An application of the Life Satisfaction Approach (LSA) to value the Land Consumption and Ecosystem Services

Original
An application of the Life Satisfaction Approach (LSA) to value the Land Consumption and Ecosystem Services / Bravi, Marina; Bottero, Marta; Dell'Anna, Federico. - In: JOURNAL OF THE KNOWLEDGE ECONOMY. - ISSN 1868-7865. - ELETTRONICO. - 15:(2024), pp. 2988-3013. [10.1007/s13132-023-01150-x]

Publisher:
Springer

Published
DOI:10.1007/s13132-023-01150-x

Journal of the Knowledge Economy (2024) 15:2988–3013
https://doi.org/10.1007/s13132-023-01150-x

An Application of the Life Satisfaction Approach (LSA) to Value the Land Consumption and Ecosystem Services

Marina Bravi[1] · **Marta Bottero**[1] · **Federico Dell'Anna**[1]

Received: 16 October 2021 / Accepted: 21 February 2023 / Published online: 20 March 2023

Abstract

Land systems combine land use and land cover, considering that their changes have important consequences for the local environment and human well-being and are pervasive factors of regional and global environmental change. More specifically, land consumption (LC), due to the occupation of originally agricultural, natural, or semi-natural areas, implies a progressive loss of key environmental resources and ecosystem services (ESs), reducing the individual well-being. Furthermore, policy makers need data on the benefits of public goods in monetary terms to support well-being-oriented decision-making. This work seeks to demonstrate that life satisfaction approach (LSA) can be applied to a practical assessment goal with the intention to give a monetary value to the LC and consequently to a loss of important ESs. The Italian case study is investigated with the help of a national survey database reporting the subjective well-being index (SWBI) subsequently grouped by regions. The overall intent is to make explicit to the policymakers that biodiversity and ESs are valuable to society and that their further degradation will result in irreversible damages to local communities. Using nationally representative data from the Multi-Purpose Survey on Italian Families in Italy over 2012–2016, results suggest that the national average annual income willingness to accept (WTA) related to consumed land is equal to –0.0827 €/m^2 on average, while the social cost for LC and the loss of related ESs affects 0.01% of the Italian GDP per year. Finally, the possibility of estimating and comparing the WTA with the land market values brings the method presented here closer to cost-based estimates overcoming the limitations of contingent valuation methods.

Keyword Life satisfaction approach (LSA) · Land consumption (LC) · Subjective well-being index (SWBI) · Land uses (LUs) · Ecosystem services (ESs)

✉ Federico Dell'Anna
federico.dellanna@polito.it

Extended author information available on the last page of the article

Introduction

Land consumption (LC) is now considered the most important threat to the preservation of ecosystem functions[1]. Losses of fundamental environmental resources due to the occupation of originally agricultural, natural, or semi-natural areas are usually related to the construction of new buildings and settlements, city expansion, infrastructure development, densification, or conversion of land within an urban area. In general, soil consumption is defined as a change from a non-artificial coverage — natural and unused soil — to an artificial one. It should be specified that land uses (LUs) and LC are different concepts. The former can be considered as the result of human interaction with the land and a description of how the land is practically used in human activities. LC, on the other hand, refers to the biophysical cover of the earth's surface, including artificial surfaces, agricultural areas, forests, semi-natural areas, wetlands, and water bodies, as defined by Directive 2007/2/EC. Furthermore, the land system concept combines LUs and LC considering that changes in land systems have substantial consequences for the local environment and human well-being and are pervasive factors in the regional and global environmental change. More specifically, soil sealing is the main cause of land system degradation in Europe, resulting in increased flood risk, contributing to climate change, threatening biodiversity, producing loss of fertile agricultural land and natural and semi-natural areas, and generating a progressive and systematic destruction of the landscape, especially rural (Alam & Van Quyen, 2017; Li et al., 2021; Liu et al., 2022). Given the extremely long time required for soil formation, land can be considered a substantially non-renewable and progressively scarce resource that generates a wide range of valuable ecosystem services (ESs), although land use decisions often ignore their value. As defined above, the term ESs covers a wide range of connections between environment and human well-being, including supporting services (e.g., nutrient cycling, soil formation), provisioning services (e.g., food, fresh water), regulating services (e.g., climate regulation, flood mitigation), and cultural services (e.g., recreational, spiritual, esthetic) (Millennium Ecosystem Assessment, 2005).

From an economic point of view, biodiversity and ecosystems can be seen as part of our natural capital, and the benefit flow represents the interest that society receives, even if unaware. But measured by the land area that can support human settlements, the earth is shrinking with a growing population, which contributes to an increasing volume of waste and consumption of free resources. While the scientific community has tried to change its paradigms by including environmental resources in the estimation of

---

[1] The term "ecosystem functions" has different meanings; on the one hand, they are used to describe the ecosystem functioning (e.g., maintenance of energy fluxes, nutrient, or CO_2 recycling) and, on the other, to recall the benefits derived by humans from the different processes where the ecosystem is involved (e.g., agricultural production and waste treatment) (de Groot et al., 2002). However, some authors have pointed out that there is not a definitive classification (Dominati et al., 2010), particularly when researches are focused on soil and its functions. They characterized the following roles that soil plays in the provision of ES: fertility (nutrient cycle); filter and reservoir (water purification); structural (animals, plants, and humans support); climate regulation (greenhouse gas sequestration); biodiversity conservation (species habitat); and resource (source of raw materials).

a balance between cost and benefits related to LC, policymakers have more difficulty to include this goal in their agenda (Frijters et al., 2020). But today, we have to consider all contributions to welfare creation, from those derived from human capital and the built environment to those received from natural capital, for determining the optimal use of necessarily limited resources. Moreover, the concept of LC, rather than land use, emphasizes the problem of the permanent loss of natural capital by recalling another issue, very important today, namely, that of irreversible environmental risk (Chen et al., 2020; Liu et al., 2020; Wu et al., 2020). The present work tries to demonstrate that a theoretical approach based on life satisfaction approach (LSA) can be applied to a practical assessment goal with the intent to give a monetary value to the LC and consequently to a loss of important ESs. Indeed, there is a considerable body of literature on life satisfaction in economics. But small body of literature suggests that external influences, in particular natural environments, are key drivers of life satisfaction (Ambrey & Fleming, 2014a). In this direction, economic valuation could become a tool to make explicit to policymakers that biodiversity and ESs are scarce resources and that their further degradation will result in irreversible damage to society as a whole.

According to ISPRA (2022), soil consumption continues to transform the Italian territory at a high rate. In 2021, 69.1 km^2 were artificially covered, recording the highest value in the last 10 years. On the national level, 7.2% of the soil has been consumed, but with strong geographical differences, with regions exceeding 10% of the soil consumed and others recording shares of less than 5%. In this sense, the increase in soil consumption and the relative disappearance of green areas slows down the achievement of the goals defined by the UN 2030 Agenda for Sustainable Development in different ways, and it is therefore interesting to study the phenomenon in relation to the environmental and socio-economic characteristics of the different Italian regions.

Adopting a relatively novel approach, this paper uses self-reported life satisfaction data from the Multi-Purpose Survey on Italian Families in Italy over 2012–2016 to place a monetary value on LC and related ESs in Italian regions. The LSA seems suitable for the valuation of complex environmental assets because it does not require respondents to have specific knowledge of the asset in question nor does it ask them to perform the unfamiliar task of placing a monetary value on a non-market asset. Moreover, the ability to estimate and compare the WTA with land market prices puts the method provided here closer to cost-based estimates, overcoming the constraints of contingent valuation methods.

The paper is organized as follows; the second section introduces a summary of different topics interesting from the perspective of economic valuation, while the third section explains the LSA with attention to environmental and LU applications. A practical assessment of LC for the Italian case study follows, while a reminder for policymakers is included in the final conclusions.

Land Consumption, Soil Degradation, and Ecosystem Service Issues

The question of the protection of natural capital as a guarantee for the maintenance of human well-being began on the Rio de Janeiro convention of 1992, when international agreements recognized the importance of natural resources. Since their conceptual introduction, the knowledge base on ESs has been greatly enriched. Since the publication of the Millennium Ecosystem Assessment (MEA), international projects and researches for ES classification and evaluation have multiplied (Millennium Ecosystem Assessment, 2005). In 2007, the international project The Economics of Ecosystems and Biodiversity (TEEB) presented an analysis of the global economic benefit generated by biodiversity and defines methods of economic evaluation of biodiversity and ESs, in order to equip decision-makers with the necessary tools to define economic value and support their choices and integrate decision-making processes (Oliveira & Pinto, 2020). In the field of research, different definitions and classifications of ESs have been provided in recent decades, making it increasingly difficult to define a single vocabulary and evaluation handbook (Caprioli et al., 2021; Gómez-Baggethun & Barton, 2013). For this reason, in the context of the European Union Strategy for Biodiversity until 2020, the Mapping and Assessment of Ecosystems and their Services (MAES) working group has decided to adopt the international classification system CICES as a common basis (Maes et al., 2013, 2012). This made it possible to provide member states with a shared working method and a common ES assessment and mapping approach (Floris & Ruggeri, 2017).

Compared to MEA and TEEB, CICES attempts to be more comprehensive and updated classifications, dividing the ESs into three main sections:

- Provisioning services: basic and raw materials (water, fibers, genetic materials, food production, and fuels)
- Regulation and maintenance services: regulate physical, biological, and ecological processes (climate change, carbon sequestration, water, and air quality)
- Cultural services: non-material benefits (spiritual and intellectual enrichment and recreational and esthetic values).

Ecosystems support human well-being through procurement, regulatory, and cultural services. The MEA defines five main components of human well-being that are supported in a different way by ecosystem services: the basic material needs for a good life, health, good social relationships, safety, and freedom of choice and action. The latter is a fundamental condition for the concept of equity and fairness and influenced by other components of well-being.

As shown in Fig. 1, the links between ESs and human well-being are closely connected with different primary needs able to provide crucial human support. In this perspective, more attention should be given to planning support tools, and quality data to assess a priori the extent to which planning processes can affect land use highlights how the deterioration and impoverishment of ecosystems and the consequent loss of ESs.

There is now a considerable body of literature about the economic valuation of soil consumption. Graves et al. (2015) derived the total economic cost of soil degradation in England and Wales by distinguishing between on-site and off-site costs and market and non-market effects. They recalled the need to value soil degradation, for example, for flood risk and climate change control. Many

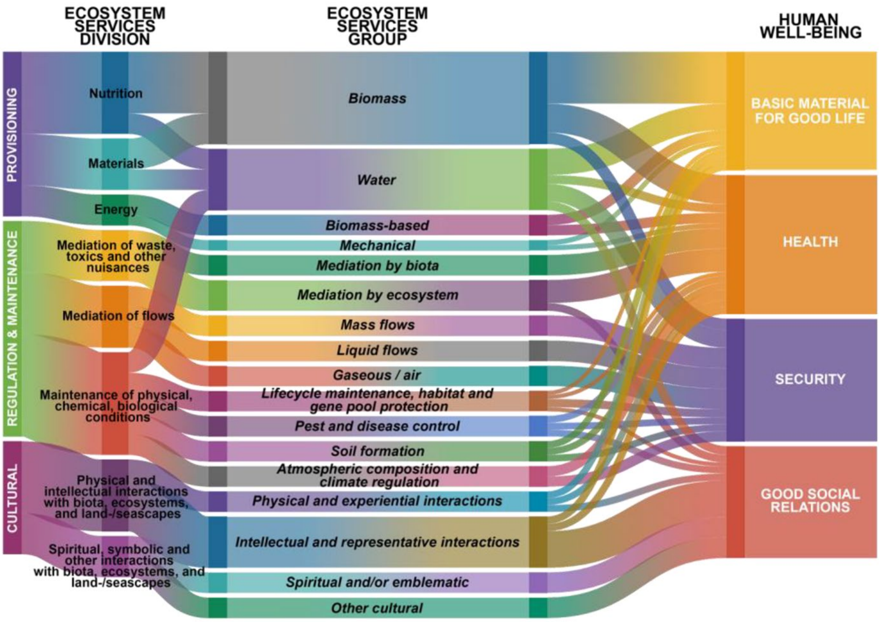

Fig. 1 Link between ecosystem services and human well-being (authors' elaboration inspired by Maes et al. (2012) and Millennium Ecosystem Assessment (2005))

other attempts have been made, starting from the report of Gorlach et al. (2018), reviewing over 60 studies and quantifying the economic impact of soil degradation. From this respect, it is very important to clarify the difference between LC and land degradation and how the ES framework finds its place within them. Indeed, the latter has been used to link natural capital, including soil, and the people's prosperity and well-being, becoming an all-encompassing term whose meaning, and boundaries are not uniformly understood.

Dominati et al. (2010) wisely noticed that, when looking at soil, one of the difficulties of a coherent framework linking natural capital and ESs is the confusion created by the use of different terminologies employed by three disciplines: ecology, economics, and soil science (pedology). First, natural capital is distinct from manufactured capital, which involves a process of resource transformation. In turn, land is a production factor involving inter alia real estate development. Natural capital, like all other forms of capital, is a stock as opposed to a flow of goods and services. Furthermore, soil scientists use different concepts such as soil components and soil properties, mainly from a chemical–physical point of view. As some authors point out (Boyd & Banzhaf, 2007; Fisher et al., 2009), if it is already difficult to identify how different types of soils deliver different ESs, things get further complicated when trying to give them a value. For example, LUs are often considered as a proxy for the ES flow provided, but it would be necessary to better distinguish anthropogenic uses from all-natural habitats. Indeed, another critical issue is the not always linear relationship between biodiversity conservation and the ESs approach (Goldman & Tallis, 2009; Yang & Wang, 2019).

For a while, ESs have not been considered holistically linked to the natural capital from which they derive. For example, general frameworks gave little emphasis to the role of soil types in the provision of ESs. The main goal of these estimates, made globally, was to provide a value to different biome types that could be easily transferred (benefit transfer) (Costanza et al., 1997; de Groot et al., 2002; Farber et al., 2002). Subsequent research has since shown that the wide range of terrestrial habitats, but also the difference in methodologies, cannot refer to standardized estimates once and for all (Costanza et al., 2014).

Furthermore, in the field of territorial and environmental policies, the purpose of the estimate cannot be considered a negligible issue (Bateman et al., 2014; Enssle & Kabisch, 2020). For example, ESs generate income flows (amount per unit time), as opposed to stocks and processes. This is very important from the economic valuation perspective. In economics, capital does not coincide with a flow of services (incomes) but with their capitalization through suitable interest rates. In this sense, benefit/cost estimates should be treated with caution, bearing in mind that the land market can be still considered a reference point when territorial policies are at stake.

The considerations just made are useful precisely to specify that the present application does not pretend to distinguish between the value of different types of soils and ESs but rather to estimate a willingness to accept for the progressive loss of uncovered land, considering the close relationship between individual well-being and natural environment.

Effects of Ecosystem Services on Subjective Well-Being

Benefits provided by the ecosystem are innumerable, and a wide literature has explored the relationships between ESs and individual well-being (Conceição & Bandura, 2008; Hu et al., 2018). Usually, people enjoy natural areas for recreational purposes, like walking, hiking, playing outdoor sports, relaxing, experiencing, and learning about nature and biodiversity (Botes & Zanni, 2020; Dechasa et al., 2020). All these actions contribute to individual well-being and mindfulness improving environmental awareness. While psychological effects of nature on humans have long been known (Manning et al., 2016; Roszak, 2001; Sørensen, 2014), it has only recently been discovered that subjective well-being index (SWBI) can be profitably used to assess environmental benefits/costs (Dolan et al., 2008; Layard et al., 2012).

The SWB concept has been studied in economics, sociology, and psychology and, in general, in the field of the behavioral sciences. In this regard, Diener (1984) identified two fundamental SWB components, cognitive and affective; the first represents the process by which each individual evaluates, retrospectively, and in terms of satisfaction, his own life as a whole; the second indicates the emotions that the subject experience during their daily life. Contrary to the cognitive component, which implies an *ex-post* reflection on one's life up to a certain moment, the affective component is linked to the present, to the current situation, and to emotions that can be positive (positive affects) or negative (negative affects). In fact, the economic valuation of environmental benefits/costs proceeded mostly using the concept of life satisfaction, therefore referring to the cognitive component (Diener et al., 2015; Saeedi & Dabbagh, 2020).

A fundamental step in the debate on SWB was the analysis of the relationship between happiness and wealth. Easterlin (1974) was the first to highlight the existence of a not proportional relationship between population's income and well-being level. More later, Clark et al. (2008) clarified how, in the utility function, relative income can affect economic behavioral models in different domains.

More specifically, the measurement of individual welfare and happiness, using data on reported SWB, has made great progress and has led to a new field in economics (Kahneman & Sugden, 2005).

In the literature, many applications of this method are available for different purposes (Welsch & Kühling, 2009). Four main domains are identifiable, bearing in mind that, at the moment, a general and more thorough summary would require a separate work. The four domains of investigation could be identified as follows:

1. Environmental damages: e.g., air pollution, climate change and extreme weather events, and natural disasters (Bertram & Rehdanz, 2015; Cuñado & de Gracia, 2013; Ferreira et al., 2013; Li et al., 2014; MacKerron & Mourato, 2009; Sekulova & van den Bergh, 2013; von Möllendorff & Hirschfeld, 2016; Yuan et al., 2018).
2. Environmental benefits: e.g., natural environment, pro-environmental behavior, scenic amenities, and greenery (Ambrey & Fleming, 2014a; Ambrey & Fleming, 2014b; Doherty et al., 2014; Huang et al., 2020; Hudson et al., 2019; Tsurumi et al., 2018; Verhofstadt et al., 2016).
3. Land uses: e.g., natural lands, urban green spaces, and urban land uses (Aguado et al., 2018; Alfonso et al., 2016; Bertram & Rehdanz, 2015; Kant et al., 2016; Kopmann & Rehdanz, 2013; Tsurumi & Managi, 2015).
4. Energy supply and infrastructures: e.g., nuclear power, wind turbines, and electricity supply (Krekel & Zerrahn, 2017; Rehdanz et al., 2015; Welsch & Biermann, 2014).

The second and the third domain is closer to the goal of the present work, but in this case, the issue of the geographical scale of the analysis is fundamental.

Methodological Framework

A working framework was set up to answer the research questions. The workflow requires a series of interconnected steps, as defined in Fig. 2. The main steps can be summarized as follows. First of all, the objective of the research was set, i.e., the evaluation of ecosystem services related to land consumption in Italy from regional aggregated data on the subjective well-being index. The next key step is to construct an empirical model of SWB using knowledge weights on the determinants of

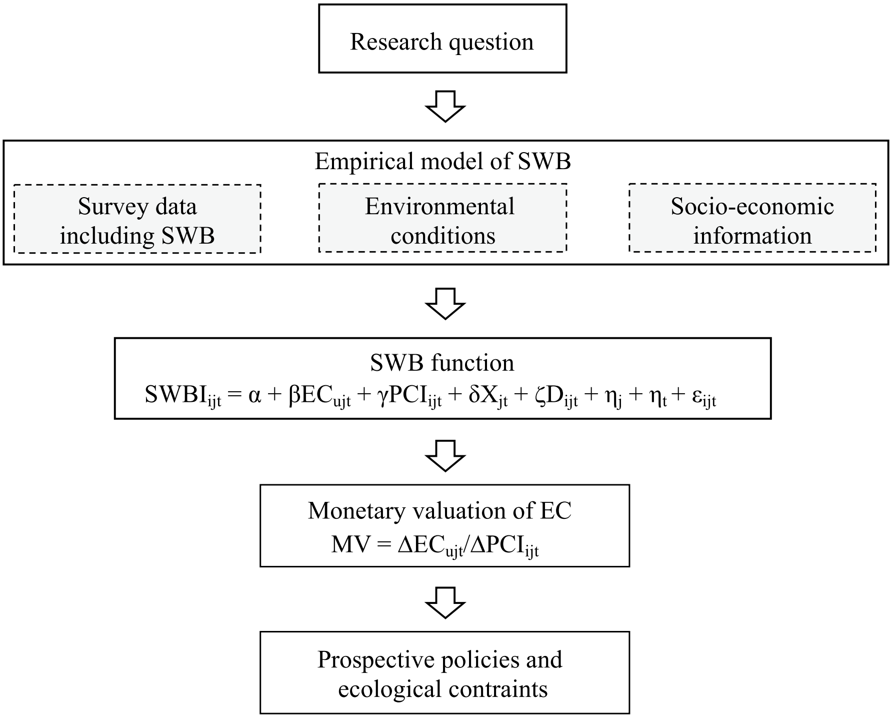

Fig. 2 Research workflow

well-being (Barrington-Leigh, 2021). The key element is the measurement of actual LS reports, usually part of a wider questionnaire. It must be remembered that data on SWBI are usually collected in large-scale surveys led to the national or international level. Some of these refer to single countries, such as the General Social Surveys in the USA or the Multi-Purpose Survey on Italian Families in Italy. Others, like the European Quality of Life Surveys or the World Values Surveys, cover several countries. SWB is usually elicited through a question like this, “All things considered, over the last few days, how would you rate your overall satisfaction with your life,” in a Likert-scale from 1 to 10 points, but also with other ratings, as 1 to 3, or 1 to 4 points. In Italy, i.e., it is measured through an 11-point scale ranging from 0 (very dissatisfied) to 10 (very satisfied).

All these surveys bring with them the problem of the statistical representativeness of the sample. To stay with the Italian case, the Multi-Purpose Survey is the result of a stratified sample designed to be significant at the national or regional scale (ISTAT, 2018). It would instead make sense to go down to a smaller scale, e.g., as urban, that is not reachable with this type of survey. However, understanding the extent to which regional, or local, differences in SWB exist and are related to other factors appears as an important goal (Goetzke & Rave, 2015). At the same time, regions ensure, from the estimating point of view, the necessary variation of the index, as will be seen below. Moreover, the variation between regions (or countries) allows the valuation of the marginal change in income, because this approach is not able to foresee any future state of the environmental condition as it is usually doing in contingent or simulated markets (Ferrer-i-Carbonell, 2005). For example, Kopmann and Rehdanz (2013) consider changes in natural land cover, estimating the willingness to pay for different types of habitat (agricultural, forestry, grasslands, wetlands, etc.). They gather information on land cover of the total area of the European regions NUTS 2 (in percentage) through the CORINE database (Coordination of Information on the Environment) and employ the output of European Quality of Life Survey. In another study, Bertram and Rehdanz (2015) employ a local survey for estimating the value of urban green spaces in Berlin, linking the respondents' location and spatial information with GIS data. They found that the effect of the available amount of urban green space is non-linear with respect to the marginal utility, first increasing and then decreasing, due to the distance effect. Tsurumi et al. (2018) apply the LSA to evaluate green spaces in terms of affluence, people's preference for greenery, and distance from their houses in Japan, while Krekel et al. (2016) investigate the effect of urban land use on residential well-being in major German cities using the European Urban Atlas that allows to employ data on land use rather than land cover. The application presented below is instead based on a simple but strong hypothesis, namely, that the land is a progressively scarce resource and that the anthropic pressure and urbanization process influence, as expected, the market land values but, at the same time, the residents' willingness to pay to have more free and natural space (or the willingness to accept to be compensated for the loss).

Within the model, other living conditions that may influence well-being are considered, along with any other measurable life circumstances related to an individual or his or her geographic region. Since the objective is to measure the impact of land consumption on an individual's well-being, crucial information is the environmental conditions of the area in which the individual is located. In this case, SWB represents an empirical approximation of the individual utility, and it can be used for estimating the value of environmental goods and services (Welsch, 2009). From the empirical estimating point of view, environmental conditions can be considered in a simple OLS function[2] along with income and other variables as follows (Eq. 1):

$$SWBI_{ijt} = \alpha + \beta EC_{ujt} + \gamma PCI_{ijt} + \delta X_{jt} + zD_{ijt} + \eta_j + \eta_t + \varepsilon_{ijt} \tag{1}$$

where $\mathrm{SWBI}_{\mathrm{ijt}}$ is the subjective well-being self-reported by the respondent i in a geographical position j on date t; α is the constant term; EC_{ujt} describes the environmental condition; $\mathrm{PCI}_{\mathrm{ijt}}$ is the per capita income of i; X_{jt} is a series of determinants observed on individual level (e.g., age, marital status, employment, health state, social relationships); D_{ijt} describes other characteristics that affect individual well-being, such as, for example, the housing or social conditions of the area of residence; and $\eta_j + \eta_{\mathrm{t}} + \varepsilon_{\mathrm{ijt}}$ are unobserved terms, where the first two

---

[2] Empirical applications have employed both linear and ordered probit models. The SWBI could be interpreted both as an ordinal and cardinal variable. However, Ferrer-i-Carbonell and Frijters (2004) found that both approaches can provide robust results. Moreover, using OLS certainly makes the estimation process easier, including the MV calculation.

represent the effects of fixed location and time, respectively. These express the invariant characteristics that are common to all people in a place *j* and on date *t*, while $\varepsilon_{\mathrm{ijt}}$ is the disturbance term covering non-observable characteristics joined in the measurement error. The remaining terms are the coefficients of the single independent variables.

Once these parameters have been estimated, the SWB function can be used to obtain a monetary valuation of EC variation by differentiating for the income and resolving for the marginal value (MV) relative to EC, such that (Eq. 2)

$$\begin{aligned} MV &= \Delta EC_{ujt} / \Delta PCI_{ijt} \\ &= \left(\Delta SWBI_{ijt} / \Delta EC_{ujt}\right) / \left(\Delta SWBI_{ijt} / \Delta PCI_{ijt}\right) \\ &= \Delta PCI_{ijt} / \Delta EC_{ujt} = \gamma / \beta = \overline{\mathrm{PCI}}(\gamma / \beta) \end{aligned} \tag{2}$$

where γ and β are the coefficients estimated through the LS function and $\overline{\mathrm{PCI}}$ is the per capita income measured at the sample mean or in another point, on the basis of the estimating requirements. This last step ensures that the estimate can be brought back to the monetary scale, bearing in mind that even the non-marginal quantity of EC is implicitly measured at the same point.

In other words, in the case of environmental damages, it is possible to compute the increase in income that would be necessary to compensate an individual for a decrease in environmental quality. In this case, MV can be interpreted as the willingness to accept for compensation or a monetary amount for this loss. A crucial requirement for obtaining reliable valuations from LSA function is that the marginal value is correctly estimated. The specification of the arguments of the function, in other words, the introduction of explanatory variables and the use of a correct functional form, is fundamental in this regard.

The monetization of ecosystem services is an open question as government authorities and policy makers base their choices on a political economic process using cost–benefit analysis (CBA) while remaining a key tool for assessing welfare in public policies. In this context, the LSA is a useful tool for defining the benefits of public goods, which are difficult to measure in monetary terms through market-based approaches such as revealed preferences approaches (e.g., hedonic prices) (Dell'Anna et al., 2022; Mei et al., 2018). Furthermore, the LSA method avoids some important difficulties that characterize the approaches of stated preferences (e.g., contingent valuation). In the LSA method, only the level of well-being is required, overcoming the problem of strategic responses (Odermatt & Stutzer, 2017).

A monetary Valuation of LC

The Italian Case Study

Italy has one of the highest levels of LC in Europe, despite the peculiarities of the Italian territory due to the orographic and environmental characteristics, which should avoid urban sprawl in areas of high environmental and territorial fragility.

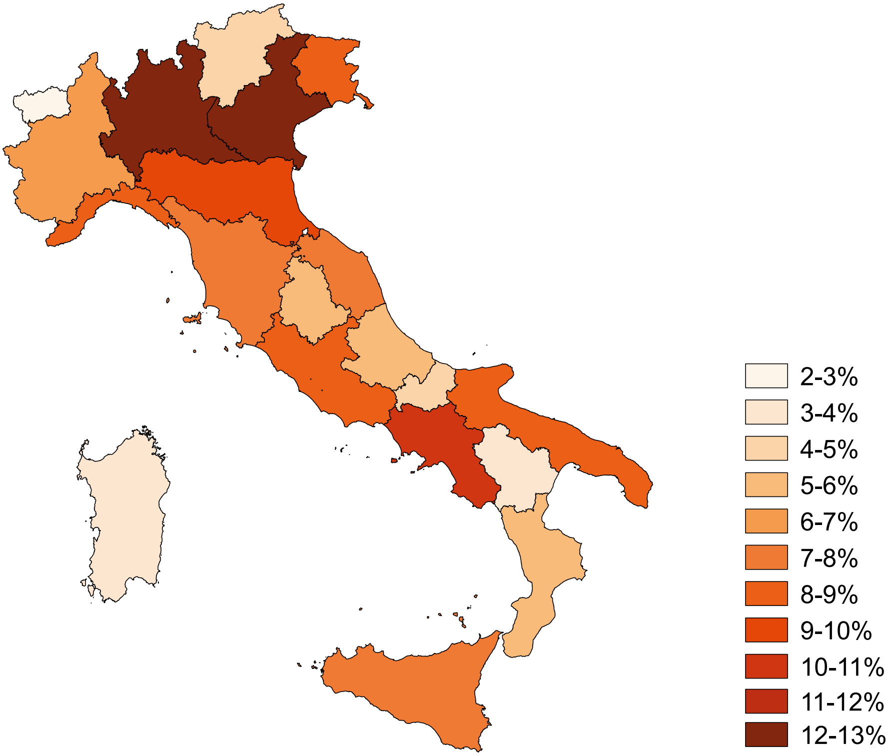

Fig. 3 Land consumption (LC) in Italian regions in 2017

In Italy, estimates and dynamics of LC describe a process concentrated in the plains. The threatened natural and semi-natural areas are found mainly in the coastal areas and in the valley bottoms. Moreover, in the last few decades, two apparently antithetical phenomena have occurred in Italy: LC and forest expansion. As already mentioned, LC represents the occupation of originally agricultural, natural, or semi-natural surfaces, in favor of artificial cover, e.g., buildings, infrastructures, and service areas. Forest expansion, on the other hand, is that natural process which, through different phases, involves the establishment of forests on areas previously classified as other wooded lands, grasslands, pastures, and uncultivated land. The National System for Environmental Protection (NSEP) reports that, from the 1950s to date, LC in Italy has never stopped, touching the major urban centers and the provinces with the highest population density. The soil sealed surface grew from 1950 to 2016, from 2.7 to 7.6% of the national territory, registering a rate of 184% compared to the initial data. At the same time, with the impetuous advance of artificial covers, the forest surfaces have made progress. The year 2018 will probably be remembered as the year in which the forests exceeded the arable land, which instead has for centuries represented the historical pattern of the Italian landscape. As shown in Fig. 3, the consumed soil exceeds 5% in 15 regions, with the highest value in Lombardy (reaching almost 13%), Veneto, and Campania. Aosta Valley is the only region below 3% of LC. These values are justified by the regional morphology and the historical evolution of the territory. This has meant deep changes in ecosystems, with, for example, the excessive expansion of some species previously marginalized and/or hunted by humans.

In light of the particular conditions of criticality of the Italian territory, it has become essential to reach the zero goal of net LC by 2050 coherently to the demographic growth and European policies. The importance of a reduction in LC has been widely reaffirmed in Europe by preparing guidelines to limit, mitigate, and compensate for soil sealing. In other words, the member states should ensure the limitation of these phenomena by reducing the conversion and transformation rate of the agricultural and natural land and by re-using/regenerating the already urbanized areas, with the definition of realistic LC targets at the national and regional level (ISPRA, 2017). In Italy, the monitoring and measuring of LU and LC are ensured by the National System for Environmental Protection (SNPA) as established by Law 132/2016; this allows to follow the evolution of land transformation dynamics and urban growth through thematic cartography and elaboration of specific indicators. Monitoring takes place through the production of a national map of LC on a raster (regular grid) of 10×10m, produced according to a classification system whose first level divides the entire territory into consumed land and free or unused land.

In this context, and in relation to the more general governance goals, there is a growing demand for monetary estimates of economic values of ESs outside the market. This application tries to demonstrate the validity and reliability of the LSA for estimating the inhabitants' willingness to accept compensation for uncovered land loss.

Application Results

The econometric model is quite simple because an aggregated SWBI is computed, thus avoiding the problem of the individual heteroskedastic component in LS function. In fact, when individual data are employed, it is worth remembering that the unobservable or subjective component — ε_{ijt} in equation (Eq. 1) — retains, in the vast majority of applications, a strong weight, limiting the percentage of variation explained by the model (R^2 <30–40%). Conversely, the function based on aggregated data could be simpler to be specified, and usually, it presents higher variation coefficients. The equation described in (Eq. 1) is simplified, and it becomes (Eq. 3):

$$SWBI_{jt} = \alpha + \beta PLC_{jt} + \gamma PCI_{jt} + \lambda YEAR12 + \delta YEAR13 + \zeta YEAR14 + \eta YEAR15 + \varepsilon_{jt} \tag{3}$$

where SWBI is the mean of the subjective well-being self-reported from a sample of individuals in a region *j* on date *t*, α is a constant term, PLC_{jt} is the percentage of land consumption on the total of the territorial surface of each Italian region on date *t* (Fonte, SNPA), and PCI_{jt} is the mean of the per capita income at regional level on date *t*, or in alternative, the per capita GDP and year (from 12 to 15) are the time dummy variables with 2016 as the base, and ε_{jt} is the disturbance term covering non-observable characteristics joined in the measurement error.

Briefly, the variable representing the LC percentage on the total of the territorial (regional) surface is that environmental under investigation while the dummy variables are taking into account the variation of the index at different points of time. Due to the sampling problems mentioned above, and since the aggregated SWBI appears to be significant exclusively at the national and regional scale, Table 1 shows the aggregated SWBI by region from 2012 to 2016. By simply observing the indexes, it is useful to notice a certain stability of the average SWBI in the first 4 years, except for a specific positive increase in 2016 (Fig. 4). This confirms, among other things, what has been stated in the literature: the SWBI has a certain constancy over time but a variation guaranteed by space (Clark, 2018).

Both per capita income and GDP were tested, and the model containing the first appeared more consistent with the research goal. Using GDP instead of PCI can lead to more general reasoning around macroeconomic variables, but the goal of this experiment is to estimate the average WTA for the progressive loss of uncovered/undeveloped land. Table 2 shows the econometric results of the application, and Tables 3 and 4 contain the estimates summary of the MV for single regions in 2016 that are function of PCI (or GDP), LC percentage, territorial surface in m^2, and inhabitants' numbers. As shown in Table 2, the coefficients of the variables of the years assume a negative value (2016 omitted), as expected. Considering the per capita GDB (PCGDB), in 2012, the SWB coefficient is −0.123, indicating a level almost equal to that of 2016. In 2013 and 2014, the SWB recorded a decreasing trend, equal to −0.167 and −0.153, respectively. The decrease in well-being can be determined by the decrease in the quality of work, the minimum economic conditions, and life satisfaction in the regions of southern Italy. Over the years, the gap between the south and the rest of the country has remained unchanged or has opened further. The coefficient for 2015 assumes a value of −0.207, highlighting a strong decrease in well-being caused by the many political and economic events that have affected Italy both on a regional and global scales (ISTAT, 2016).

Following Eq. 2, the WTA per capita income for each Italian region was calculated. In detail, the average income was multiplied by the ratio between γ coefficient (PCI), or PCGDP, and the β (PLC). The cost was calculated for the entire population of each region, multiplying the individual WTA by the inhabitants' number. In order to obtain a comparable value between regions, the WTA was related to consumed land in order to obtain an income WTA per m^2. Table 3, more specifically, highlights the estimates of the annual cost flow for the loss of undeveloped soil and related ESs. Consistent with the previous considerations — difference between an income stream and capital value — the calculation of a capital value range per m^2 is introduced in the last two columns. This allows, albeit roughly, to compare the WTA with the market values and to reason in terms of policies. The WTA per capita in the regions of Lazio, Liguria, and Lombardy is much higher than the national average. One reason for the higher WTA may be due to the land transformation dynamics that these regions are experiencing. Considering the period 2012–2016, at the national level, about 55% of changes occurred in a context with medium or

Table 1 Aggregated index of SWB by the Italian NUTS 2 region, years 2012–2016

Region	**2012**			**2013**			**2014**			**2015**			**2016**		
	Mean	St. Dev.	Case n.	Mean	St. Dev.	Case n.	Mean	St. Dev.	Case n.	Mean	St. Dev.	Case n.	Mean	St. Dev.	Case n.
Abruzzo	6.90	1.86	1618	6.91	1.66	1120	6.84	1.89	1398	6.90	1.73	1560	7.10	1.77	1595
Aosta Valley	(*)			7.28	1.68	599	7.18	1.80	705	7.22	1.66	881	7.18	1.65	720
Apulia	6.64	1.81	2445	6.61	1.74	1603	6.58	1.79	2218	6.64	1.75	2322	6.87	1.76	2293
Basilicata	6.68	1.74	1275	6.69	1.89	878	6.52	1.71	728	6.65	1.63	1193	6.76	1.72	1236
Calabria	6.69	1.90	1960	6.74	1.84	1351	6.87	1.82	1059	6.64	1.87	1942	7.05	1.61	1857
Campania	6.36	1.67	2989	6.43	1.56	2047	6.22	1.52	1715	6.20	1.67	3131	6.55	1.60	2996
Emilia-Romagna	6.92	1.77	1971	6.79	1.84	1357	6.97	1.80	2150	6.86	1.81	2071	7.12	1.65	2031
Friuli-Venezia Giulia	6.94	1.82	1483	7.00	1.81	923	7.11	1.74	1076	7.05	1.85	1423	7.15	1.61	1383
Lazio	6.65	1.75	2185	6.72	1.71	1525	6.87	1.79	975	6.75	1.71	2073	6.95	1.60	1955
Liguria	6.91	1.61	1578	6.98	1.63	1010	6.99	1.67	1372	6.81	1.70	1588	6.97	1.60	1370
Lombardy	7.05	1.68	3087	6.93	1.83	2225	7.05	1.76	1321	6.96	1.81	3429	7.22	1.66	3026
Marche	6.96	1.70	1564	6.88	1.72	1062	6.82	1.70	1368	6.88	1.72	1533	7.01	1.66	1459
Molise	6.80	1.83	1274	6.74	1.83	837	6.80	1.77	989	6.47	1.63	1213	7.03	1.56	1114
Piedmont	7.08	1.73	3638	6.82	1.72	1771	7.04	1.81	864	6.83	1.81	2642	7.16	1.66	2448
Sardinia	6.81	1.91	1741	6.77	1.97	1090	6.79	2.02	984	6.69	1.91	1613	6.91	1.94	1583
Sicily	6.54	1.80	2635	6.45	1.79	1652	6.49	1.82	2418	6.50	1.88	2480	6.86	1.80	2259
Tuscany	6.82	1.64	2184	6.81	1.72	1349	6.83	1.76	1987	6.85	1.73	2239	7.08	1.67	2149
Trentino-Alto Adige	7.44	1.63	2337	7.45	1.58	1495	7.52	1.68	1108	7.55	1.63	2119	7.64	1.58	2173
Umbria	6.81	1.85	1247	6.84	1.75	785	6.72	1.97	1159	6.86	1.78	1134	6.97	1.74	1100
Veneto	6.96	1.73	2447	6.81	1.96	1648	6.79	1.90	1371	6.97	1.70	2284	7.11	1.73	2375
Missing			6806			4403			4617			6356			6292
Italy	6.84	1.67	46464	6.81	1.78	30730	6.81	1.81	31582	6.79	1.78	45226	7.03	1.68	43414

(*) In 2012, Piedmont was unified to Aosta Valley

Source: elaboration on ISTAT: Multi-Purpose Survey on Italian Families, years 2012–2016

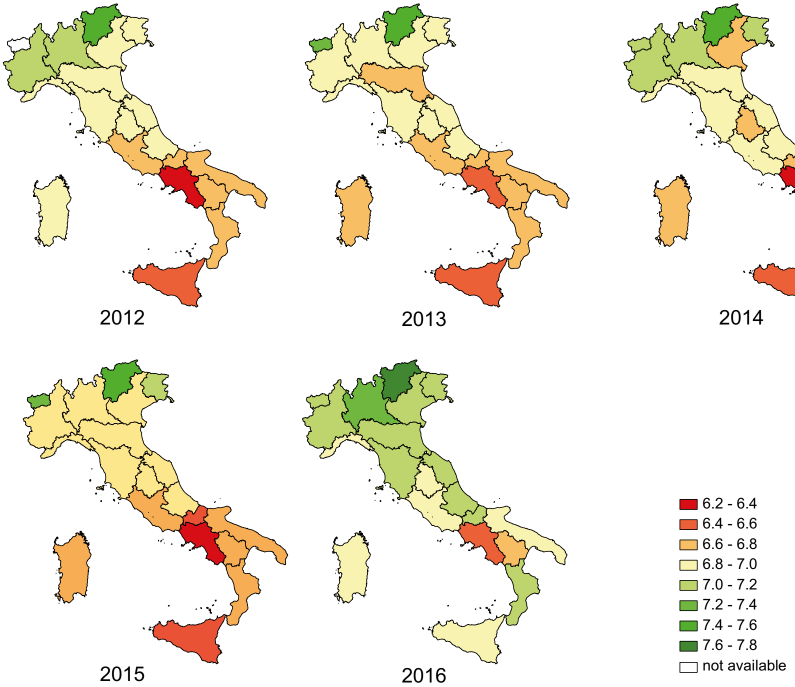

Fig. 4 Average SWB index

low density of land use (ISPRA, 2017). Various regions have achieved a percentage of changes in this context of over 70% (76.6% in Liguria, 71.2% in Lombardy). The changes in artificial contexts are 9% in Italy whereas 9.5% in Lombardy, 11.1% in Liguria, and 11.3% in Lazio. These data highlight the relevance of the low-density context as the one most at risk for the phenomenon of consumption, probably due to the greater ease of transformation of the uncovered areas that remain included in the urbanized areas between the infrastructural axes or in any case in territories that they have already lost the character of widespread naturalness.

Another discussion must be made about the findings contained in Table 4, where the estimate was obtained using the per capita GDP. The total GDP could also have been used, and the results would not have changed. It was only a unit of measurement choice. Since GDP is a complex macroeconomic indicator, the interpretation of the impact of the social cost for LC and the loss of related ESs must be made more consistent in terms of flows and percentages. On average, this cost affects 0.01% of GDP per year. However, the percentage, which in itself does not seem to be too high, must be referred to the level of annual growth which, in Italy, has been minimal in recent years. However, the economic reasoning is perfectly consistent with the physical–territorial reasoning. Italy is not a country that can count on great environmental resources. Its total surface area is only 301,340 km^2, of which mountains account for 35.2%, and 7.914 km is coastline. Consequently, even a small increase in LC could mean a lot.

Table 2 OLS regression model estimates

Dependent variable: SWBI	Unstandard coefficients	Std. error	Standard coefficients	*t*	Sig.	Dependent variable: SWBI	Unstandard coefficients	Std. error	Standard coefficients	*t*	Sig.
	B		Beta				*B*		Beta		
(Constant)	6.404	0.062		103.066	0.000	(Constant)	6.158	0.079		77.737	0.000
PCGDP	0.000032	0.000	0.845	16.148	0.000	PCI	0.000063	0.000	0.831	14.909	0.000
YEAR_12	−0.123	0.041	−0.191	−3.009	0.003	YEAR_12	−0.143	0.043	−0.223	−3.322	0.001
YEAR_13	−0.167	0.041	−0.261	−4.111	0.000	YEAR_13	−0.163	0.043	−0.254	−3.776	0.000
YEAR_14	−0.153	0.041	−0.239	−3.764	0.000	YEAR_14	−0.148	0.043	−0.230	−3.420	0.001
YEAR_15	−0.207	0.041	−0.322	−5.078	0.000	YEAR_15	−0.200	0.043	−0.312	−4.646	0.000
PLC	−0.033	0.005	−0.355	−6.817	0.000	PLC	−0.035	0.005	−0.372	−6.698	0.000
R	*R* square	Adjusted *R* square	Std. error	Number of observations:100		*R*	*R* square	Adjusted *R* square	St. error	Number of observations: 100	
0.876	0.767	0.752	0.12858			0.859	0.738	0.721	0.13620		

Source: our elaboration on ISTAT

Table 3 OLS regression model estimates, per capita income (2016)

Region	Per capita income	% land consumption	Territorial surface (m^2) × 1,000,000	PLC (m^2) × 1,000,000	Inhabitant number	Annual flow (euro)	Annual flow per m^2	Capital value range	
								Min	Max
Abruzzo	16,187.00	5.06	10,831.84	548.09	1,326,513	−38,650,078.68	−0.0705	−7.0518	−70.5176
Aosta Valley	21,036.80	2.91	3,260.9	94.89	127,329	−4,821,470.47	−0.0508	−5.0810	−50.8100
Apulia	13,700.30	8.33	19,540.9	1,627.76	4,077,166	−100,545,115.23	−0.0618	−6.1769	−61.7691
Basilicata	13,428.50	3.37	10,073.32	339.47	573,694	−13,866,929.78	−0.0408	−4.0849	−40.8487
Calabria	12,427.80	5.14	15,221.9	782.41	1,970,521	−44,080,633.59	−0.0563	−5.6340	−56.3399
Campania	13,020.30	10.35	13,670.95	1,414.94	5,850,850	−137,123,680.06	−0.0969	−9.6911	−96.9111
Emilia-Romagna	22,127.20	9.58	22,452.78	2,150.98	4,448,146	−177,165,029.11	−0.0824	−8.2365	−82.3649
Friuli-Venezia Giulia	20,167.90	8.86	7,924.36	702.10	1,221,218	−44,332,924.50	−0.0631	−6.3143	−63.1435
Lazio	18,925.10	8.26	17,232.29	1,423.39	5,888,472	−200,591,858.60	−0.1409	−14.0926	−140.9257
Liguria	21,387.70	8.32	5,416.21	450.63	1,571,053	−60,482,178.45	−0.1342	−13.4217	−134.2173
Lombardy	22,093.60	12.97	23,863.65	3,095.12	10,008,349	−398,016,827.04	−0.1286	−12.8595	−128.5951
Marche	18,422.60	7.19	9,401.38	675.96	1,543,752	−51,191,866.07	−0.0757	−7.5732	−75.7322
Molise	14,407.00	4.06	4,460.65	181.10	312,027	−8,091,671.38	−0.0447	−4.4680	−44.6801
Piedmont	20,342.00	6.75	25,387.07	1,713.63	4,404,246	−161,264,109.84	−0.0941	−9.4107	−94.1069
Sardinia	15,260.40	3.75	24,100.02	903.75	1,658,138	−45,546,928.44	−0.0504	−5.0398	−50.3977
Sicily	13,036.20	7.17	25,832.39	1,852.18	5,074,261	−119,068,346.25	−0.0643	−6.4285	−64.2854
Tuscany	19,935.70	7.1	22,987.04	1,632.08	3,744,398	−134,364,951.38	−0.0823	−8.2327	−82.3274
Trentino-Alto Adige	22,914.00	4.53	13,605.5	616.33	1,059,114	−43,683,368.75	−0.0709	−7.0877	−70.8767
Umbria	17,849.80	5.62	8,464.33	475.70	891,181	−28,633,324.70	−0.0602	−6.0193	−60.1926
Veneto	19,743.70	12.28	18,345.35	2,252.81	4,915,123	−174,676,885.16	−0.0775	−7.7537	−77.5374
Italy	17,371.85	7.61	301,338	22,933.30	60,665,551	−1,896,970,697.06	−0.0827	−8.2717	−82.7169

Source: our elaboration on ISTAT

Table 4 OLS regression model estimates, per capita GDP (2016)

Region	Per capita GDP	% of land consumption	Inhabitant number	Annual flow (euro)	GDP annual flow (euro)
Abruzzo	23,742	5.06	1,326,513	−30,539,705.84	31,494,071,646
Aosta Valley	34,298	2.91	127,329	−4,234,792.77	4,367,130,042
Apulia	17,634	8.33	4,077,166	−69,718,055.99	71,896,745,244
Basilicata	20,461	3.37	573,694	−11,382,645.27	11,738,352,934
Calabria	16,595	5.14	1,970,521	−31,709,862.78	32,700,795,995
Campania	17,791	10.35	5,850,850	−100,938,155.01	104,092,472,350
Emilia-Romagna	34,576	9.58	4,448,146	−149,138,517.43	153,799,096,096
Friuli-Venezia Giulia	30,346	8.86	1,221,218	−35,936,078.96	37,059,081,428
Lazio	32,342	8.26	5,888,472	−184,673,901.99	190,444,961,424
Liguria	31,312	8.32	1,571,053	−47,702,120.28	49,192,811,536
Lombardy	36,800	12.97	10,008,349	−357,146,417.65	368,307,243,200
Marche	26,405	7.19	1,543,752	−39,527,536.06	40,762,771,560
Molise	19,250	4.06	312,027	−5,824,504.00	6,006,519,750
Piedmont	29,832	6.75	4,404,246	−127,406,028.29	131,387,466,672
Sardinia	19,944	3.75	1,658,138	−32,067,785.96	33,069,904,272
Sicily	17,076	7.17	5,074,261	−84,022,381.42	86,648,080,836
Tuscany	30,063	7.1	3,744,398	−109,156,690.50	112,567,837,074
Trentino-Alto Adige	38,624	4.53	1,059,114	−39,667,606.43	40,907,219,136
Umbria	24,072	5.62	891,181	−20,802,433.00	21,452,509,032
Veneto	32,186	12.28	4,915,123	−153,404,265.58	158,198,148,878
Italy	26,667	7.61	60,665,551	−1,568,771,440.50	1,617,795,548,015

Source: our elaboration on ISTAT

Overall, in Italy, consumed soil now represents 7.63% of the total territory with the characteristics just mentioned. In 2017, LC exceeds 5% in 15 regions with the highest percentage value in Lombardy (reaching 12.99%), Veneto (12.35%), and Campania (10.36%). Emilia-Romagna, Friuli-Venezia Giulia, Lazio, Apulia, and Liguria follow, with values between 8 and 10%. Valle d'Aosta, a very small region, is the only one that remains below the 3% threshold. It is clear that the largest increases over the last year have occurred in the regions with the highest economic growth rates located in Northern Italy. Congedo et al. (2017) calculated the area consumed in Italy within a buffer of 150 m from permanent water bodies, showing that several regions in Northern Italy (especially Liguria, which has about a quarter of the consumed area within this buffer) are potentially affected by flooding, with consequences on people's safety. This is one of the possible impacts of soil consumption on society. A large portion of the

Italian nation is subject to possible environmental consequences, which could be assessed through the modeling of ecosystem services. The economic evaluation of ES in this sense could be relevant for spatial and urban planning and for policy makers to assess the relationship between the spatial distribution of environmental components and artificial areas (King et al., 2021). In this direction, it seems useful to give a value to this loss and to remember that it represents a social cost for present and future generations.

Conclusions

LC is emerging as a global environmental concern; together with climate change and severe weather events, it has relevant effects on different terrestrial habitats. Attention to the environment and the need to protect and promote sustainable use of the terrestrial ecosystem has been highlighted in recent years by the Sustainable Development Goals issued by United Nations. In particular, the Goal 15 aims to integrate ecosystem and biodiversity principles into national and local development processes. Although the importance of the LC and ESs is now globally recognized, policies, especially at European level, remain still rather incomplete today. But, since the land system changes are the direct result of human decision-making at multiple scales, local, national, or global, more attention to this problem could still improve the current situation (de Groot et al., 2010). In other words, land must be governed in such a way as to preserve its potential to deliver goods and services to present and future generations. Especially in areas with high population densities and high demand for ESs, the future availability of these services must be considered in order to promote effective and sustainable decision-making and prevent further ecosystem degradation (Lauf et al., 2014). For example, in Italy, a specific national law on LC has not yet been launched, despite being urged by several parties. Only some regions have introduced the principle of control of the LC with different results on territories, sometimes conflicting. Local data to support a well-being-oriented decision-making are needed.

In this paper, the life satisfaction approach has been applied to link SWB and LC in Italian regions. In detail, the estimated coefficients allowed to calculate the implicit WTA for compensating a given increment in LC. Our findings support previous studies showing that SWB is strongly linked to the satisfaction of basic human needs and to the social costs due to the loss of free resources (Aguado et al., 2018; Costanza et al., 2007; Hsu, 2019; Tay et al., 2015; Tong et al., 2020). This work has shown that the loss of undeveloped land, natural or semi-natural, has a value for the society. It also showed that the Italian regions highlight, according to their LC levels and the population's income, an interesting geographical pattern of the WTA for compensation. This result does not appear trivial since it is also a function of the inhabitants' well-being which, in turn, is a function of income, population density, and environmental conditions. This assessment is therefore multidimensional and provides, from this point of view, a useful indicator for territorial and environmental policies in order to reduce regional ecological risk.

Territorial governance has become an important issue in recent times when we are overwhelmed by environmental, social, and technological changes that have significantly changed our lifestyle (Xing et al., 2020; Zambrano-Monserrate et al., 2020). In this sense, the environment and the land system acquire a new value for society that has become aware of the importance of different bundles of benefits for its survival and well-being. The results obtained from this research experiment can become a useful tool to guide political choices that maximize the well-being of society by managing land use regulations taking into account the conditions of the ecosystems (Ahmadi Mirghaed et al., 2020).

Concerning the literature and previous applications, where there is greater use of individual SBWI versus an aggregate territorial index, this work emphasizes the application chances of an approach that reduces the weight of subjective heterogeneity in the LS function. In this perspective, the study seems suitably consolidated given the use of aggregate happiness indicators considered more accepted than individual ones. As stated by Diener (2006), the aggregate data are suitable for capturing the general well-being of the population. In addition, national statistical data resources ensure that sample heterogeneity is achieved at no cost. Developing a study based on specific surveys for the assessment of a specific problem at the national level whenever it is needed would be unlikely (e.g., contingent valuation). The use of statistically significant data allows the development of fast research and obtaining comparable results.

Another issue, directly related to these findings, is that of dissemination and communication of the research works. In fact, not surprisingly, the majority of research focused on economic valuation of non-market goods and services is not well-known by policy makers or properly disseminated (Frijters et al., 2020; Odermatt & Stutzer, 2017; Stutzer, 2020). Although there are excellent reasons for making better use of these assessments in territorial field, even today, European members do not follow the same protocols for integrating cost–benefit analysis into public policy. Compared, for example, to Great Britain, Italy does not have a strong tradition in this sense. The consequence is that the same concept of cost–benefit estimation, from the public point of view, is considered random and aimless. The fact that the academic and scientific environment continues to demonstrate its validity highlights, even more, the strong communication and interaction gap between policymakers and researchers. To this end, it is useful to conclude this work by remembering what operational possibilities of estimating costs of LC could be: (a) protection and conservation of the natural habitat with good effects on species (animals and plants) and landscapes (rural characters, scenic quality); (b) internalization of territorial development costs; (c) control of population density; (d) mitigation of climate change effects (investments in territories safety and prevention of landslides and floods); (e) individual well-being and improvement of health (reduction of health costs); and (f) supply and maintenance of common public goods.

A final, but not useless, consideration concerns the issue of economic growth at the expense of territorial resources and ESs. Particularly in times of ecological and economic crisis, the emphasis on returning to growth "at whatever cost" is dangerously linked to the further consumption of free resources, such as land. This work has shown that the regions with the highest population density, whose economic development is more advanced, pay the highest cost in terms of lost flow of ecological benefits. Estimates of this loss are not normally counted from the point of view of policymakers who, on the contrary, continue to emphasize the importance of GDP growth. Although the energy crisis is highlighting the close link that must exist between transition towards a sustainable development model and consumption of free resources, there are still who are convinced that these are at our infinite disposal. The economic valuation of these resources and the loss of their services are strategic to make a wider public understand the extent of the damage we are suffering. This work has favored a method not based on stated preferences which, despite their refinement, have not solved the problems related to the psychology of choice (Gilovich et al. 2002; Kahneman, 2011). Moreover, the distance from real markets has contributed to generating distrust on the part of non-academic sectors. On the contrary, the possibility of being able to estimate and compare the WTA with the real estate market values — in this case, a range between 8.27 and 82.71 €/m^2 has been reported — brings the method closer to cost-based estimates, allowing negotiating LUs between public and private subjects. This has been observed in a context where, as stated above, there are no standardized estimates for different types of LUs providing different bundles of ESs.

Regarding the limitations of this application, additional socio-economic variables in the sample could better describe the SBW function. But unfortunately, it is not possible to find annually updated data describing the sample in this sense.

However, the obtained results are perfectly consistent with the policies that place the problem of managing anthropogenic pressure on ecosystems and free resources at the center. Research can still make many contributions in this direction, even providing estimates suitable for different decision-making contexts. A Europe-wide comparison could provide more information for the future.

Funding Open access funding provided by Politecnico di Torino within the CRUI-CARE Agreement.

References

Aguado, M., González, J. A., Bellott, K., López-Santiago, C., & Montes, C. (2018). Exploring subjective well-being and ecosystem services perception along a rural–urban gradient in the high Andes of Ecuador. *Ecosystem Services, 34*, 1–10. https://doi.org/10.1016/j.ecoser.2018.09.002

Ahmadi Mirghaed, F., Mohammadzadeh, M., Salmanmahiny, A., & Mirkarimi, S. H. (2020). Decision scenarios using ecosystem services for land allocation optimization across Gharehsoo watershed in northern Iran. *Ecological Indicators, 117*, 106645. https://doi.org/10.1016/j.ecolind.2020.106645

Alam, R., & Van Quyen, N. (2017). The conversion of biodiversity-rich land and ecosystem services. *Environmental Economics and Policy Studies, 20*, 157–178. https://doi.org/10.1007/S10018-017-0188-3

Alfonso, A., Zorondo-Rodríguez, F., & Simonetti, J. A. (2016). Perceived changes in environmental degradation and loss of ecosystem services, and their implications in human well-being. *International Journal of Sustainable Development & World Ecology, 24*, 561–574. https://doi.org/10.1080/13504509.2016.1255674

Ambrey, C., & Fleming, C. (2014a). Public greenspace and life satisfaction in urban Australia. *Urban Studies, 51*, 1290–1321. https://doi.org/10.1177/0042098013494417

Ambrey, C. L., & Fleming, C. M. (2014b). Valuing ecosystem diversity in South East Queensland: A Life satisfaction approach. *Social Indicators Research, 115*, 45–65. https://doi.org/10.1007/s11205-012-0208-4

Barrington-Leigh, C. P. (2021). Life satisfaction and sustainability: A policy framework. *SN Social Sciences, 1*(7), 1–25. https://doi.org/10.1007/S43545-021-00185-8

Bateman, I. J., Harwood, A. R., Abson, D. J., Andrews, B., Crowe, A., Dugdale, S., Fezzi, C., Foden, J., Hadley, D., Haines-Young, R., Hulme, M., Kontoleon, A., Munday, P., Pascual, U., Paterson, J., Perino, G., Sen, A., Siriwardena, G., & Termansen, M. (2014). Economic analysis for the UK national ecosystem assessment: Synthesis and scenario valuation of changes in ecosystem services. *Environmental and Resource Economics, 57*, 273–297. https://doi.org/10.1007/s10640-013-9662-y

Bertram, C., & Rehdanz, K. (2015). The role of urban green space for human well-being. *Ecological Economics, 120*, 139–152. https://doi.org/10.1016/j.ecolecon.2015.10.013

Botes, C. M., & Zanni, A. M. (2020). Trees, ground vegetation, sidewalks, cycleways: Users' preferences and economic values for different elements of an urban street—A case study in Taipei. *Environmental Economics and Policy Studies, 23*, 145–171. https://doi.org/10.1007/S10018-020-00284-5

Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics, 63*, 616–626. https://doi.org/10.1016/j.ecolecon.2007.01.002

Caprioli, C., Bottero, M., Zanetta, E., & Mondini, G. (2021). Ecosystem services in land-use planning: An application for assessing transformation scenarios at the local scale. In C. Bevilacqua & E. Al (Eds.), *Smart Innovation, Systems and Technologies* (pp. 1332–1341). Springer Nature. https://doi.org/10.1007/978-3-030-48279-4_124

Chen, Y., Lu, H., Li, J., & Xia, J. (2020). *Effects of land use cover change on carbon emissions and ecosystem services in Chengyu urban agglomeration, China*. Stochastic Environmental Research and Risk Assessment. https://doi.org/10.1007/s00477-020-01819-8

Clark, A. E. (2018). Four decades of the economics of happiness: Where next? *Review of Income and Wealth, 64*, 245–269. https://doi.org/10.1111/roiw.12369

Clark, A. E., Frijters, P., & Shields, M. A. (2008). Relative income, happiness, and utility: An explanation for the Easterlin paradox and other puzzles. *Journal of Economic Literature, 46*, 95–144. https://doi.org/10.1257/jel.46.1.95

Conceição, P., & Bandura, R. (2008). *Measuring subjective wellbeing: A summary review of the literature*. United Nations Development Program.

Congedo, L., Marinosci, I., Riitano, N., Strollo, A., De Fioravante, P., & Munafò, M. (2017). Monitoring of land consumption: An analysis of loss of natural and agricultural areas in Italy. *Annali di Botanica, 7*, 1–9. https://doi.org/10.4462/annbotrm-13843

Costanza, R., D'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R. G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387*, 253–260. https://doi.org/10.1038/387253a0

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S., & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change, 26*, 152–158. https://doi.org/10.1016/j.gloenvcha.2014.04.002

Costanza, R., Fisher, B., Ali, S., Beer, C., Bond, L., Boumans, R., Danigelis, N. L., Dickinson, J., Elliott, C., Farley, J., Gayer, D. E., Glenn, L. M., Hudspeth, T., Mahoney, D., McCahill, L., McIntosh, B., Reed, B., Rizvi, S. A. T., Rizzo, D. M., et al. (2007). Quality of life: An approach integrating opportunities, human needs, and subjective well-being. *Ecological Economics, 61*, 267–276. https://doi.org/10.1016/j.ecolecon.2006.02.023

Cuñado, J., & de Gracia, F. P. (2013). Environment and happiness: New evidence for Spain. *Social Indicators Research, 112*, 549–567. https://doi.org/10.1007/s11205-012-0038-4

de Groot, R. S., Alkemade, R., Braat, L., Hein, L., & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making. *Ecological Complexity, 7*, 260–272. https://doi.org/10.1016/j.ecocom.2009.10.006

de Groot, R. S., Wilson, M. A., & Boumans, R. M. J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics, 41*, 393–408. https://doi.org/10.1016/S0921-8009(02)00089-7

Dechasa, F., Senbeta, F., & Guta, D. D. (2020). Economic value of wetlands services in the Central Rift Valley of Ethiopia. *Environmental Economics and Policy Studies, 23*, 29–53. https://doi.org/10.1007/S10018-020-00277-4

Dell'Anna, F., Bravi, M., & Bottero, M. (2022). Urban green infrastructures: How much did they affect property prices in Singapore? *Urban Forestry & Urban Greening, 68*, 127475. https://doi.org/10.1016/j.ufug.2022.127475

Diener, E. (1984). Subjective well-being. *Psychological Bulletin, 95*, 542–575. https://doi.org/10.1037/0033-2909.95.3.542

Diener, E. (2006). Guidelines for national indicators of subjective well-being and ill-being. *Applied Research Quality Life 1*, 151–157. https://doi.org/10.1007/s11482-006-9007-x

Diener, E., Oishi, S., & Lucas, R. E. (2015). National accounts of subjective well-being. *American Psychologist, 70*, 234–242. https://doi.org/10.1037/a0038899

Doherty, S. T., Lemieux, C. J., & Canally, C. (2014). Tracking human activity and well-being in natural environments using wearable sensors and experience sampling. *Social Science & Medicine, 106*, 83–92. https://doi.org/10.1016/j.socscimed.2014.01.048

Dolan, P., Peasgood, T., & White, M. (2008). Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *Journal of Economic Psychology, 29*, 94–122. https://doi.org/10.1016/j.joep.2007.09.001

Dominati, E., Patterson, M., & Mackay, A. (2010). A framework for classifying and quantifying the natural capital and ecosystem services of soils. *Ecological Economics, 69*, 1858–1868. https://doi.org/10.1016/j.ecolecon.2010.05.002

Easterlin, R. A. (1974). Does economic growth improve the human lot? Some empirical evidence. In *Nations and Households in Economic Growth* (pp. 89–125). Elsevier. https://doi.org/10.1016/B978-0-12-205050-3.50008-7

Enssle, F., & Kabisch, N. (2020). Urban green spaces for the social interaction, health and well-being of older people— An integrated view of urban ecosystem services and socio-environmental justice. *Environmental Science & Policy, 109*, 36–44. https://doi.org/10.1016/j.envsci.2020.04.008

Farber, S. C., Costanza, R., & Wilson, M. A. (2002). Economic and ecological concepts for valuing ecosystem services. *Ecological Economics, 41*, 375–392. https://doi.org/10.1016/S0921-8009(02)00088-5

Ferreira, S., Akay, A., Brereton, F., Cuñado, J., Martinsson, P., Moro, M., & Ningal, T. F. (2013). Life satisfaction and air quality in Europe. *Ecological Economics, 88*, 1–10. https://doi.org/10.1016/j.ecolecon.2012.12.027

Ferrer-i-Carbonell, A. (2005). Income and well-being: An empirical analysis of the comparison income effect. *Journal of Public Economics, 89*, 997–1019. https://doi.org/10.1016/j.jpubeco.2004.06.003

Ferrer-i-Carbonell, A., & Frijters, P. (2004). How important is methodology for the estimates of the determinants of happiness? *The Economic Journal, 114*, 641–659. https://doi.org/10.1111/j.1468-0297.2004.00235.x

Fisher, B., Turner, R. K., & Morling, P. (2009). Defining and classifying ecosystem services for decision making. *Ecological Economics, 68*, 643–653. https://doi.org/10.1016/j.ecolecon.2008.09.014

Floris, M., & Ruggeri, D. (2017). Planning with ecosystem services in the Natura 2000 Network of the metropolitan city of Cagliari. In *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (pp. 401–415). Springer Verlag. https://doi.org/10.1007/978-3-319-62407-5_28

Frijters, P., Clark, A. E., Krekel, C., & Layard, R. (2020). A happy choice: Wellbeing as the goal of government. *Behavioural Public Policy, 4*, 126–165. https://doi.org/10.1017/bpp.2019.39

Gilovich, T., Griffin, D., Kahneman, D. (2002). Heuristics and biases. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511808098

Goetzke, F., & Rave, T. (2015). Regional air quality and happiness in Germany. *International Regional Science Review, 38*, 437–451. https://doi.org/10.1177/0160017615589008

Goldman, R. L., & Tallis, H. (2009). A critical analysis of ecosystem services as a tool in conservation projects. *Annals of the New York Academy of Sciences, 1162*, 63–78. https://doi.org/10.1111/j.1749-6632.2009.04151.x

Gómez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics, 86*, 235–245. https://doi.org/10.1016/j.ecolecon.2012.08.019

Gorlach, B., Landgrebe-Trinkunaite, R., Interweis, E., Bouzit, M., Darmendrail, D., & Rinaudo, J. D. (2018). Assessing the economic impacts of soil degradation. In *Final Report to European Commission. DG Environment. ENV.B.1/ETU/2003/0024Ecologic*.

Graves, A. R., Morris, J., Deeks, L. K., Rickson, R. J., Kibblewhite, M. G., Harris, J. A., Farewell, T. S., & Truckle, I. (2015). The total costs of soil degradation in England and Wales. *Ecological Economics, 119*, 399–413. https://doi.org/10.1016/j.ecolecon.2015.07.026

Hsu, K.-C. (2019). Effect of distinct land use patterns on quality of life in urban settings. *Journal of Urban Planning and Development, 145*, 05019016. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000522

Hu, W., Zhang, S., Song, Y., Liu, T., Lin, Y., & Zhang, A. (2018). Effects of multifunctional rural land use on residents' wellbeing: Evidence from the Xinzhou District of Wuhan City. *China. Sustainability, 10*, 3787. https://doi.org/10.3390/su10103787

Huang, Q., Yin, D., He, C., Yan, J., Liu, Z., Meng, S., Ren, Q., Zhao, R., & Inostroza, L. (2020). Linking ecosystem services and subjective well-being in rapidly urbanizing watersheds: Insights from a multilevel linear model. *Ecosystem Services, 43*, 101106. https://doi.org/10.1016/j.ecoser.2020.101106

Hudson, P., Botzen, W. J. W., Poussin, J., & Aerts, J. C. J. H. (2019). Impacts of flooding and flood preparedness on subjective well-being: A monetisation of the tangible and intangible impacts. *Journal of Happiness Studies, 20*, 665–682. https://doi.org/10.1007/s10902-017-9916-4

ISPRA, 2017. Consumo di suolo, dinamiche territoriali e servizi ecosistemici.

ISPRA, 2022. Consumo di suolo, dinamiche territoriali e servizi ecosistemici.

ISTAT. (2016). *BES/2016*. Il benessere equo e sostenibile in Italia.

ISTAT. (2018). *BES/2018*. Il benessere equo e sostenibile.

Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux, New York.

Kahneman, D., & Sugden, R. (2005). Experienced utility as a standard of policy evaluation. *Environmental and Resource Economics, 32*, 161–181. https://doi.org/10.1007/s10640-005-6032-4

Kant, S., Vertinsky, I., & Zheng, B. (2016). Valuation of First Nations peoples' social, cultural, and land use activities using life satisfaction approach. *Forest Policy and Economics, 72*, 46–55. https://doi.org/10.1016/j.forpol.2016.06.014

King, S., Vardon, M., Grantham, H. S., Eigenraam, M., Ferrier, S., Juhn, D., Larsen, T., Brown, C., & Turner, K. (2021). Linking biodiversity into national economic accounting. *Environmental Science & Policy, 116*, 20–29. https://doi.org/10.1016/j.envsci.2020.10.020

Kopmann, A., & Rehdanz, K. (2013). A human well-being approach for assessing the value of natural land areas. *Ecological Economics, 93*, 20–33. https://doi.org/10.1016/j.ecolecon.2013.04.014

Krekel, C., Kolbe, J., & Wüstemann, H. (2016). The greener, the happier? The effect of urban land use on residential well-being. *Ecological Economics, 121*, 117–127. https://doi.org/10.1016/j.ecolecon.2015.11.005

Krekel, C., & Zerrahn, A. (2017). Does the presence of wind turbines have negative externalities for people in their surroundings? Evidence from well-being data. *Journal of Environmental Economics and Management, 82*, 221–238. https://doi.org/10.1016/j.jeem.2016.11.009

Lauf, S., Haase, D., & Kleinschmit, B. (2014). Linkages between ecosystem services provisioning, urban growth and shrinkage – A modeling approach assessing ecosystem service trade-offs. *Ecological Indicators, 42*, 73–94. https://doi.org/10.1016/j.ecolind.2014.01.028

Layard, R., Clark, A. E., & Senik, C. (2012). The causes of happiness and misery. In J. Helliwell, R. Layard, & J. Sachs (Eds.), *World Happiness Report* (pp. 59–89). UN World Happiness Report.

Li, S., Liu, Y., Yang, H., Yu, X., Zhang, Y., & Wang, C. (2021). Integrating ecosystem services modeling into effectiveness assessment of national protected areas in a typical arid region in China. *Journal of Environmental Management, 297*, 113408. https://doi.org/10.1016/j.jenvman.2021.113408

Li, Z., Folmer, H., & Xue, J. (2014). To what extent does air pollution affect happiness? The case of the Jinchuan mining area, China. *Ecological Economics, 99*, 88–99. https://doi.org/10.1016/j.ecolecon.2013.12.014

Liu, W., Zhan, J., Zhao, F., Zhang, F., Teng, Y., Wang, C., Chu, X., & Kumi, M. A. (2022). The tradeoffs between food supply and demand from the perspective of ecosystem service flows: A case study in the Pearl River Delta. *China. Journal of Environmental Management, 301*, 113814. https://doi.org/10.1016/j.jenvman.2021.113814

Liu, Y., Hou, X., Li, X., Song, B., & Wang, C. (2020). Assessing and predicting changes in ecosystem service values based on land use/cover change in the Bohai Rim coastal zone. *Ecological Indicators, 111*. https://doi.org/10.1016/j.ecolind.2019.106004

MacKerron, G., & Mourato, S. (2009). Life satisfaction and air quality in London. *Ecological Economics*. https://doi.org/10.1016/j.ecolecon.2008.10.004

Maes, J., Egoh, B., Willemen, L., Liquete, C., Vihervaara, P., Schägner, J. P., Grizzetti, B., Drakou, E. G., La Notte, A., Zulian, G., Bouraoui, F., Luisa Paracchini, M., Braat, L., & Bidoglio, G. (2012). Mapping ecosystem services for policy support and decision making in the European Union. *Ecosystem Services*. https://doi.org/10.1016/j.ecoser.2012.06.004

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L., Berry, P., Egoh, B., Puydarrieus, P., Fiorina, C., Santos, F., Paracchini, M. L., Keune, H., Wittmer, H., & Hauck, J. (2013). *An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020*. Publications office of the European Union. https://doi.org/10.2779/12398

Manning, M., Fleming, C. M., & Ambrey, C. L. (2016). *Life satisfaction and individual willingness to pay for crime reduction* (Vol. 50, pp. 2024–2039). Regional Studies. https://doi.org/10.1080/00343404.2015.1082030

Mei, Y., Sohngen, B., & Babb, T. (2018). Valuing urban wetland quality with hedonic price model. *Ecological Indicators, 84*, 535–545. https://doi.org/10.1016/j.ecolind.2017.09.022

Millennium Ecosystem Assessment. (2005). Ecosystem and human well-being. In *Synthesis*. World Resources Institute.

Odermatt, B. R., & Stutzer, A. (2017). *Subjective well-being and public policy*. IZA Discussion Paper.

Oliveira, S., & Pinto, L. M. C. (2020). Choice experiments to elicit the users' preferences for coastal erosion management: The case of Praia da Amorosa. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-020-00768-0

Rehdanz, K., Welsch, H., Narita, D., & Okubo, T. (2015). Well-being effects of a major natural disaster: The case of Fukushima. *Journal of Economic Behavior & Organization, 116*, 500–517. https://doi.org/10.1016/j.jebo.2015.05.014

Roszak, T. (2001). *The voice of the earth: An exploration of ecopsychology*. Phanes Press.

Saeedi, I., & Dabbagh, E. (2020). Modeling the relationships between hardscape color and user satisfaction in urban parks. *Environment, Development and Sustainability*. https://doi.org/10.1007/s10668-020-00866-z

Sekulova, F., & van den Bergh, J. C. J. M. (2013). Climate change, income and happiness: An empirical study for Barcelona. *Global Environmental Change, 23*, 1467–1475. https://doi.org/10.1016/j.gloenvcha.2013.07.025

Sørensen, J. F. L. (2014). Rural–Urban differences in life satisfaction: Evidence from the European Union. *Regional Studies, 48*, 1451–1466. https://doi.org/10.1080/00343404.2012.753142

Stutzer, A. (2020). Happiness and public policy: A procedural perspective. *Behavioural Public Policy, 4*, 210–225. https://doi.org/10.1017/bpp.2019.44

Tay, L., Kuykendall, L., & Diener, E. (2015). Satisfaction and happiness – The bright side of quality of life. In *Global Handbook of Quality of Life: Exploration of Well-Being of Nations and Continents* (pp. 839–853). https://doi.org/10.1007/978-94-017-9178-6_39

Tong, W., Lo, K., & Zhang, P. (2020). Land Consolidation in rural China: Life satisfaction among resettlers and its determinants. *Land, 9*, 118. https://doi.org/10.3390/land9040118

Tsurumi, T., Imauji, A., & Managi, S. (2018). Greenery and subjective well-being: Assessing the monetary value of greenery by type. *Ecological Economics, 148*, 152–169. https://doi.org/10.1016/j.ecolecon.2018.02.014

Tsurumi, T., & Managi, S. (2015). Environmental value of green spaces in Japan: An application of the life satisfaction approach. *Ecological Economics, 120*, 1–12. https://doi.org/10.1016/j.ecolecon.2015.09.023

Verhofstadt, E., Van Ootegem, L., Defloor, B., & Bleys, B. (2016). Linking individuals' ecological footprint to their subjective well-being. *Ecological Economics, 127*, 80–89. https://doi.org/10.1016/j.ecolecon.2016.03.021

von Möllendorff, C., & Hirschfeld, J. (2016). Measuring impacts of extreme weather events using the life satisfaction approach. *Ecological Economics, 121*, 108–116. https://doi.org/10.1016/j.ecolecon.2015.11.013

Welsch, H. (2009). Implications of happiness research for environmental economics. *Ecological Economics, 68*, 2735–2742. https://doi.org/10.1016/j.ecolecon.2009.06.003

Welsch, H., & Biermann, P. (2014). Fukushima and the preference for nuclear power in Europe: Evidence from subjective well-being data. *Ecological Economics, 108*, 171–179. https://doi.org/10.1016/j.ecolecon.2014.10.022

Welsch, H., & Kühling, J. (2009). Using happiness data for environmental valuation: Issues and applications. *Journal of Economic Surveys, 23*, 385–406. https://doi.org/10.1111/j.1467-6419.2008.00566.x

Wu, C., Chen, B., Huang, X., & Dennis Wei, Y. H. (2020). Effect of land-use change and optimization on the ecosystem service values of Jiangsu province, China. *Ecological Indicators, 117*, 106507. https://doi.org/10.1016/j.ecolind.2020.106507

Xing, L., Hu, M., & Wang, Y. (2020). Integrating ecosystem services value and uncertainty into regional ecological risk assessment: A case study of Hubei Province, Central China. *Science of The Total Environment, 740*, 140126. https://doi.org/10.1016/j.scitotenv.2020.140126

Yang, Y., & Wang, K. (2019). The effects of different land use patterns on the microclimate and ecosystem services in the agro-pastoral ecotone of Northern China. *Ecological Indicators, 106*. https://doi.org/10.1016/j.ecolind.2019.105522

Yuan, L., Shin, K., & Managi, S. (2018). Subjective well-being and environmental quality: The impact of air pollution and green coverage in China. *Ecological Economics, 153*, 124–138. https://doi.org/10.1016/j.ecolecon.2018.04.033

Zambrano-Monserrate, M. A., Ruano, M. A., & Sanchez-Alcalde, L. (2020). Indirect effects of COVID-19 on the environment. *Science of The Total Environment, 728*, 138813. https://doi.org/10.1016/j.scitotenv.2020.138813

Authors and Affiliations

Marina Bravi[1] · **Marta Bottero**[1] · **Federico Dell'Anna**[1]

Marina Bravi
marina.bravi@polito.it

Marta Bottero
marta.bottero@polito.it

[1] Interuniversity Department of Regional and Urban Studies and Planning, Politecnico di Torino, Viale Mattioli 39, 10128 Turin, Italy