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Benefits of coastal recreation in Europe: Identifying trade-offs and priority regions for sustainable management

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ABSTRACT

This paper examines the welfare dimension of the recreational services of coastal ecosystems through the application of a meta-analytical value transfer framework, which integrates Geographic Information Systems (GIS) for the characterization of climate, biodiversity, accessibility, and anthropogenic pressure in each of 368 regions of the European coastal zone. The relative contribution of international, domestic, and local recreationists to aggregated regional values is examined. The implications of the analysis for prioritization of conservation areas and identification of good management practices are highlighted through the comparative assessment of estimated recreation values, current environmental pressures, and existing network of protected sites.

1. Introduction

The remarkable growth in coastal tourism and recreation in Europe in the past decades has consolidated the role of these sectors as major drivers for local employment and regional economic development. This is the case both in highly popular destinations in southern European countries as well as in large parts of the North and Baltic Seas and remote areas such as the Western Isles of Scotland (Jones et al., 2011; Hasselström, 2008). The converse side of this growth has often been an increase in the pressure and impacts on environmental quality, biodiversity, and overall health of the coastal and marine ecosystems. The Millennium Ecosystem Assessment identifies in tourism and recreation-related infrastructure development the second largest threat to the sustained provision of the ecosystem services generated in coastal habitats (MA, 2005). Given the high standing of a healthy natural environment among visitors' preferences, such trend may, if not reversed, ultimately backlash on coastal tourism demand, reversing the very factors that set it in motion in the first place (Onofri and Nunes, 2013). The European Union (EU) has long recognized the need for sustainable tourism management of its coastal margin. In September 2010, the European Council embraced the Integrated Coastal Zone Management Protocol of the Barcelona Convention,[1] which calls for rational planning management of the “irreplaceable ecological, economic and social resource[s]” that are associated with coastal zones. It encourages sustainable tourism, sporting, and recreational activities that “preserve coastal ecosystems, natural resources, cultural heritage and landscapes” (Protocol on Integrated Coastal Zone Management in the Mediterranean, 2009).

There is an increasing interest and understanding in the scientific literature regarding the economic values provided by marine protected areas and the possibility to combine nature conservation with the sustainable provision of valuable services, such as outdoor recreation and nature tourism (Kettunen and ten Brink, 2013). The evidence so far, however, is typically site- and context-specific, and there is a lack of analytical frameworks at the regional and national level for a comprehensive assessment of services value flows and

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[1] Please consult www.unep.ch/regionalseas/regions/med/t_barcel.htm for more information.

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the distributional implications of different management options. Such knowledge is crucial for understanding the trade-offs of alternative policies and setting priorities for sustainable governance (Samonte et al., 2014).

From an economic perspective, policies for the sustainable governance of coastal recreation are founded on the thorough assessment of their impacts on human welfare. The economic valuation of the benefits of recreational activities is challenged by the fact that the associated welfare impacts are often not reflected in market transactions. Within the toolbox of valuation techniques that environmental economists have at their disposal to infer the value of non-market goods and services, one can distinguish two major categories: stated preference methods, which rely on the simulation of a market through a questionnaire administered to a sample of the affected population (e.g., contingent valuation method, choice experiments); and revealed preference methods, which seek to elicit preferences and implicit prices from actual, observed, market-based information that is indirectly linked to the ecosystem service in question (e.g., travel cost method, hedonic pricing).

Although the number of applications of non-market valuation techniques to coastal recreation is steadily growing, valuations typically have a limited geographical and socio-economic scope. As a consequence, the use of value transfer is increasingly regarded as a practical way of valuing ecosystem services without pursuing an *ad hoc* primary valuation study (Brouwer, 2000; Troy and Wilson, 2006). Value transfer refers to the procedure of drawing inferences on the unobserved monetary value of an ecosystem good or service by borrowing existing valuation estimates from comparable sites. Although it is recognized as a second-best strategy when primary research is not possible or plausible due to time or budget limitations (Liu et al., 2011), several international initiatives have highlighted its attractiveness to assess environmental change at large geographic scale, where primary valuation is unlikely or impracticable (Stern, 2007; Braat and ten Brink, 2008; TEEB, 2010). Several application of meta-analytical value transfer – i.e., resulting from the statistical analysis of a collection of previous individual primary valuation studies – to the investigation of recreation benefits are available in the literature (Rosenberger and Loomis, 2000), including studies with a focus on coastal ecosystems (Brander et al., 2007; Liu and Stern, 2008; Ghermandi and Nunes, 2013; Londoño and Johnston, 2012). The integration of meta-analytical value transfer and Geographic Information Systems (GIS) has emerged as particularly suitable to scale up values from localized changes in individual ecosystem sites to multiple ecosystem sites within a large geographic or administrative area (Brander et al., 2012).

This paper implements GIS tools and meta-analytical transfer techniques to investigate the spatial distribution of economic values of recreational services provided by coastal ecosystems in the European coastal zone and analyze the implications thereof from a planning and management perspective. After presenting the meta-analytical framework and using econometric techniques to identify the drivers of coastal recreation values, a value transfer function is applied to estimate the flow of recreation values in each of the 368 regions of the European coastal zone. The role of international, domestic, and local beneficiaries to the formation of the aggregate regional values is assessed. The spatial overlap of the estimate values with extant environmental pressures and the established network of protected areas allows for the identification of twenty-one priority regions for improved environmental management. In addition, twelve regions are singled out and recommended for further investigation, where high recreation values are associated with high protection status, possibly as a result of good coastal recreation management practices.

2. Material and methods

2.1. Valuation dataset and effect-size estimate

A research for both published and unpublished primary valuation studies of coastal recreation was conducted using a variety of resources. Studies were retrieved from online databases, websites of academic journals and through keyword searches online search engines. Unpublished working papers, reports, conference proceedings and dissertations were obtained from working paper series of academic and research institutions, governmental and environmental organizations. The search was limited to studies written in English, French, German, Italian or Spanish.

The criteria for the final selection of studies were as follows. Only studies focusing on actual use values were considered, i.e., estimates of passive, option and quasi-option values or mixed estimates of use and non-use values were excluded. No benefit transfer estimate was selected. Non-market value estimates from both outdoor recreation activities (i.e., activities undertaken as part of daily or weekend routines) and nature tourism were included (i.e., activities that people enjoy while on holiday and usually include an overnight stay) (Bell et al., 2007). Valuation methodologies that were included are: stated preference methods (contingent valuation and choice experiment); revealed preference methods (travel cost method); and combined stated and revealed preference methods (contingent behavior). Only studies from Europe and North America (USA and Canada) were included in order to limit the heterogeneity across socio-economic and cultural contexts (Nelson and Kennedy, 2009). All observations in the dataset ought to fulfill the requirements for the effect-size and moderator variables of the meta-regression model. The final dataset is composed of 38 studies, from which 177 separate value observations could be extracted.

The effect-size used in this study is the value of an individual coastal recreation trip, expressed in international dollars (I$) relative to the year 2007.[2] The majority of observations reported per-person values rather than per-household estimates. Values expressed in currencies other than US$ or referring to years other than 2007 were standardized by means of Purchasing Power Parity (PPP) factors from the Penn World Table 6.3 (Heston et al., 2009) and GDP deflator indexes from the US Economic Research service (www.ers.usda.gov/data/macroeconomics). The standardized recreation trip values were found to range between 0.1 and 1000 I$/person/trip, with a majority of values clustered between 3 and 100 I$/person/trip. The median effect-size is 22.41 I$/person/trip.

Table 1 gives an overview and graphical summary of the primary valuation studies in the dataset, including number of observations extracted, size of the usable survey sample and average effect-size estimate per study.

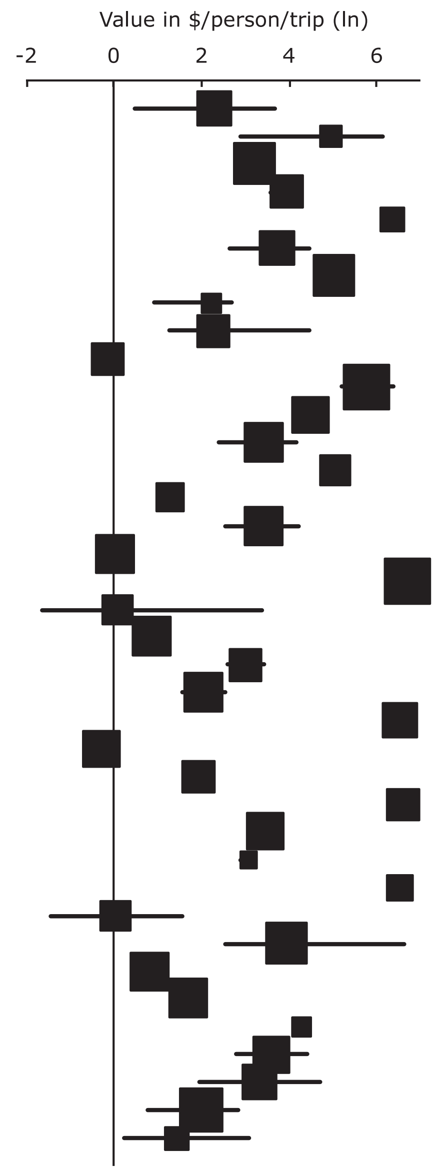
2.2. Moderator variables and model specification

The moderator variables of the model were selected based on

[2] Based on the average conversion rate in 2007: US$1 = €0.7308. For Sandström et al. (2000) and Landry et al. (2003) the value of a recreation trip was calculated from a total yearly value, based on the number of individual recreation trips as reported in the study.

Table 1
Overview of primary valuation studies (left) and forest plot of effect-size estimates (right) Agnello and Han, 1992; Bell, 1981; Bergstrom et al., 1990, 2004; Bhat, 2003; Bonnieux and Appere, 2003; Brown et al., 1981; Cantrell et al., 2004; Falk et al., 1994; Hanley et al., 2003; Hausman et al., 1995; Huang et al., 1997; Johnston et al., 2002; Jones and Stokes Associates Inc, 1987; King, 1995; Kling and Herriges, 1995; Landry et al., 2003; Leeworthy and Bowker, 1997; Lin, 1994; Lipton, 2004; Machado and Mourato, 1999; Marangon et al., 2002; Martínez-Espiñeira and Amoako-Tuffour, 2008; Mourato et al., 2003; Oh et al., 2008; Park et al., 2002; Parsons et al., 2009; Péronnet et al., 2003; Rosato and Defrancesco, 2002; Rudloff et al., 1997; Sandström, 1998; Shivlani et al., 2003; Thomas and Stratis, 2002; Wey, 1990; Whitehead et al., 2000; Whitehead et al., 2008a, 2008b; Whitmarsh et al., 1999.

Study ref.	Country	Obs.	Avg. value (ln)
Agnello and Han, 1992	USA	9	2.29
Bell, 1981	USA	6	4.96
Bergstrom et al., 1990	USA	1	3.23
Bergstrom et al., 2004	USA	3	3.97
Bhat, 2003	USA	1	6.36
Bonnieux and Appere, 2003	FRA	6	3.74
Brown et al., 1981	USA	2	5.02
Cantrell et al., 2004	USA	12	2.24
Falk et al., 1994	USA	12	2.27
Hanley et al., 2003	GBR	1	-0.14
Hausman et al., 1995	USA	6	5.79
Huang et al., 1997	USA	3	4.50
Johnston et al., 2002	USA	4	3.42
Jones and Stokes, 1987	USA	8	5.06
King, 1995	USA	3	1.28
Kling and Herriges, 1995	USA	6	3.41
Landry et al., 2003	USA	4	0.02
Leeworthy and Bowker, 1997	USA	1	6.71
Lin, 1994	USA	9	0.09
Lipton, 2003	USA	1	0.86
Machado and Mourato, 1999	PRT	2	3.00
Marangon et al., 2002	ITA	5	2.04
Martinez-Espineira et al., 2008	CAN	5	6.55
Mourato et al., 2003	GBR	1	-0.28
Oh et al., 2008	USA	3	1.95
Park et al., 2002	USA	2	6.61
Parsons et al., 2008	USA	1	3.46
Peronnet et al., 2003	FRA	2	3.07
Rosato and Defrancesco, 2002	ITA	2	6.53
Rudloff et al., 1997	FRA	2	0.06
Sandstrom, 1998	SWE	10	3.94
Shivlani et al., 2003	USA	2	0.81
Thomas and Stratis, 2002	USA	1	1.69
Wey, 1990	USA	8	4.28
Whitehead et al., 2000	USA	4	3.59
Whitehead et al., 2008a	USA	15	3.32
Whitehead et al., 2008b	USA	5	1.99
Whitmarsh et al., 1999	GBR	9	1.44



Note In the forest plot, primary values are shown as squares, centered on the average effect-size estimate for the study. The horizontal lines show the variability of the values across observations within studies. The size of the square is proportional to the logarithm of the sample size.

Table 2
Moderator variables of the meta-regression model.

Variable	Definition	Summary[a]
Ecosystem type:		
NEARSHORE	Binary for near-shore, open-water ecosystems	19/177
REEF	Binary for coral reefs	4/177
LAGOON	Binary for lagoons and coastal marshes	29/177
BEACH	Binary for sandy beaches	90/177
ESTUARY	Binary for estuarine ecosystems (omitted)	10/177
MIXED	Binary for mixed ecosystems	26/177
Ecosystem service:		
SPORTFISH	Binary for boat and shore fishing	90/177
HUNT	Binary for recreational hunting[b]	11/177
HIKEVIEWSWIM	Binary for hiking, nature viewing, and swimming	99/177
PLEASUREBOAT	Binary for pleasure boating	38/177
NAMERICA	Binary for studies from USA and Canada	134/177
Valuation method:		
CVM_OE	Binary for open-ended contingent valuation	42/177
CVM_OTHER	Binary for contingent valuation other than open-ended (omitted)	24/177
CHOICE	Binary for choice experiment method	7/177
ZTCM	Binary for zonal travel cost method	3/177
TCM_OTHER	Binary for travel cost method (individual and RUM)	82/177
CONT_BEHAV	Binary for contingent behavior method	19/177
DAYTRIP	Proportion of sampled recreationists on a day trip [0–1]	0.76 (0.38)
SUBSTITUTES	Binary for valuations accounting for substitute sites	63/177
ENVCHANGE	Binary for valuations of environmental changes	82/177
UNPUBLISHED	Binary for unpublished working papers, reports and theses	67/177
HOUSEHOLD	Binary for effect-size estimates expressing a per-household value	34/177
YEAR	Years elapsed since first survey in the dataset (1975)	19.51 (7.03)
LNREAL_GDPPC	Real GDP per capita [I$/person/year, 2007, log][c,d]	10.81 (0.18)
LNPOPDENS	Population density [inhabitants per km^2, log][e,f]	4.73 (1.53)
MIN_TEMP	Minimum monthly temperature [°C][e,g]	1.64 (7.59)
MIN_PR	Minimum monthly precipitation [mm][e,g]	60.9 (20.8)
LNACCESS	Travel time to city with >50,000 inhabitants [hours, log][e,h]	4.70 (7.59)
LNNUTRIENTS	Nutrients within 5 km from coast [ton/km^2/year, log][e,i]	2.58 (2.08)
MARINBIODIV	Shannon index of marine biodiversity[e,j]	4.45 (1.51)

[a] For binary variables, frequency of occurrence in the dataset; for continuous variables, mean value and standard deviation.
[b] All the 11 observations of recreational hunting values are from US studies.
[c] At NUTS-2 level for Europe, state level for USA and OECD territorial level 2 for Canada.
[d] Source: Eurostat (epp.eurostat.ec.europa.eu).
[e] At NUTS-3 level for Europe, county level for USA and OECD territorial level 3 for Canada.
[f] In year 2000. Source: US Census Bureau (www.census.gov) and Eurostat.
[g] Evaluated at 10 min resolution. Source: BioClim (Hijmans et al., 2005).
[h] Source: EC Global Accessibility Maps (bioval.jrc.ec.europa.eu/products/gam/index).
[i] Source: Halpern et al. (2008).
[j] Evaluated at 0.5° resolution. Source: Ocean Biogeographic Information System, OBIS (www.iobis.org).

theoretical expectations and empirical outcomes of previous valuation studies and meta-analyses of ecosystem service values. Table 2 provides an overview of the moderator variables and their range of variability in the dataset. Context variables were evaluated at the Level 2 or 3 of the Nomenclature of Territorial Units for Statistics (NUTS-2 and NUTS-3) of the European Union.[3]

Five ecosystem types are considered: near-shore open water, coral reefs, lagoons, sandy beaches, and estuaries.[4] A sixth category (MIXED) is included to account for sites that are a mosaic of different ecosystem types without a prevailing one. More than half of all observations refer to beach recreation. Four categories of recreational services are considered. Most observations include a valuation of recreational fishing, either from boat or shore (SPORTFISH) and/or non-extractive recreational activities such as hiking, nature viewing, swimming and diving (HIKEVIEWSWIM). Since a valuation may pertain to a range of activities, no omitted category is defined and the observations in Table 2 for ecosystem service variables do not add up to 177.

Factual and methodological heterogeneity are controlled for in the selection criteria of primary studies and by including appropriate moderator variables in the regression function. Estimates from tropical ecosystems (e.g., mangroves) and developing countries are excluded. A regional dummy variable (NAMERICA) controls for any residual heterogeneity between European and North American estimates that may remain after site and context characteristics are controlled for in the meta-regression model (Rosenberger and Loomis, 2000; Shrestha and Loomis, 2003; Sen et al., 2011). Regarding methodological heterogeneity, a series of binary study descriptors are included to control for observable differences between fixed effect sizes.[5] Among contingent valuations, the expectation is for open-ended elicitation formats (CVM_OE) to be more liable to free-riding behavior, possibly resulting in lower estimates than other elicitation formats (CVM_OTHER) (Bateman and Jones, 2003). Also, several studies have argued on empirical grounds that contingent valuation estimates are lower than travel cost values (Bateman and Jones, 2003). A binary variable (ENVCHANGE) is included to identify valuations

[3] epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction.

[4] Due to the low number of observations, coastal marshes are lumped together with lagoons in a single category. Despite the small sample (4 observations), a separate binary is included for coral reefs, an ecosystem type that is absent from European seas.

[5] This corresponds to assuming explainable heterogeneity as discussed by Nelson and Kennedy (2009). Alternative model formulations are the random-effect-size model for unexplainable heterogeneity and the mixed-effect-size model for partially explainable heterogeneity.

of environmental changes as opposed to total consumer surplus estimates.[6] Environmental changes could not be included in quantitative terms since they are often only qualitatively described in the primary studies. A binary variable (HOUSEHOLD) identifies per-household estimates that could not be converted to individual values due to missing information on average household size (Bateman and Munro, 2009). The SUBSTITUTES variable identifies valuation estimates that were obtained controlling for substitution effects, for which lower value estimates are expected. The share of sampled recreationists that are on a day trip to the valued site is captured by the variable DAYTRIP. The expectation is for day-trip visitors to have lower per-trip values than recreationists on multiple-day trips (Leeworthy and Bowker, 1997; Park et al., 2002; Bhat, 2003). The variable YEAR captures the number of years elapsed since the first survey in the dataset (1975). It controls for changes in value over time due to refinement of valuation techniques or shifts in consumers' preferences. A variable identifying estimates from unpublished reports and theses is included as well (UNPUBLISHED).[7]

This study expands the range of spatially explicit context variables that were used in previous meta-analyses to include a characterization of environmental quality, biodiversity richness, size of potential market of recreationists, and climatic profile of the valued sites. All context variables are evaluated applying Geographic Information Systems (GIS) to the local context of the valued sites. The average concentration of nutrients in sea waters within 5 km from the coast (LNNUTRIENTS) is used as a proxy for water quality and is expected to be positively correlated with recreation values (King, 1995; Choe et al., 1996; Kawabe and Oka, 1996; Huang et al., 1997; Whitehead et al., 2000; Hanley et al., 2002). A positive correlation between richness of marine biodiversity (MARINBIODIV) and values is also expected (Park et al., 2002; Bhat, 2003; Carr and Mendelsohn, 2003). Climatic conditions at the valued sites are captured by two variables: minimum monthly temperature (MIN_TEMP) and precipitation (MIN_PR) over the period 1960–90. Mean and maximum monthly values were also considered, but finally discarded due to a lower explanatory power. Population density (LNPOPDENS) and accessibility of the coastal sites (LNACCESS), expressed as travel time to the nearest large city (see EC Global Accessibility Maps; bioval.jrc.ec.europa.eu/products/gam/index), may also contribute to the recreational experience and help to discriminate between nature-oriented and mass recreation. Finally, the real per-capita Gross Domestic Product (LNREAL_GDPPC) of the local economy, calculated at NUTS-3 level, is included to capture income effects.[8]

A non-structural utility theoretic model is estimated:

$$\ln(y_i) = \alpha_0 + \alpha_1 x_{i,1} + \ldots + \alpha_k x_{i,k} + \varepsilon_i \tag{1}$$

where $\ln(y_i)$ is the natural logarithm of the value expressed in standardized units of 2007 I$/person/trip; the subscript i is an index for the n observations; α_0 is a constant term; ($\alpha_1, \ldots, \alpha_k$) are unknown coefficients of the moderator variables ($x_1, \ldots, x_n$); and ε is the error term. The model is semi-logarithmic with exception of some of the context variables, which are included in logarithmic form (see Table 2).

The estimated model is designed to account for potential issues with heteroskedasticity of effect-size variances. Non-homogenous variance may arise from different variable sizes of respondents' samples as well as estimation procedures in the primary studies. Since the variance of the primary estimates is not reported in most of the considered studies, the heteroskedastic-consistent, robust Huber-White standard error estimators and a weighted least-squares model are used, in which (the logarithm of) sample size is used as a proxy of variance (de Blaeij et al., 2003; Florax et al., 2005; Day, 1999).

Table 3
Econometric results of the meta-regression of individual, per-trip values.

	Full model		Restricted model	
	Coeff.	Std. Err.	Coeff.	Std. Err.
NEARSHORE	0.989**	0.444	0.996***	0.357
REEF	1.397	1.070	1.090	0.757
LAGOON	1.104	0.684	1.071*	0.555
BEACH	0.147	0.468	0.333	0.292
MIXED	1.057	0.839	0.981	0.608
SPORTFISH	−1.050***	0.401	−1.038***	0.359
HUNT	0.828	0.861	0.601	0.733
HIKEVIEWSWIM	−0.928**	0.395	−0.909***	0.323
PLEASUREBOAT	−0.225	0.410	−0.085	0.322
NAMERICA	0.191	0.415		
CVM_OE	2.329***	0.428	2.210***	0.382
CHOICE	1.473**	0.600	1.656***	0.625
ZTCM	1.634**	0.739	1.632***	0.609
TCM_OTHER	3.131***	0.459	3.112***	0.410
CONT_BEHAV	3.080***	0.510	3.087***	0.443
DAYTRIP	−1.422***	0.464	−1.512***	0.343
SUBSTITUTES	−0.591*	0.306	−0.474*	0.273
ENVCHANGE	−1.712***	0.241	−1.758***	0.214
UNPUBLISHED	0.036	0.280		
HOUSEHOLD	0.066	0.355		
YEAR	0.028	0.031		
LNREAL_GDPPC	1.508*	0.796	1.387*	0.734
LNPOPDENS	−0.287**	0.116	−0.332***	0.092
MIN_TEMP	0.042	0.034	0.061**	0.027
MIN_PR	−0.008	0.009		
LNNUTRIENTS	−0.147*	0.136	−0.184***	0.061
MARINBIODIV	0.272**	0.136	0.237***	0.076
Constant	−69.085	64.946	−10.879	7.716
R-square	0.768		0.765	
Adjusted R-square	0.726		0.732	
Root MSE	1.018		1.007	
Shapiro–Wilk test, p-level	0.079*		0.103	
Breusch–Pagan test, p-level	0.38		0.296	
Max VIF	4.72		7.79	

Note Weighted least square regression with robust standard error estimators. Number of observations = 177. The symbols ***, **, and * respectively indicate 1%, 5% and 10% statistical significance levels.

2.3. Transfer and scaling up of recreation values

The results of the meta-regression of individual values are transferred and scaled up to regional level in order to assess the distribution of aggregate recreation values across the European coastal zone. The coastal zone of the EU is composed by 446 NUTS-3 regions, 372 of which have a sea border, 73 do not have a sea border but more than half of their population lives within 50 km from the coast, and one (Hamburg) is included due to its maritime character (Collet, 2010). Since all recreational activities considered in this

[6] One may expect studies valuing environmental change to be more likely to apply stated preference methods, which could lead to the problem of multicollinearity. The correlation between the ENVCHANGE variable and the binary variable identifying values obtained with stated preference methods is however reasonably low (r = 0.33). The correlation with each of the individual valuation method variables is lower than 0.3.

[7] See Discussion section for a more thorough treatment of the issue of publication bias.

[8] In the cases where the valued coastal site is divided among two or more NUTS-3 regions, the average GDP per capita across the regions is assumed.

study take place at the interface between land and sea, only the regions with a sea border are considered.[9]

First, the best-fit regression function is independently estimated to obtain an average individual, per-trip value of recreational activities in each of the coastal regions. A GIS is used to calculate the average, regional value of the spatial variables in the model. The values of population density and GDP per capita are available from Eurostat. For the remaining variables, conservative assumptions are made: the MIXED ecosystem type is assumed due to the composite nature of land uses in each of the NUTS-3 regions; the average composition of the sample is assumed to be representative of the recreational uses in the EU coastal zone, in the absence of detailed regional statistics of recreational use; the DAYTRIP variable is assumed equal to 1 for local recreationists and equal to 0 for domestic and international visitors; the SUBSTITUTE variables is assumed equal to 1; the average composition of the sample is assumed for the variables identifying the valuation method used in the primary studies.

Second, the individual values are aggregated based on the estimated number of coastal recreation trips in each of the NUTS-3 regions. Three categories of recreationists are considered: international tourists, domestic visitors residing outside the investigated region, and local recreationists. Eurostat provides the number of arrivals of international and domestic tourists at the NUTS-2 level. Such number accounts for arrivals in collective accommodation establishments and private tourism accommodation (e.g., hotels and similar establishments, tourist campsites, holiday dwellings). Same-day visitors are excluded. The number of arrivals was downscaled from NUTS-2 to NUTS-3 level weighing by the number of bed-spaces in accommodation establishments, which is available from Eurostat. Data referring to 2007 or the most recent available year are used for the calculation.

The number of recreation trips taken by the population residing within NUTS-3 coastal regions was estimated based on values from the literature. Machado and Mourato (1999) found that 30% of a representative sample of Greater Lisbon urban area residents visited the beaches in the Estoril coast during the year of investigation, each taking on average 9.8 trips. Mourato et al. (2003) observed that 76% of the population of England and Wales visited the sea in the year of study, taking on average of 5.7 trips. Such value can be compared with the number of trips previously observed by the UK Day Visits Survey in 1998, i.e., 52% of the population visited the sea, taking on average 4 trips per year (National Centre for Social Research, 1999). In Sweden, Eggert and Olsson (2003), found that 100% of the residents of the Swedish west coast counties aged between 18 and 65 visited the Skagerrak coast during the year of study. Two different studies regarding the Stockholm Archipelago found visitation rates in the range 43–52% among residents of the two neighboring counties (Sandström et al., 2000; Söderqvist and Scharin, 2000). Sandström et al. (2000) report an average number of yearly trips equal to 5.1. Studies from the USA found values in similar ranges (Hausman et al., 1995; Leeworthy, 2001). In the absence of Europe-wide statistics regarding the frequency of coastal visits by local residents, a constant participation rate for local recreation trips across Europe is assumed. As a conservative estimate, the participation rate (52%) and average yearly number of trips (four trips) observed by the UK Day Visits Survey in 1998 is used in the analysis. All local visitors are assumed to be on same-day trips.

2.4. Overlap with coastal erosion patterns and nature protection areas

Two independently derived indicators of environmental pressure and nature protection status in the regions composing the European coastal zone are spatially superimposed to the estimated aggregated values of coastal recreation with the purpose of identifying areas where high recreation values may be under threat and regions where high recreation services and nature protection are provided side-by-side.

Among the many environmental stressors that affect the European coastal zone, the European Environment Agency (EEA, 2010) reports coastal erosion as the single largest cause of changes to coastal ecosystems, accounting for 64% of the total ecosystem loss between 2000 and 2006. Accordingly, the focus in this study is on coastal erosion, although the analysis can be extended to include other stressors such as sprawl of economic sites and infrastructure and urban residential sprawl. To assess the level of exposure to coastal erosion, the analysis relies on the results of the EUROSION (2004) project, which classifies NUTS-2 regions in four categories of risk, based on the expected impact (including sea level rise) and sensitivity to coastal erosion. Data is available for 18 EU countries. In our analysis, the same level of exposure is attributed to all the NUTS-3 regions constituting each of the 90 NUTS-2 regions for which data is available.

For the assessment of the current level of coastal ecosystem protection, the analysis relies on the extent of protected sites belonging to the Natura 2000 network, the largest network of protected areas in the territories of the European Union. For each of the coastal NUTS-3 regions, the proportion of the coastal zone within 10 km from the shoreline that is protected by Natura 2000 sites is used, as reported by EEA (2010). Regions are classified based on the percentage proportion of protected territory into four equally-spaced categories with proportions of protected territory ranging between 0-20%, 20–40%, 40–60% and 60–80%, respectively. In order to control for their different aerial extent, this specific analysis relies on recreation value estimates per unit of area, as obtained dividing the total recreation values by the total area of each of the 368 coastal NUTS-3 regions, and classify them into five categories of quantiles, placing an equal number of regions in each category. Data for all three layers of analysis – recreation values, coastal erosion, and area of protected sites – is available in 339 NUTS-3 regions.

3. Results

3.1. Estimation of meta-regression model

Table 3 shows the econometric results of the meta-regression of individual, per-trip recreation values. Results are presented both for the full model and a restricted model, in which five statistically insignificant variables are dropped. There is no substantial change in model explanatory power and result implications if the restricted model is considered.[10] The coefficients of the full and restricted models are similar in sign, size and significance, with the exception of the LAGOON and MIN_TEMP variable, which are insignificant in the full model. The lack of significance of the NAMERICA variable in

[9] Since the dataset is specifically targeted to the temperate regions of Europe, the overseas department and territories of France are not included, thereby reducing the number of NUTS-3 regions to 368.

[10] The variable LNACCESS is dropped from the full model as it is highly correlated with LNPOPDENS (covariance = −0.868, p-level = 0.000).

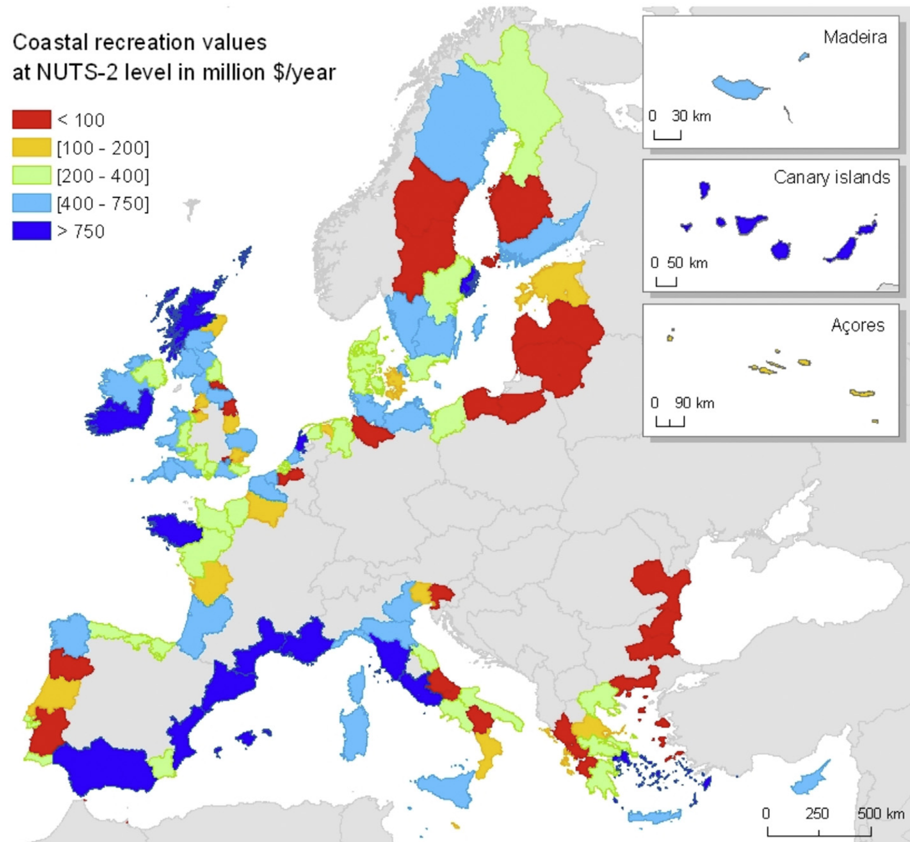


Fig. 1. Distribution of the estimated flux of recreation values in the coastal region of Europe at the NUTS-2 level, expressed in million $/year.

the full model provides empirical support for pooling together North American and European estimates. Such result is consistent with previous meta-analyses of ecosystem service values that did not find significant differences between North American and European sites once other context-based, explanatory variables were controlled for (Brander et al., 2006; Ghermandi et al., 2008).

The robustness of the regression results was investigated by means of standard diagnostic regression tests. The analysis of outliers, leverages and measures of influence did not lead to the elimination of any of the observations in the dataset. The Shapiro–Wilk test does not reject the hypothesis of normal distribution of residuals at the 5% significance level. The Breusch–Pagan test and variance inflation factor (VIF) indicate that heterogeneous variance of the residuals and multicollinearity between predictor variables are unlikely to play a substantial role. Finally, no issue with model specification is suggested by the link test (p-level = 0.299) and Ramsey RESET test (p-level = 0.074). The explanatory power of the models is high (adjusted R-square = 0.732 for the restricted model).

The estimated coefficients in the restricted model generally reflect a priori expectations. Methodological variables are highly significant and exert a strong influence on the value estimates. Such influence is confirmed by the standard regression coefficients (beta coefficients), which are high in absolute value for methodological variables and low for ecosystem types and services. The negative sign of the DAYTRIP variable indicates that same-day trips generate lower economic values than trips with overnight stay. Accounting for substitution effects in the primary valuation studies produces lower value estimates. Studies assessing the welfare impact of an environmental change produce statistically lower values than studies assessing the total consumer surplus of the recreational experience at the investigated sites.[11] The highest estimates are produced by the travel cost and contingent behavior methods. Contrarily to expectations, contingent valuation studies using open-ended question as elicitation format produce higher value estimates than other elicitation formats. Regarding study and context specific-variables, recreational activities taking place in near-shore waters and lagoons produce the highest per-trip values. Sport fishing, hiking, viewing and swimming are the least highly valued recreational activities. The coefficient of real GDP per capita is positive, indicating that income plays a role in explaining the reported values. The individual preferences of recreationists are, on average, towards more pristine conditions, as reflected by low population density and anthropogenic pressure on water quality. Richness in marine biodiversity is found to attract recreationists and the importance of climatic variables is confirmed by the coefficient of the MIN_TEMP variable, indicating higher values for warmer, Mediterranean climates.

3.2. Aggregated recreation values in the EU coastal zone

The results of the scaling up exercise suggest that substantial differences in coastal recreation use and values exist both across and within countries. Such differences concern the distribution of

[11] The sensitivity of the model with respect to the ENVCHANGE variable was tested. Excluding this variable from the restricted model reduces the value of the R-square from 0.765 to 0.678. The sign and magnitude of the statistically significant variables remain largely unchanged, with the exception of NEARSHORE and CHOICE (which become not significant). The variable PLEASUREBOAT and the constant term become significant at the 5% level.

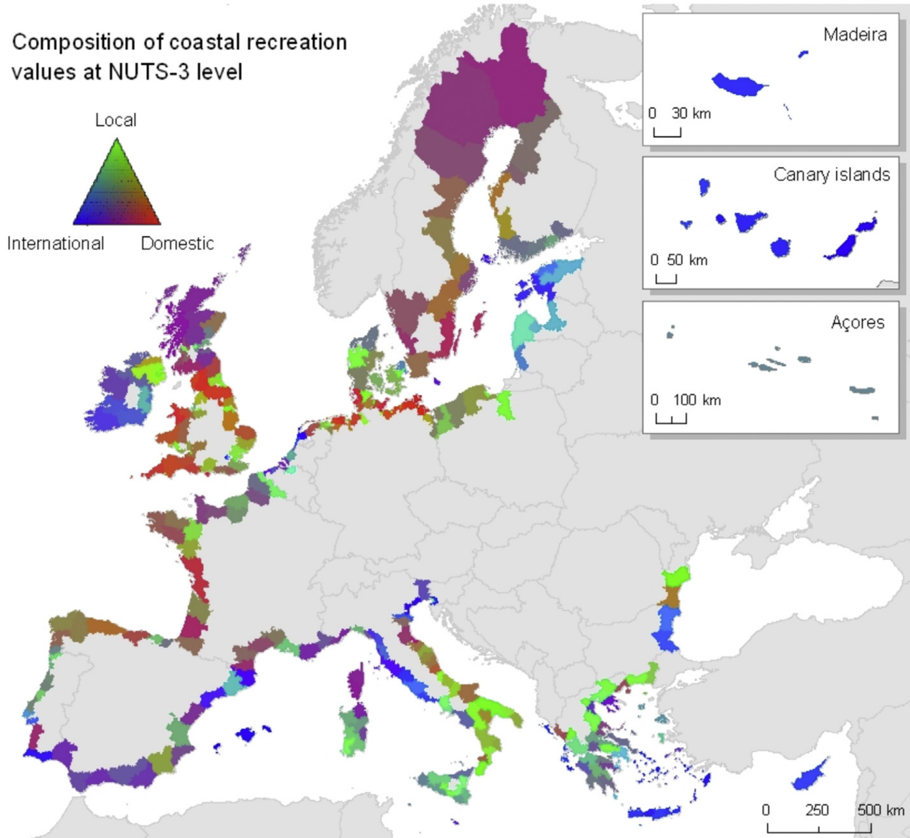


Fig. 2. Composition of the estimated recreation value flows in coastal NUTS-3 regions of Europe according to beneficiary category (international, domestic, local visitors).

total and individual values as well as the relative role of international, domestic, and local recreationists in the composition of total regional values. Fig. 1 shows the distribution of total coastal recreation values across the coastal region of Europe, aggregated at NUTS-2 level. The total estimated values for international, national and local recreationists, disaggregated at the level of the 368 coastal NUTS-3 regions of the EU are provided in the Supplementary material.[12]

High recreation values are concentrated along the Mediterranean coast and in islands. Eight of the nineteen NUTS-3 regions in the top value 5%ile are located in Spain, four in the Canary Islands and two in the Balearic Islands. The highest total recreation value estimate in our dataset is in Fuerteventura (I$2.24 billion/year). The lowest total value among coastal NUTS-3 regions is in Tulcea, Romania (I$863,953/year). Among the regions in the low range of values are several independent cities in Northern Germany and two regions in England (Kingston upon Hull and Southampton). Low values are found in long stretches of the Baltic coast, southeastern European coast, and various regions in Greece, south of Italy and Portugal. Substantial patterns of intra-country variation are found between north and south regions of Italy, continental and insular Greece, and within Portugal.[13]

The observed distribution of aggregated values reflects both the differences in number of recreation trips and individual, per-trip values. Of the nineteen NUTS-3 regions at the top 5%ile of estimated values, only eight are among those with the highest number of recreation trips. In other regions, a low individual recreational value per trip corresponds to a high number of recreation trips. In Napoli, for instance, the ninth highest number of recreation trips coincides with a low per-trip recreation value (6.03 I$/person for day trips). High per-trip values are found in insular regions of Spain, Greece, Portugal, Scotland and Ireland. Low values are found in East and North European regions and metropolitan areas (e.g., Outer London, Grande Porto). The highest day-trip value is in Fuerteventura (337.10 I$/person), the lowest in Riga (0.56 I$/person).

The degree to which international, domestic and local recreation trips contribute to total recreation value varies substantially across regions. Fig. 2 provides an overview of the spatial variability and overlap of the three components of the total value in 366 coastal NUTS-3 regions of Europe.[14] The colors of the map represent the

[12] The sensitivity of the aggregate recreational benefits to the treatment of the recreational hunting and per-household estimates was tested. For recreational hunting, a separate model was estimated excluding the 11 observations with a recreational hunting component and the relative HUNT variable. For per-household estimates, an additional separate model was estimated using the state or country average household size for each of the 34 per-household observations and excluding the HOUSEHOLD variable from the model. In both cases, there are only minor changes in the regression, values transfer and scaling up results with respect to the restricted model presented in the manuscript, with the estimated flux of recreation values in the coastal region of Europe affected for less than 0.5%.

[13] A sensitivity analysis was performed to assess how the uncertainty related to the number of recreational visits by local residents may affect the total aggregated recreation value. Averaged over 366 NUTS-3 regions, a ±50% change in the number of yearly trips taken by local residents would result in a ±12% change in the estimated total recreation value. Regions where most of the values are accrued to local residents are more affected. The three most affected regions are: Flensburg, Kreisfreie Stadt (±44%), Tulcea (±39%) and Bari (±38%).

[14] Melilla (Spain) and Outer London – East and North East (UK) are excluded from this analysis since no information is available regarding the number of international visitors.

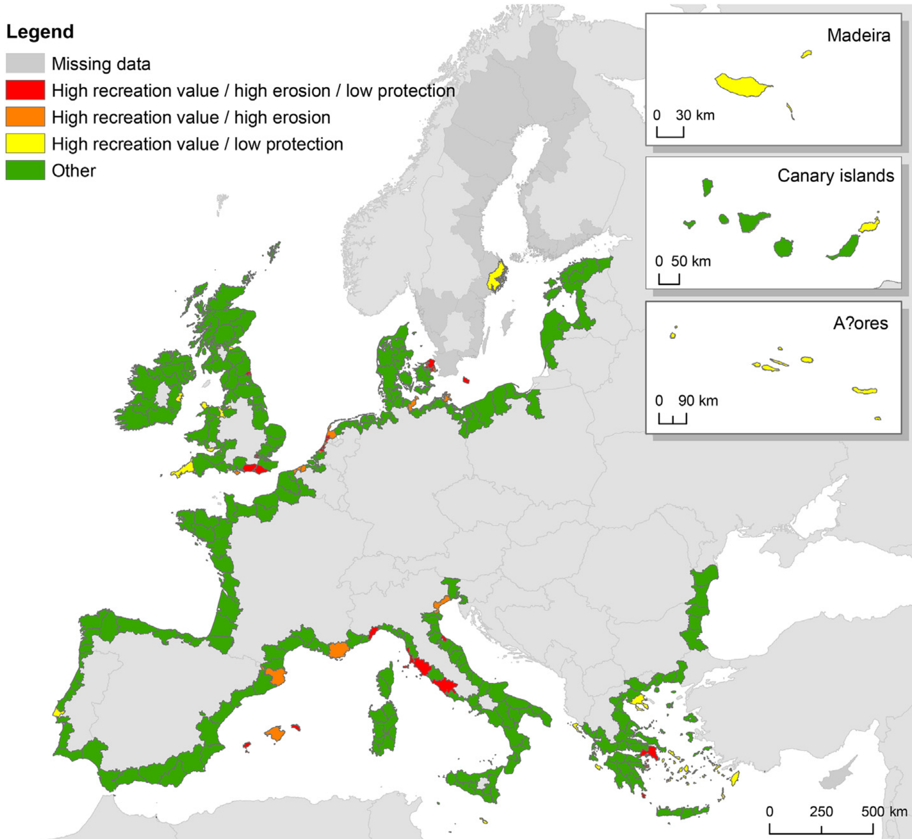


Fig. 3. NUTS-3 coastal regions where high recreation values are concomitant with high exposure to coastal erosion and/or poor environmental protection.

proportion of each of the three components, whereas the color is determined as a composition of three color bands: (i) blue, which represents the recreation value of international travelers; (ii) red, which represents the recreation value of domestic visitors; and (iii) green, which represents the value for local recreationists. The saturation of the color in each band in each region ranges between 0 and 255 and is determined by the local value of the components as proportion of the total value. Regions where the three indexes are split in close to equal proportions are thus represented in gray shades.

A clear distinction is found between the contribution of international visitors to the total recreation value in Mediterranean and central-northern European coastal regions. All twenty-five NUTS-3 regions with the highest proportion of recreational values from international visitors are located in the Mediterranean, with the exception of Inner London – West and the Atlantic islands of Spain and Portugal. Ten of these regions are located in Greece and nine in Spain. The proportion of international recreation value for these regions ranges between 63% and 79% of the total value. At the other end of this range, the regions in which international visitors play a lesser role in the composition of the total recreation value are primarily independent cities located along the coast of Germany and coastal regions in Northern Ireland. The international component of the total recreation value in these regions ranges between 2% and 4%. Domestic recreation appears to play a much more important role in Germany and the UK than in Southern European coastal regions. Among the twenty-five NUTS-3 regions with the highest proportion of domestic recreation value are eleven and twelve coastal regions in Germany and UK, respectively (91–93% of the total recreation value in Rügen, Blackpool and Ostvorpommern).

The map in Fig. 3 shows the results of the spatial overlap analysis of the estimated recreation values with exposure to coastal erosion and nature protection sites. Twenty-one "high-risk" NUTS-3 regions are identified as being of particular concern due to the concomitant presence of high recreation values, poor protection status and high erosion risk. These regions are depicted in red in Fig. 3 and are located in six EU countries: United Kingdom (Tyneside, Inner London – West, Inner London – East, Brighton and Hove, East Sussex CC, and West Sussex), Italy (Savona, Rimini, Livorno, Grosseto, and Roma), the Netherlands (Alkmaar en omgeving, IJmond, Agglomeratie Leiden en Bollenstreek, and Agglomeratie 's-Gravenhage), Denmark (Københavns omegn, Nordsjælland, and Bornholm), Spain (Eivissa y Formentera and Menorca), and Greece (Attiki). These areas are of particular significance for coastal planning and management since they are likely to present high returns on investments aimed at the preservation of the current coastal ecosystems, from the perspective of the human welfare impacts derived from recreation activities.

In parallel to the identification of priority regions where high recreation values may be at risk, it is of interest to single out regions where high recreation values are provided alongside a high level of nature protection. Such regions may be of particular relevance for the identification of sustainable coastal planning and management policies. Among the investigated 339 NUTS-3 regions, twelve regions are found where high recreation values (i.e., equal to or higher than the 60%ile of values per unit of area) coincide with high level of nature protection (i.e., where more than 40% of the coastal land is protected in Natura 2000 sites). These regions are mostly located in central and northern European countries, such as the Netherlands (Overig Groningen, Kop van Noord-Holland, Delft en Westland, Groot-Rijnmond, Zeeuwsch-Vlaanderen, and Overig

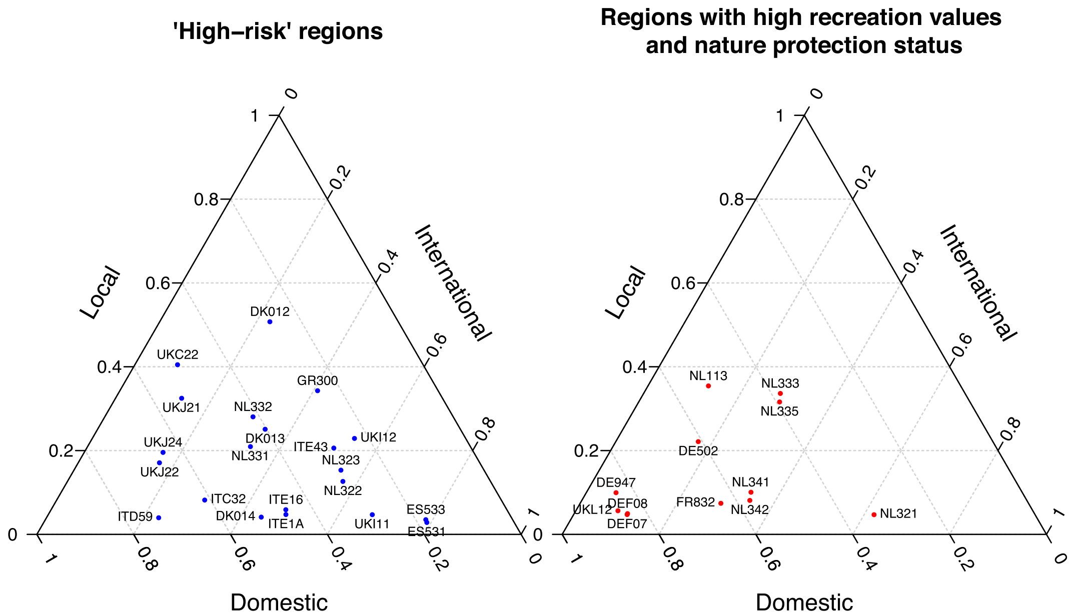


Fig. 4. Ternary plot of distribution of recreation values among international, domestic and local visitors for selected coastal NUTS-3 regions as identified by their ISO 3166-1 alpha-2 code.

Zeeland), Germany (Bremerhaven, Kreisfreie Stadt, Aurich, Nordfriesland, and Ostholstein), and the United Kingdom (Gwynedd), the only exception being the region of Haute-Corse in France.

Although it is important to assess the overall value to society of ecosystem services such as coastal recreation, one key aspect that remains too often on the margin of the decision-making process regarding the provision of ecosystem services is the assessment of the distributional aspects associated with the identification of the beneficiaries from the provision of services, including their social and economic status, and the characterization of the winners and losers from changes in the *status quo*, as resulting from different management strategies (Tallis and Polasky, 2009). The methodological approach proposed in the present study can provide a starting point for such analyses. Fig. 4, for instance, shows in two ternary plots the composition of the total recreation values for the 21 "high-risk" regions and for the 12 regions with combined high recreation values and nature protection status. For each of the regions, the total value is subdivided into the fractions pertaining to international, domestic and local visitors.

In "high-risk" regions, the majority of the aggregated recreation values are accrued to domestic and international visitors, who, respectively, account on average for 40.7% and 41.2% of the total value in the 21 investigated regions. On the other hand, regions with high recreation values and good protection status rely more heavily on domestic visitors (61.5% of total value) and substantially less on international (23.6% of total value) and local visitors (14.9% of total value). Different patterns of domestic and international coastal tourism and recreation are likely to reflect different tourism and recreation management policies (e.g., investments in tourist facilities and accommodation structures) and coastal access policies such as the traditional free access policy in Scandinavia as opposed to regions where strong private property rights are enforced (Bell et al., 2007). Such distributional issues and the implications of different management strategies thereupon (i.e., identifying the winners and the losers of a specific policy) should be well present in the mind of decision makers, for instance in the prioritization of allocation of funding for environmental conservation or the development of economic activities related to coastal tourism and recreation.

4. Discussion and conclusions

This paper presents a methodology for the transfer and scaling up of coastal recreation values, demonstrating how information from spatially and contextually limited primary valuation studies can be extrapolated to scales that are more consistent with the scope of decision for regional and national administrators and policy-makers. The obtained monetary estimates support the notion that the non-market values of coastal recreation contribute substantially to the economies of European coastal regions and the wellbeing of coastal users. There exists a significant revenue capture potential from the current levels of consumer surplus of outdoor recreationists and nature tourists.

In spite of their potential to meet the decision-makers' demand for information in a suitable format, one should not ignore the limitations of value transfer techniques, particularly when international value transfer is involved. While the limitations of value transfer techniques have been investigated extensively in the literature (Nelson and Kennedy, 2009), there is still a limited understanding of the potential of scaling up techniques, particularly due to the lack of reliable accuracy and validity tests (Brander et al., 2012). In the application presented in this paper, for instance, there is a clear potential for an improved, bottom-up approach in the aggregation of ecosystem service values, which would rely on value estimates for individual coastal ecosystems rather than on aggregated numbers of yearly regional visitors for scaling up. Such level of spatial analysis is more consistent with the actual choices faced by the recreationists and would allow for a better characterization of the substitution effects across recreational sites. Such analysis is however hindered by the lack of local statistics on recreation demand over the entire EU coastal zone and the still inadequate resolution of some of the necessary GIS layers. For instance, the impossibility to include in this study data on per-day trips that are undertaken by international and domestic visitors due to data limitations, likely results in an underestimation of the total coastal recreation values. In a sense, value transfer and scaling up techniques are thus an additional tool in the valuation toolbox that can provide preliminary indications on key areas and management priorities for further investigation, and as such is complementary to rigorously framed primary valuation studies.

The present analysis raises a number of important issues for the sustainable management of the European coastal zone. First, the identification of the determinants and extent of non-market coastal recreation values provides a practical tool that can help balancing the needs of development with the conservation of the natural resources, thereby complementing other classification schemes for marine coastal areas where a socio-economic dimension is typically absent. Second, the explicit and transparent formulation of the recreational value function supports the development of scenario analyses for future changes in the quality or quantity of the environmental resources or shifts in the recreation demand. Third, accounting for the distribution of recreational values allows for the identification of the winners and losers of alternative policies and can thus support the design of appropriate payment for environmental services schemes. Finally, the aggregation of values at regional level offers support to potential management applications at the regional, national and international level by allowing users to visualize the explicit location of important landscape elements and overlay them with other relevant themes for analysis, as demonstrated in this study in application to coastal erosion patterns and environmental protection by Natura 2000 sites. Overall, the results of the present analysis are expected to contribute to the discussion regarding the sustainable management of tourism and recreational activities in the European coastal margin, as promoted in the context of the Integrated Coastal Zone Management Protocol.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2015.01.047.

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