about ICZM recommended to policy-makers in order to improve

individual ICZM knowledge. Furthermore, (Ioppolo et al., 2013) deal with the application of ICZM dictates to a sustainable eco-tourism programme about a coastal site in Italy. Beach management and its sustainability, in particular in some eroded beaches, are stricter related to the reduction of sand surfaces and overcrowding. In this study, crowding especially during the weekend was one of the main significant factor that characterized the urban beaches of Lidi di Comacchio and natural beach of Fiume Santo. Furthermore, high crowding level was correlated to poor evaluations of recreational activities and equipment in the same beach categories. These results demonstrated that if crowding was high, tourists paid more attention to beach conditions such as services and recreational activities. The lack or poor offer of some facilities (e.g. rentals, toilets or showers) suggesting that these services could be essential for users' satisfaction (Lozoya et al., 2014).

469

470 5.2 WTP

471 From 52% to 57% of users interviewed were willing to pay a positive sum of money to obtain an
472 improvement in beach management through the setting of a new voluntary based financial scheme. These
473 percentages are slightly lower than 58% reported in the Italian survey (conducted on 4,126 records) by
474 (Rodella et al., 2019b). This result is particularly undesirable for Lidi di Comacchio (52.2% yes) also
475 considering its low median WTP of 9.86 €..

476 The cross-section multivariate regressions are overall significant. Bid values are linked to a negative
477 coefficient and statistically significant, providing a test of the theoretical validity of the datasets.

478 Furthermore, respondents yes answer decreased from Bid 0 to Bid 1, underlying robust statistical and
479 economic dataset (Carson, 2000). Interestingly, the type of beach assumes heterogeneous values for
480 consumers across locations, and some additional covariates such as frequency of visits show the
481 importance of analyzing common features and differences across beaches. WTP for the beach and
482 additional socio-economic factors are varying across sites, with some relevant implications for managers
483 and planners. This CVM study presents an attempt to estimate willingness to pay to enhance the
484 preservation of three beaches, and as such is not without its limitations.

485 Firstly, it elicits WTP for the guarantee in some of beach services and some of the people's attitudes related
486 to different uses of the beach but does not capture the full value of beach as ecosystem service. In fact,
487 CVM and other economic methods like Travel Cost Method (TCM) and Hedonic Prices (HPs) are based on
488 comparability of values (Martinez-Alier et al., 1998), which implies that ecosystem services can be
489 measured by reducing their values to a single monetary unit. However, beaches have many attributes
490 contributing both to ecosystem service and to environmental quality, and some of them may not be
491 easily and/or meaningfully translated into a monetary scale (Ariza et al., 2012). In the absence of other

492 attempts to assess beach value, this study serves as a guide for further research on the topic, but to
 493 address the management needs, other value dimensions of beach need to be studied (Stålhammar and
 494 Pedersen, 2017), like processes related to beach bio-physical condition (e.g. water- sand pollution, the
 495 effect of human changes to the physical condition of the beach), gains and losses of sediments in relation
 496 to protection of coastal facilities, ect.. Non-WTP does not necessarily imply that people do not value the
 497 beach – they may be valued instead in nonmonetary terms, including underlying intrinsic values concerning
 498 the existence, inspiration or aesthetic enjoyment (Chan et al., 2012; Jacobs et al., 2016). These values can
 499 be accounted for using nonmonetary valuation techniques, e.g. sociocultural valuation and integrated
 500 valuation methods (Gómez-Baggethun et al., 2014), which can be integrated with monetary assessments to
 501 achieve sustainable management (Norton et al., 1998).

502 Secondly, it was not specified in the survey how ecosystem service provided by each beach would change
 503 following the better management of the littoral. Survey respondents had to make a decision based on
 504 assumptions, which is difficult to do without a certain degree of familiarity with the ecosystem service
 505 concept and appropriate information about possible beach changes (Blomquist and Whitehead, 1998).
 506 Therefore, CVM may present problems derived from an absence of preferences on some characteristics of
 507 ecosystems (Diamond and Hausman, 1994), even if it takes into account the bequest and option values.
 508 Bequest values refer to the value of the satisfaction obtained from preserving a natural environment for
 509 future generations. Option values refer to the wtp for retaining an option to use a beach that would be
 510 difficult or impossible to replace and for which no close substitute is available (Ariza et al., 2012).

511 Thirdly, some respondents may feel that it is unethical to place a monetary value on public goods such as
 512 wildlife or environmental quality, while others may argue that these goods should be provided “free of
 513 charge” (Lindsay et al., 1992; Rodella et al., 2019a). In fact, people fail to give value to the use of an
 514 ecosystem like a beach although this is important for its preservation, while they are more confident to the
 515 evaluation of services and recreational activities, especially in Italy. This aspect derives from the fact that
 516 most of the Italian beaches have private access and it is necessary to pay for using their facilities, like
 517 sunbeds, umbrellas, equipment, ect. This implies that users believe that they already pay enough for
 518 staying at the beach thus they hesitate to find a value for contributing to beach sustainability. Moreover,
 519 this attitude is exacerbated by local users, which assume that beach facilities and maintenance must be
 520 covered by the payment of local taxes (Rodella et al., 2019a). Nevertheless, our findings could be useful to
 521 compare the WTP (seasonal payment) and the daily expense on the beach, in order to evaluate if the users’
 522 environmental behavior is higher than the recreational behavior. Considering the same temporal extension
 523 for each value, so the user that stay 1 day at the beach (23,5% at Lido di Venezia, 13,8% at Lidi di
 524 Comacchio and 25% at Fiume Santo; Table 5), we can assume that the environmental attitude is higher
 525 than the recreational one for Lido di Venezia and Fiume Santo. Indeed, WTPs of both sites are higher than

the daily expenses (wtp of 15,53€ and daily expense of 12,29€ at Lido di Venezia; wtp of 11.87€ and daily expense of 4.57€ at Fiume Santo). This result is probably due to the particular cultural and historical value of the Venetian littoral and the environmental and landscape value of Porto Torres-Stintino coast. On the contrary, users of Lidi di Comacchio showed less environmental behavior (wtp of 9.86€ lower than daily expenses 15,32€), probably related to the poor landscape and scenery value of these beaches and their unattractive urbanization (Rodella and Corbau, 2020). In conclusion, our approach aims to obtain an economic value following a sustainable and conservative purpose also according to carrying capacity final aim. This implies that economic methods like CVM and others focus on the characteristics valued by humans, thus aspects not easily perceived may be ignored.

5.3 Carrying capacity and beach valuation

Many studies are generally concerned about the comprehensive assessment of the environment and the economy (Sowman and Raemaekers, 2018). They are also trying to achieve sustainable development by revealing substantial conflicts between socio-economic development and resource-environment systems (Hák et al., 2016; Madeira et al., 2018). Carrying capacity assessment is helpful to promote the coordinated development of the environment and human activities. It can not only calculate the optimal quantity of factors (population, land, water resources, etc.), but also promotes the fairness and sustainability of resource consumption to meet environmental thresholds. Studies on beach carrying capacity have been undertaken at a number of sites on the European coast (Basterretxea-Iribar et al., 2019; Bon de Sousa et al., 2018; Gonson et al., 2018; López-Dóriga et al., 2019), although only limited researches have been conducted on Italian beaches (Corbau et al. 2019; Rodella et al. 2017). In this study, carrying capacity was estimated applying the Cifuentes (1992) method that is dependent both on physical parameters and on corrective and management factors of the beaches (Cifuentes, 1992; Rodella et al., 2017a; Saltarén et al., 2008). Concerning the available surfaces identified in the satellite images and the relative beach zonations, some consideration could be taken into consideration. First of all, the dimensions of each area depend on the actual beach width, and in case of administrative concession of a part of the beach ("Bagno" or "Lido" in Italy) the spatial distribution of users across the beach is almost uniform, and with the exception of very wide beaches, the entire subaerial beach surface is exploited (I. Rodella et al., 2017a; Valdemoro and Jiménez, 2006). Secondly, in relatively wide beaches the safe zone, which acts as a buffer area between the resting zone and the service zone, is presented. Similar zoning has been adopted by (Polette et al., 2003) in a carrying capacity analysis on Brazilian beaches. Thirdly, on the Mediterranean coast, resting area is usually restricted to 20-25 meters (Valdemoro and Jiménez, 2006) closer to the waterline due to the hot on the rest of the beach. Users justify this behavior by citing the fact that sand gets very hot on sunny days, and walking across large areas of the beach is uncomfortable. In view of these considerations, we can consider our CC estimation as the maximum number of users that can stay at a beach. This number has

560 been reduced with the application of the corrective factors (Error! Reference source not found.).
 561 Corrective factors were used to obtain the RCC acting on the PCC in different ways. Although the Waste and
 562 Water factors did not affect the results (similar for all beaches and close to 1), Erosion and Access factors
 563 modify the carrying capacity according to the beach geomorphological characteristics. For instance, the
 564 carrying capacity was “greatly” reduced along eroded stretches such as in Lido di Nazioni (fc2 of 0.3680;
 565 Table 15) and also reported by (Montanari and Marasmi, 2014). The application of the OMC index affects
 566 the ECC results in terms of tourist presence (Table 8). Beach management, in fact, was greatly affected by
 567 poor recreational activities at all sites excluding Lido di Nazioni (Figure 6). On the contrary, quality of
 568 services was the best parameter that raised OMC index at Lido di Venezia and the other Lidi di Comacchio.
 569 Fiume Santo, for its characteristics, has been critically affected by OMC index even if this site presented
 570 high value for quality and cleaning of the beach.
 571 Contingency valuation and carrying capacity allowed the determination of the total monetary valuation for
 572 each beach (Figure 7). Lido di Venezia had the highest valuation (from almost 32 € to about 50 M€/season;
 573 Figure 7b), only considering the northern and the southern zones of the littoral. In comparison with other
 574 beaches, Lido di Venezia presented the greatest beach width (up to 220 m in 2018) and the highest
 575 available net surface. On the other hand, Lidi di Comacchio and Fiume Santo beaches presented beach
 576 width that varied from about 20 m (Fiume Santo, Lido di Nazioni and Lido di Pomposa) to about 100 m (Lido
 577 degli Scacchi e Porto Garibaldi). Therefore, these coastal localities presented carrying capacities and beach
 578 values lower than Lido di Venezia, also after the application of corrective factors.
 579 A special case concerns the beach of Fiume Santo. Indeed, part of the littoral, as defined by the Coastal Use
 580 Plan - CUP (Sassari Municipality, 2016), is located within the area of territorial jurisdiction of Olbia and
 581 Golfo Aranci Port Authorities (extended to the Porto Torres Harbor). Therefore, this specific area cannot be
 582 considered as a planning area. Therefore, considering the only planning beach area of 3,637 m² permitted
 583 by the Coastal Use Plan - CUP (Sassari Municipality, 2016), the PCC1 and PCC2 should be 455 and 727 users
 584 respectively. Consequently, the beach value 1 and 2 should be 2,123 €/day and 3,397 €/day respectively,
 585 thus very smaller than those obtained in our results.
 586 From a social and management point of view, it seems useful to compare local investment and economic
 587 valuation. Although the limitations of the method used must be borne in mind, this comparison provides an
 588 approximation to cost-benefit analysis (CBA). In this study, we focused attention only on recent investments
 589 because historical investments have a residual economic value close to zero. Furthermore, recent – public or
 590 private - investments better reflect the management needs of each beach (before the investments). In this
 591 sense, the analysis appears as a cost-opportunity exercise comparing the recent investments made for
 592 conservation by part of public and/or private subjects with the willingness to pay by part of tourists for
 593 conserving the beaches. Furthermore, in a CBA analysis, the estimated total WTP (average WTP*population

of reference) minus the costs to produce the change (beach conservation) conveys a net benefit or cost figure.

Other costs (beach fees, cleaning costs and different businesses around the tourist activities like hotels, restaurants, etc..), are not relevant to analyze the welfare change under the analysis. In fact, other costs may be used in the overall assessment of the beach financial value in the status quo, but not for the examination of proposed changes as conservation scenarios of the frequented beach.

At Venezia City, in the period 2018-2020, the local government has estimated a total amount of about 23,4 M€ (Città di Venezia, 2017) of which about 4,3 M€ (Table 9) also for Lido di Venezia beach management and maintenance (in some cases the amounts are established also for other Venezia localities and is not possible to obtain the specific amounts for Lido di Venezia, e.g. safety of bridges and piers). As can easily be seen, the economic valuations calculated using the WTP for one season (31,8-50,9 M€) were not compensated by the annual investment made by the local government on the beach of the municipality. Lidi di Comacchio and Fiume Santo showed a gap between investments made by managers of the beaches and beach economic valuation (Table 9). Actually, the total amount of investment in Lidi di Comacchio for the period 2017-2019 is 13,297,875 € (Municipality of Comacchio, 2016), of which 600,000 € is for the beach (divided in 400,000 € for “harbor channel” dredging and 200,000 € for urban requalification/maintenance of littoral zone in 2017).

Dredging is not a direct beach maintenance activity but we decided to include it in the local investment amount because it is a source of sand for beach nourishment. In this sense, investments made for dredging could be also considered as investments for beach preservation. Nevertheless, the marine sediments dredged in harbors or near large industrial and urban areas usually show high levels of contamination (Rodella et al., 2017), thus their reuse must complain of legislation (i.e. Italian Legislative Decree 152/2006, the Nitrates Directive (Council Directive 91/676/EEC; European Community 1991), and the Water Framework Directive (Directive 2000/60/EC; European Community 2000).

This investment did not achieve the beach value that varied from 24,7 to 39,6 M€. Again, local projects could invent new forms of funding that bring together effectiveness (raising money) and acceptability/involvement of people (De Buysere et al., 2012; Hörisch 2019). The worse situation is presented for the beach of Fiume Santo. Since 2010, indeed, local administration did not invest in this beach and there will not plan investment for the next few years (Sassari Municipality, 2017). This condition is probably due to the fact that this beach is partially located in an area of industrial use as mentioned above and between two different municipalities (Stintino and Porto Torres). Because of this, the administrations probably do not invest in this beach, although its preservation is absolutely necessary to preserve the SCI and SPA zones (ITB010002 “Stagno di Pilo and Casaraccio”; ITB013012 “Stagno di Pilo, Casaraccio and Saline di Stintino”). The lack of investments is potentially explained by the lower-income level of Sardinia. GDP PPS per capita in Sardinia is much lower than the Italian average. In 2016, it was 20,600€, far below the Italian (28,200€) and the European average

(29,200€). This indicator, from 2008 to 2014, has registered a 6.2% decrease (higher than the Italian average decrease, 4.5%)⁸. It is even more relevant in developing regions to operationalize mixed funding schemes, trying to activate the local and also global community for the funding of environmental public good quality. In Sardinia region, for instance, the European Funding scheme for the Environment Protection & Resource Efficiency, funded more than 164M€⁹ for environmental regional protection. However, only 28% of this amount was effectively spent during the reference period of 2014-2020. This negative data, thus indicated that more effort should be done in order to find a balance between investment scheduling and management and the preservation of a good or a resource like a beach.

Table 9: Comparison of local investments and beach values per season

Localities	Local investments (€)	Beach value 1 per season (€)	Beach value 2 per season (€)
Lido di Venezia	4,322.875,61 (in 3 years 2018-2020)	31,851,696	50,962,714
Lidi di Comacchio	600,000 (in 3 years 2017-2019)	24,787,149	39,659,438
Fiume Santo	0	892,358	1,427,773

It is worth noting that CVM studies find a coherent real-world mechanism in donations based schemes. This means that social value is underestimated by public investments. It is a sign of the crisis of public action towards the funding of environmental public goods, specifically for actions towards the achievement of Sustainable Development Goals (SDG)¹⁰ 7 (Energy), 11 (Cities), 12 (Sustainable Consumption and Production), 14 (Oceans) that are directly or indirectly covered by the present study. Additional funding can be generated by increasing local (earmarked) taxes or through financial tools such as project-based crowdfunding or donation-based trusts. The latter might present higher social acceptability and deeply involve the community of users around the beach enhancement project. Tax based contributions and voluntary donations, which are exposed to free riding, possibly complement. Values found in this study are higher than the values found in other similar studies in different coastal areas: 324 US\$/ha year (Edwards and Gable, 1991); 1791 US\$/ha year (Taylor and Smith, 2000), 609.9 USD million per year at Cha-Am beach, Thailand (Saengsupavanich, 2019). This may be related to the fact that the intensity of beach use in the Mediterranean may be higher than in other coastal locations as reported by Ariza et al. (2012). These findings should be considered in future studies valuing beach services in the

⁸ <https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/sardinia>

⁹ <https://cohesiondata.ec.europa.eu/programmes/2014IT16RFOP015>

¹⁰ The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including those related to poverty, inequality, climate, environmental degradation, prosperity, and peace and justice. The Goals interconnect and in order to leave no one behind, it is important that we achieve each Goal and target by 2030. <https://www.un.org/sustainabledevelopment/sustainable-development-goals/> (last access on August, 3 2019)

653 area. The fact that the economic valuation attributed by users to beaches is lower than the investment is
654 also affected by specific local dynamics, therefore specificities should be considered in future studies of
655 beach management. With the results obtained when valuing beaches from an economic point of view, it
656 seems realistic to suggest the possibility of implementing a kind of “beach management tax., and/or a
657 “beach donation-based trust” The establishment of tax or a trust may be especially interesting for
658 protecting landscape and natural beaches, bear in mind that the beach is also the first protection system
659 against the coastal flooding and damage (Utizi et al., 2016). The targeted tools that are detached from the
660 general public budget fuelled by income taxes. That sum of money could allow the establishment of more
661 effective, direct, proactive measures operated through the local community (or extended to the larger
662 users’ community), such as the land purchase or the implementation of public participation research
663 programs. This would allow the change of focus of beach management in the area, from the short-term
664 satisfaction of users, to socio-ecological system conservation.

665

666 **6 Conclusions**

667 This research presents an integrated approach linking the analysis of users' perception, carrying capacity and
668 willingness to pay, for the enhancement of beach preservation in Italy. Several surveys were carried out in
669 three beaches collecting more than 400 questionnaires and topographical data analyzed using statistical
670 methods. Beach features were analyzed in order to identify beach typologies, the zonation of the beach and
671 finally the carrying capacity.

672 Results show that people express a significant willingness to pay for coastal preservation in Italy, probably
673 because tourists well-known the erosion term and considered erosion as a relevant problem of the beach,
674 even though they were clearly uninformed about the defence interventions and related effects. **Moreover,**
675 **users’ were willing to pay probably because of their habitual frequentation of the beach, mainly for its**
676 **recreative function during the summer season.** As also suggest by user perception analysis, with regard to
677 the visitors’ attitudes toward beach management, two points deserve to be mentioned. One is the crowding
678 problem on the sites, which perhaps reflects the overcapacity use of beach resources. Therefore, beach
679 management has to pay attention to the number of visitors arrived, especially during peak tourism seasons.
680 The other one is that based on the survey responses, most visitors have shown their concerns over the
681 recreative quality of the beaches, which may create a negative effect on the travelers’ repeated visit(s), the
682 level of their WTP, and probably reducing the beach’s revenue potential in the future.

683 Results outline the importance of investigating demand latent features for better and more informed
684 management and planning of resources that should be framed around sustainability, wellbeing and
685 profitability goals.

Multivariate analysis shows that the economic value depends on the beach management typology (available surfaces) and therefore to their physical, real and effective carrying capacities. The estimation of two carrying capacities allowed us to obtain two different beach values and, therefore, to better estimate the possible real value of the beaches. In this analysis, we also compared economic beach valuation with the expenditure on general maintenance by local Administrations. The results show a gap between investments made by managers of the beaches and beach economic valuation.

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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: