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Valuing Urban Landscape Using Subjective Well-Being Data: Empirical Evidence from Dalian, China

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Abstract: It has been well recognized that the urban landscape ecosystem is able to make a great contribution to the quality of life for people who live in the city and beyond, thus it can potentially accrue a significant economic value to the human well-being. However, due to its public good nature, it is difficult to monetizing its values in a systematic manner. In this paper, we attempt to assess the economic value of the urban landscape through people's life satisfaction approach utilizing a large sample of dataset complied from the general public survey in Dalian City which is one of the well-known tourism cities in China. The results indicate that most of the urban landscape attributes impose significant effects on people's life satisfaction, thus accruing a considerable amount of value to the local residents. Taking a 10-point ranking scale for the urban landscape quality as an example, the household willingness to pay on average reaches ¥24,579 per annum for one point of ranking level increase. Relative to the low level of household income, those high-income households are much keener to the changes of the landscape quality. If the urban landscape quality is disaggregated into five levels, household's marginal willingness-to-pay diminishes as the urban landscape's rank level is improved.

Keywords: life satisfaction approach; economic valuation; landscape sustainability; human well-being

1. Introduction

Landscape is an important component of an integrated urban ecological system, which provides diversified needs and benefits for people who live in the city, including aesthetic, recreation, environmental services, job opportunities, and living space [1–5]. However, due to the rapid urbanization and population growth, the urban space in China has been outstretched tremendously in many city areas over the last decades. However, much of the city land has been encroached by residential and commercial development uses, which have significantly misappropriated the green land space of lawn and forestry area [6,7]. This situation has been deteriorated to a degree of threatening the city's sustainable landscape development. Thus, how to coordinate the objectives of economic development and ecological reconstruction has turned out to be a critical problem the city government has to face [8,9].

It has been well received that a good landscape, including an ideal combination of residential area, infrastructure, trees, flowers, waters, lawns, parks, and roads, can provide tremendous benefits to the local people's quality of life and beyond, which is evident by observing people's high willingness to pay for houses that sit at a location of having beautiful scenery [10]. As indicated by Miccoli et al. (2014), landscape not only has intrinsic value, but also social, environmental and cultural values [11].

However, owing to its public good or quasi-public good nature, there is no clear market transaction information available that can be used to monetize the landscape's economic values. Unfortunately, undervalued resources are subject to misuse, thus causing efficiency loss. According to the Millennium Ecosystem Assessment Reports in 2005, at a globally scale, the marketed value of ecosystem associated with timber and fuel wood production only accounted for less than one third of the total economic value when non-marketed values such as carbon sequestration, watershed protection, and recreation are counted [12]. Therefore, to effectively safeguard the entire ecosystem value, it is imperative to fully recognize its total economic value as well as its value composition so that the disclosed value information of each individual value component can be used to justify land use planning in the process of urbanization drive [13].

Generally speaking, the conventional non-market valuation techniques are categorized into two types: the stated preference method and the revealed preference method [14]. Revealed preference relies on peoples' market behaviors observed under real market transaction conditions from which the economic values of the non-market good in question can be referred. Commonly used revealed preference method techniques include the travel cost method and the hedonic pricing method. The stated preference approach is normally used in valuing an environmental good. By creating a hypothetical market, research practitioners can elicit people's willingness to pay for the considered public good improvement or willingness to accept for compensating the public good loss. The contingent valuation method and choice experiment model are mostly used in stated preference study [15–17].

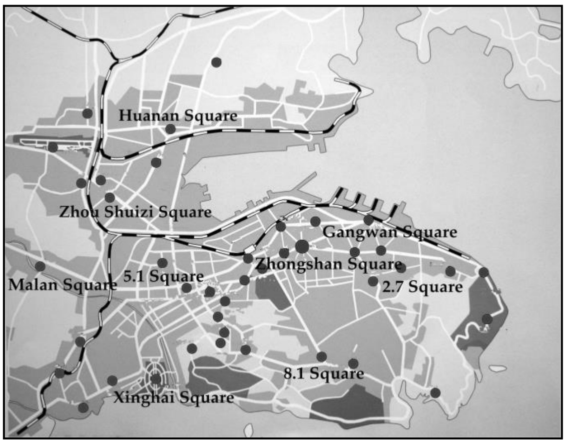
Even though hundreds of studies have been conducted in valuing non-market resources, a series of concerns remain regarding the acceptability of economic valuation results as well as their reliability in practical uses: (i) There is no a universal standard established for survey questionnaire designs under contingent valuation studies, making meaningful comparisons and cross work checking between different research results difficult [18]. (ii) There is no a single method considered superior to the others in all aspects. For example, the hedonic pricing method is generally deemed as a reliable non-market valuation method because it is based on real estate market data. Nevertheless, it relies on a strong assumption of both housing and labor markets to be in an equilibrium condition to correctly elicit the values of an environmental attribute [19]. Unfortunately, these assumptive conditions are rarely satisfied in practice due to market rigidity, policy constraints, exorbitant moving costs, etc. As a result, the revealed value of the environmental good may subject to a high bias [20]. (iii) The survey process under stated preference requires respondents to be able to fully understand the stake of the good being evaluated. In reality, this seems to be a far-fetched requirement with a great potential of leading strategic bias [21].

In recent years, a small, but growing body of literature on non-market resource valuation studies has pursued a subjective well-being survey method in valuing "intangible assets" such as amenities [22,23]. This method uses self-reported well-being (life satisfaction or happiness) as an empirical approximation to "the experienced utility" or human welfare and entails some non-market goods as explanatory variables in a micro-econometric function of subjective well-being along with income and other social demographic variables [20]. According to Welsch (2007, 2009), one can use happiness, life satisfaction and subjective well-being as proxies for an individual's utility. Therefore, as in the literature, in the present paper, the three terms are used interchangeably [22,24]. The model results are utilized in computing the average marginal rate of substitution between household income and the considered environmental goods, which yields the respondents' marginal willingness to pay (WTP) for improved environment good [25]. This new method is called the life satisfaction approach (LSA).

This happiness-based methodology offers several advantages over those conventional non-market valuation techniques. First, the life satisfaction approach neither relies on sufficient understanding of the survey participants on the good being evaluated in the survey process, nor needs to ask respondents to consider the consequences of the evaluation results. In other words, the life satisfaction approach can significantly reduce the respondents' cognition burden in the survey process that would experience in the contingent valuation survey. Second, the life satisfaction approach does not rely on housing markets being in the equilibrium condition. Under imbalanced market circumstances, the method can generate more accurate results, thus it is more adaptable for empirical research use [26,27].

In this paper, we intend to investigate the economic value of those primary urban landscape resource characteristics using the subjective well-being data and take the city of Dalian in Liaoning Province of China as a pilot study area. There are at least three novel aspects in this study:

- The current literature on landscape sustainability study has fully recognized that natural resources in urban area can contribute greatly to human well-being through provisioning natural resource based ecological services. In this study, we want to go a step further by monetizing the economic value of those natural resources which constitute an essential part of the urban landscape. We believe that simply understanding the relationship between the natural resource-based ecological services and people's life quality is not adequate to make a sound land use planning and effective landscape management decisions. The economic value information is absolute necessary for making a balanced land use policy and overall landscape management decision.
- Non-market valuation is a well-known research area in the discipline of natural resource and environmental economics. However, the vast majority of studies have been based on either revealed preference approach or stated preference methods. In this study, we attempt to adopt a novel method, the life satisfaction approach, to shed light on its merit for valuing non-market resources in general and urban landscape in particular.
- As far as the urban landscape attributes, there are some unique features of landscape in Dalian because the city landscape has a unique feature of square constructions, as squares are scattered over the entire city, including Zhongshan Square, Xinghai Square, 5·1 Square, 8·1 Square, etc., just named a few. For this reason, Dalian is dubbed "a square city" in China (see Figure 1). To some degree, the square has become a landmark or a postcard for Dalian City. Thus, it is interesting to investigate the roles played by the square construction in the city in terms of its economic value and people's preference.



(**a**)

(**b**)

Figure 1. Geographical information of the squares in Dalian City: (**a**) locations and distribution of squares; and (**b**) a typical square (Zhongshan Square). Redrawn with modifications from Zhou [28].

1.1. *Landscape Sustainability and Human Well-Being*

Ecosystem benefits people by provisioning a variety of services including regulating services, cultural services, and supporting services [29] (see Figure 2). Depending on the characteristics of the ecosystem such as composition of biodiversity and functioning types, the system influences people's life in various aspects (society, economy and policy), thus it has been widely regarded as an important bridge connecting natural capital and human well-being [30]. Compared with ecosystem services, landscape ecosystem service embodies the importance of spatial pattern and its configuration can be more easily perceived by mankind. There exists a close connection and interaction as well as bond between landscape sustainability and landscape ecology. In an early example, Wu and Hobbs (2002) recognized landscape sustainability as one of the ten key issues of landscape ecology [31]. Pursuing this line of research, Wu (2013) identified landscape sustainability as the capacity of a landscape to consistently provide long-term, landscape-specific ecosystem services essential for maintaining and improving human well-being [32]. Some prominent definitions on the landscape sustainability were also given by Cumming et al. (2013) [33]; Power and Sekar (2011) [34]; Musacchio (2009) [35]; and Nassauer and Opdam (2008) [36].

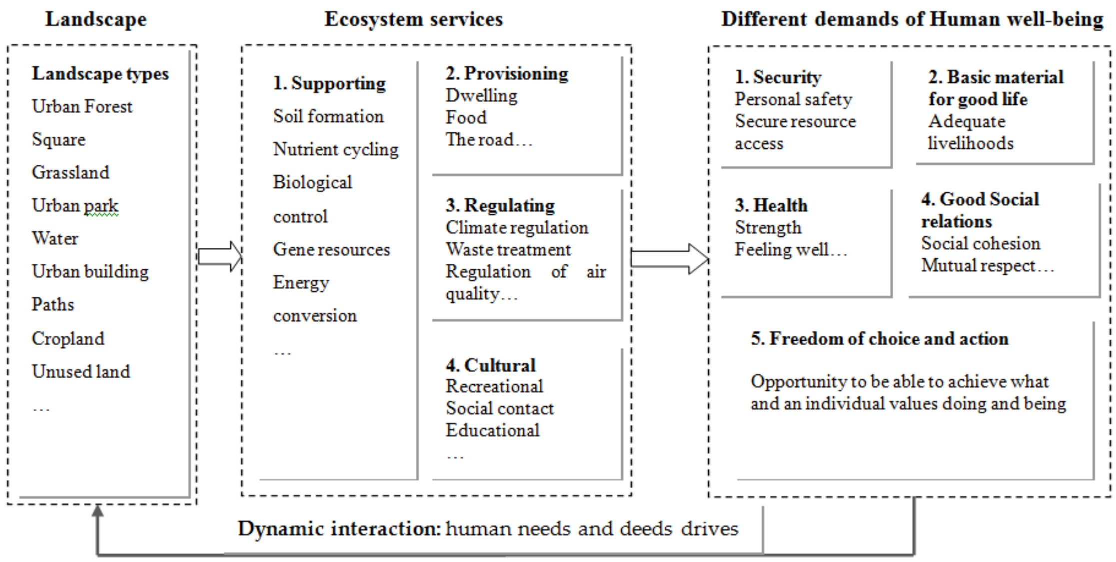


Figure 2. Relationship among landscape, ecosystem service and human well-being.

Based on conventional wisdom, well-being is a multidimensional concept depending on different perspectives and research emphases [37]. In general, human well-being is divided into two types: objective well-being and subjective well-being [38–40]. Subjective well-being directly measures the individuals' perception and emotional reaction to surrounding environment and is widely used by scholars in the study fields of economics, sociology and psychology [41,42]. Among them, the assessment content includes happiness, life satisfaction, positive emotion, social relations and support, accomplishment and personal ability, and so on. Millennium Ecosystem Assessment (MEA) (2005) assumes that human well-being consists of the five constituents: the basic material for a good life, feeling well and have a healthy physical environment, social cohesion and mutual respect, secure access to natural and other resources, and the opportunity to achieve what an individual values doing and being. Different ecosystem services meet the different demands of human well-being (see Figure 2) [12]. These ideas and ontologies have been widely accepted by ecologists over the last decade [32].

Another important aspect is that a dynamic interaction exists between humans and ecosystems. With dynamic human needs and deeds drives, ecosystems have been changing over time, which in turn impacts on the status of human well-being [43]. For this reason, landscape sustainability development is not just to focus on human welfare but also needs to correctly measure the economic value of the ecosystem to establish a sound landscape pattern best serving human well-being [44].

1.2. Valuing Landscape Using Conventional Techniques

There is a large body of literature seeking to establish the monetary value of urban landscape. Under the realm of the revealed preference approaches, the hedonic pricing method is one of the most applied methods. This is because urban landscape exerts a strong effect on housing prices in urban areas [45]. Using the real estate market transaction data, the hedonic pricing method can value each specific type of natural resources and environmental attributes. Gillard (1981) was the first author of using the hedonic pricing method to investigate the effect of landscape sightseeing on the housing prices in Los Angeles metropolitan area in the United States [46]. He found that a house with a good view can have higher sale prices. Many other researchers adopted the same method in estimating house prices attributed to the various landscape types, such as a park, lake, wetland, forest, ocean, mountain, river, etc. [19,47]. Without exception, all landscapes with enriched natural resources and beautiful environment attributes can considerably contribute to the nearby residential property values [48–50]. Furthermore, other researchers carried out similar studies to estimate economic value losses caused by different types of environmental damages, including but not limited to the value loss triggered by the existence of manufacturing facilities, cemetery, waste landfills, airport noise, and so on [51–53]. They demonstrated the fact that the discomfort landscape within the limit of sightseeing distance imposes negative effects on the housing prices. By contrast, travel cost method could also be used in valuing public resources, such as recreation parks and wildlife refuges [54–56]. There is a large body of literature concluding that the travel cost method produces a better result in valuing a landscape attraction that is far away from the city's residential areas than is within the inner city boundary [57].

In addition, there are many studies that used stated preference method to place a monetary value on landscape system. Using the contingent valuation method, Groothuis and Whitehead (2007) found that citizens are willing to pay about $1.5 million for removing billboards from the Watauga County roadsides [58]. Firoozan et al. (2012) exercised the economic valuation of the Lahijan forest in Iran [59]. The results showed that the average WTP of the tourists for the park recreational value was 8216 Rials per tourist and its total annual value was 123 billion Rials. In line with improved forest attractions, the WTP grew by 47%. Biénabe and Hearne (2006) used choice modeling to investigate the difference of people's willingness to pay toward the enhanced natural conservation and scenery protection in Costa Rica between international tourists and local residents [60].

1.3. Valuing Environmental Goods Using Subjective Well-being Data

In an early example of life satisfaction approach study, Welsch (2002) used cross-section data on reported well-being from 54 countries to value urban air pollution [26]. The author found that the improvement of air quality has a significant positive effect on the residents' life satisfaction. Similarly, later studies evaluated air pollution in different regions [61,62]. Furthermore, subjective well-being data have been used to estimate the value of noise pollution, climate change, extreme weather events, flood hazard, and non-market value of farmland [63–66]. Similarly, this paper attempts to explore the effects of the urban landscape changes on their residents' happiness based on China's situation to provide further evidence on the appropriateness of this non-market resource valuation technique.

2. Materials and Methods

2.1. Study Area and Data Collection

The data used in this study were gathered from the residents' life satisfaction survey conducted in Dalian City, which is located at the southern-most tip of Liaodong peninsula in northeastern China (see Figure 3). With the lasting efforts of afforestation in Dalian City over the past decades, the green land area in Dalian City reached 42% by the end of 2015 [67]. Since the city is located in both the Yellow sea and the Bohai sea gulf area, this coastal environment setting not only contributes greatly to subjective well-being of the local residents, but also attracted many outsiders to migrate to

Dalian City during the last three decades. Along with the urbanization drive and pursuing a large size of the municipality, the Dalian City government has long implemented a preferential policy of attracting outsiders to migrate to Dalian City. As a result, the city's residential land space has been expanded significantly due to the soaring demand of real estate development. To satisfy this land demand, several land reclamation measures have been exercised by the city government and business community, including marine land reclamation, forest removal, mountain land openings, etc., with the purpose of expanding flat land area for real estate development and constructing commercial infrastructure. It is no doubt that such undertakings have been a "double-edge sword": on the one hand, it stimulates the city's economic development, while, on the other hand, it degrades the city's natural resource preservation, thus sacrificing the city's natural beauty. Thus, the city's landscape has been transformed substantially in terms of its coastal boundaries, vegetation coverage, and even geological topography. The move has had a great negative effect on the people's life satisfaction and ultimately dissipated the level of the resident life's well-being.

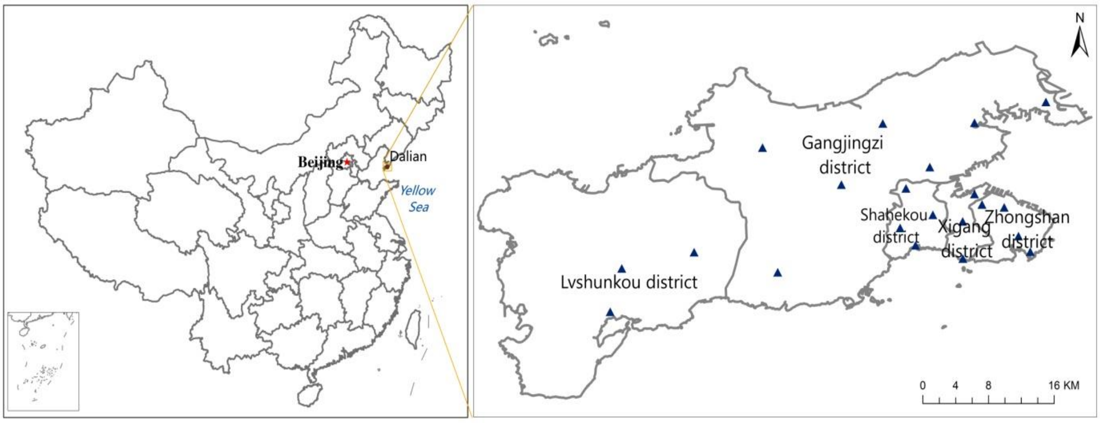


Figure 3. Dalian City map and the locations where the surveyed people reside.

To assess the effect of those landscape changes in Dalian City, a survey was conducted over the period from August to October 2015. The sampling process was made in aligning with the structure of the city's administrative jurisdiction, in which the city was classified into four levels: city government, district government, street or township administration, and the community residents committee. A roughly equal number of households were sampled from each community residents committee (see details in Table 1). To have an unbiased sampling, the proportion of sampled households from each district was consistent with the proportion of population who reside in it. For example, the number of residents in Shahekou District was the highest among the districts in Dalian (29.69%), thus the number of households sampled in this district was also the highest (150), 31.25% of the whole sample. The interviewee selection was accorded with the following three criteria: (1) a balanced sex ratio; (2) ages ranging from 18 to 60 years of old; and (3) the respondents must have lived in the city for six months or longer. A total of 480 questionnaires were distributed, of which 437 were recovered and finally used in analysis, namely a 91.04% effective survey response rate.

Table 1. The sampling design and stratification steps.

1st Layer (Location)	2nd Layer (District)	3rd Layer (Street or Town)	4th Layer (Community)	No. HH Sampled
East	Zhongshan	Feng Lin, Qing Niwa, Hu Tan, Renmin Road	4 × 2 = 8	8 × 10 = 80
□	Xigang	Renmin Square, Ba Yilu, Xiang Lujiao	3 × 2 = 6	6 × 10 = 60
Medium	Sha Hekou	Chunliu, Hei Shijiao, Xing Hai, Zhongshan Park, Xing Gongjie	5 × 3 = 15	15 × 10 = 150
□	Gan Jingzi	Ying Chengzi, Long WangTang, Xin Zhaizi, Ge Zhenbao, Pao Ya, Zhou Shuizi, Nan Guanling, Dalian Wan	7 × 2 = 14	14 × 10 = 140
West	Lv Shunkou	Tie Shan, Shui ShiYing, LongTou Town	2 × 2 + 1 = 5	5 × 10 = 50
Total	5	22	48	480
Sampling Frame	District	No. of Residents	Proportion of Residents	Proportion of Sampling
East	Zhongshan Xigang	360,000 308,000	16.94% 14.49%	16.67% 12.50%
Medium	Sha Hekou	631,000	29.69%	31.25%
West	Gan Jingzi Lv Shunkou	616,000 210,000	28.98% 9.88%	29.16% 10.41%
Total	5	2,125,000	100%	100%

2.2. Model

The life satisfaction model, adapted from Brereton, Clinch and Ferreira (2008) [65], takes the form of an indirect utility function for individual i in location k as follows:

$$\mathbf{U}^{*}_{i,k} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \ln \boldsymbol{y}_{i,k} + \boldsymbol{\beta}_2 \boldsymbol{t}_{i,k} + \boldsymbol{\beta}_3 \boldsymbol{s}_{i,k} + \boldsymbol{\beta}_4 \boldsymbol{\delta}_{i,k} + \boldsymbol{\varepsilon}_{i,k} \tag{1}$$

where $\mathbf{U}^{*}_{i,k}$ is residents' utility; $\boldsymbol{y}_{i,k}$ is household income; $\boldsymbol{t}_{i,k}$ is a vector of socio-economic characteristics including age, marital status, education, personal traits and so forth; $\boldsymbol{s}_{i,k}$ is evaluation of urban landscape quality; and $\delta_{i,k}$ is a vector of other variables that could affect residents' level of utility. In the micro-econometric function, the residents' utility is unobservable. Therefore, we take the life satisfaction as a proxy to individual's utility or subjective well-being [68]. Then, the estimated life satisfaction model can be expressed as Equation (2):

$$LS_{i,k} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 \ln \boldsymbol{y}_{i,k} + \boldsymbol{\beta}_2 \boldsymbol{t}_{i,k} + \boldsymbol{\beta}_3 \boldsymbol{s}_{i,k} + \boldsymbol{\beta}_4 \boldsymbol{\delta}_{i,k} + \boldsymbol{\varepsilon}_{i,k} \tag{2}$$

On the condition of other factors being fixed, the marginal utility attributable to the landscape quality improvement (MU_S) is equivalent to the marginal utility attributed to the income increase (MU_y) when the residents' utility is held constant [69]. For a marginal change of s, the marginal rate of substitution (MRS) between income and urban landscape can be derived from Equation (1):

$$WTP = MRS = \frac{MUs}{MUy} = \frac{\partial \mathrm{u}/\partial \mathrm{s}}{\partial \mathrm{u}/\partial \mathrm{y}} = \overline{y}\frac{\hat{\beta}_3}{\hat{\beta}_1} \tag{3}$$

where $\overline{y}$ is the mean value of household income. Based on the tenet of LSA, the WTP can simply be expressed as the marginal rate of substitution. Thus, the economic value of the urban landscape is embodied in the residents' welfare improvement. Welfare economics suggests that, besides WTP, both a compensating variation (CV) and equivalent variation (EV) are equally important metrics to be used in measuring the level of welfare change to be denominated in monetary terms. In this context, a resident's life utility level is not only related to his or her market good consumption x, but also a bundle of other environmental goods such as landscape. Assuming that an indirect utility function is $u = v(p, s, m)$, then the Hicks compensated demand function under a certain level of utility u and price p can be written as $h = h(p, s, m)$. A compensating variation can be calculated as follows:

$$u = v(p, \mathbf{s}^0, m) = v(p, \mathbf{s}^1, m - cv) \tag{4}$$

where $\mathbf{s}^0$ and $\mathbf{s}^1$ are the initial and the new level of urban landscape quality, respectively. Then,

$$CV = -\exp\left[\ln(\overline{y}) + \frac{\hat{\beta}_3}{\hat{\beta}_1}\left(\mathbf{s}^0 - \mathbf{s}^1\right)\right] + \overline{y} \tag{5}$$

Similarly, equivalent variation can be estimated as follows:

$$EV = \exp\left[\ln(\overline{y}) + \frac{\hat{\beta}_3}{\hat{\beta}_1}\left(\mathbf{s}^1 - \mathbf{s}^0\right)\right] - \overline{y} \tag{6}$$

2.3. Variable Identifications

A large body of literature has indicated that demographic factors such as age, education, income and marital status can influence people's life satisfaction [70]. Meanwhile, spatial information such as living location, length of stay, and proximity to amenities are all highly correlated with individual's life happiness [65]. However, all those factors can only make a partial contribution to the individual's life well-being. As indicated by and Lani (2016), psychological factors, personality in particular, are also the key drivers for people's life satisfaction [71]. Similarly, Boyce (2010) suggests that these personality traits may serve to explain previously unobserved heterogeneity that might confound the effects of various explanatory variables on people's life satisfaction [72]. Therefore, the "Big Five", commonly known as the connotation of an individual's personality, is introduced into models of Equations (1) and (2). By convention, self-reported personality measures generally have high levels of reliability and validity. Thus, we adopted the following questions to uncover characteristics of an individual's personality [73]:

Individuals are asked whether they see themselves as someone who . . .

- . . . is outgoing, sociable
- . . . . is relaxed, handles stress well
- . . . is original, comes up with new ideas
- . . . is considerate and kind to others
- . . . does things effectively and efficiently

Individuals were asked whether each statement phrased above applies to them on a 1 to 7 scale: "1" means the statement does not apply to them at all and "7" means it applies perfectly. The feedback answers are categorized as dummy variables ("0" if the score is less than 4; "1" otherwise).

2.3.1. Dependent Variable

In microeconomic theory, utility is a measurement of benefit or happiness a customer can accrue from a good or service consumption. However, the tricky part about utility is its unobservability and uniqueness. Thus, utility is not comparable and transferable between people. In the study of happiness economics, measurement of people's life satisfaction is always a core issue that attracts researchers' interests. In the empirical aspect, the variable of life satisfaction is usually defined from individuals' responses to the question: "All things considered, how satisfied are you with your life?" In this study, we use a similar method of defining the life satisfaction variable using a 5-point Likert scale (dissatisfied = 1; dissatisfied = 2; neither satisfied nor dissatisfied = 3; satisfied = 4; completely satisfied = 5).

2.3.2. Independent Variables

1. Identifying Urban Landscape Attributes

According to Kevin Lynch (1960), a well-known US scholar in the field of city geography study, there are five factors, path, borders, area, point and landmark, of a city's landscape that are closely linked with resident's psychology [74]. In actual urban construction, the materializations of above-mentioned elements are represented as buildings, streets, environmental facilities, construction sketches and afforestation. Furthermore, a set of different space factors could also contribute to the value of urban landscape, including recreational value, ecological service, aesthetic value, etc. [75]. To dissect economic values to be attributable to the various urban landscape attributes, in this study, we categorize the landscape into five different components: plants, coastal, buildings, road and landmark squares (see Table 2).

Each component may be comprised of multiple subordinate attributes. To identify them, two focus group discussions were held. The first group discussion was administrated with 20 residents, of which there were 12 men and 8 women with ages ranging from 20 and 55. The participants were asked to give their personal opinion of what are the most preferable landscape attributes. The second focus group consisted of research experts in the fileds of landscape planning and environment management, which included 3 professors and 5 graduate students. The main task for the second focus group discussion was to determine the most critical attributes from those attribute candidates recognized from the first focus group discussion to narrow down the number of attributes to be considered in the questionnaire design. Concentrated landscape attributes emerge after finishing the two focus group discussions, and they are space shape, proportion, color, lighting, pavement, etc. (see Table 2).

Table 2. Evaluating index and weights of different types of the urban landscape attributes.

Plants (0.15)	**Coastal (0.55)**	**Building (0.14)**	**Road (0.06)**	**Landmark Square (0.15)**
Plant diversity (0.29)	Oceanic area (0.09)	Architectural style (0.16)	Road greening (Flowers) (0.29)	Square size (Number, Area) (0.27)
Plant Appreciation (0.33)	Seawater quality (0.36)	Spatial Distribution (0.33)	Road ornaments (Brick Road and Lighting) (0.16)	Functional infrastructure (Signage, barrier-free access) (0.09)
Vegetation coverage (0.15)	Coastline vegetation (0.05)	Coordination degree with environment (0.51)	Coordination degree with urban space (0.4)	Service facilities (Bench, trashcan, bathroom) (0.16)
Plant maintenance (0.23)	Beach quality (0.39)		Traffic signs setting (0.1)	Landscape sketch (Sculpture, fountain) (0.48)
	Beach entertainment equipment (0.11)		Road advertising setting (0.05)	

Note: The data in brackets are the weights of each index.

2. Measuring Urban Landscape Quality

Assessment of urban landscape quality was divided into three stages. In the first stage, the core of subordinate landscape attributes as outlined in Table 1 (number = 21) were based on the answers to the following question: "thinking about your life in Dalian, which of these answers best describes the landscape quality as a whole?" Respondents could choose a ranking score on a sale of 1 to 10.

In the second stage, once the score of each subordinate attribute was obtained, its weight was calculated using the Analytic Hierarchy Process (AHP) method [76]. However, when the ranking score for certain attributes were very close to each other in terms of their magnitude, the entropy evaluation method was used to modify the index weights (see Table 2). All the indexes should be standardized; thus, their values are ranged from 0 to 1. We believe that the fuzzy AHP method can reduce the biases potentially caused by subjectivity under the expert's scoring process.

Lastly, the linear weight technique was used to assess each individual's comprehensive scores. The linear weights were calculated by Equations (7) and (8):

$$S = \sum_{j=1}^{m} \boldsymbol{F}_j \boldsymbol{C}_j \tag{7}$$

$$\boldsymbol{F}_j = \sum_{j=1}^{m} \left(\sum_{i=1}^{n} \boldsymbol{I}_i \boldsymbol{D}_i \right) \boldsymbol{C}_j \tag{8}$$

where S is residents' overall evaluation scores of the urban landscape, $\boldsymbol{F}_j$ is the scores at the criteria level (5 landscape types), $\boldsymbol{C}_j$ is the weight at the criteria level (5 landscape types), $\boldsymbol{I}_i$ is the scores at the index level (21 subordinate landscape attributes), and $\boldsymbol{D}_i$ is the weight at the index level (21 subordinate landscape attributes). Finally, m and n are the number of criterion level and the number of index level, respectively.

3. Analysis of the Results

Given the ordinal nature of the life satisfaction variable, an ordered probit model was used for parameter estimations via the maximum likelihood estimation technique. In comparison with the ordinary least squares model, the ordered probit model has the advantage of being able to avoid the assumption of cardinality, which, if incorrectly made, would yield estimates being both biased and inconsistent [77]. Therefore, using ordered probit model makes it easier for us to use the estimated coefficients of landscape quality and household income to calculate marginal rates of substitution (MRS) between the two variables, while this MRS represents the economic value of the urban landscape. Statistical descriptions of the data and estimated results are presented in Tables 3–6.

3.1. Descriptive Statistics

To investigate the curvilinear correlation between life satisfaction and age, a squared age variable is added to the model. All the considered variable definitions and their descriptive statistics are summarized in Table 3.

Among 437 surveyed residents, 151 rated the landscape quality with a score of less than 6 points, which means about one-third of the residents in Dalian City are not satisfied with the current local landscape conditions. This could be largely due to implementing the land reclamation projects such as the cross-sea bridge construction since this change of the land topography has destroyed a massive amount of the landscape sceneries along the coastline, upsetting people. Ultimately, the most upset people could be the ones who have lived in Dalian for many years because they have personally experienced the city's land transformation process, which could easily trigger their nostalgic sentiment because Dalian used to have the most beautiful landscape in northern China [67]. As to the respondents' personal traits, most are aged between 15 and 85 and received junior high school or higher education. The average household size is relatively small, 2–4 persons, and has an annual income of ¥87,170 per household.

Table 3. Variable specifications and its statistical descriptive.

Variable Name	Definition	Min.	Max.	Mean	St.D.
Life satisfaction	5-point Likert Scale (scale 1 to 5)	1	5	3.465	0.833
Urban landscape quality	10-point Likert Scale (1 ″not good at all″; 10 "very good")	1	10	6.480	1.551
Household income (ln)	Natural log of disposable household income	8.699	13.459	11.123	0.741
Age	Age (in years)	15	85	36.890	14.464
Age Squared	Age (in years) squared	225	7225	1569.61	1296.48
Male	Dummy variable = 1 if respondent is male	0	1	0.467	0.499
Married	Dummy variable = 1 if respondent is married	0	1	0.599	0.491
Number of Children	No. of children owned	0	5	0.602	0.672
Lower secondary	Dummy variable = 1 if respondent's highest level of education is junior high school	0	1	0.103	0.304
Higher secondary	Dummy variable = 1 if respondent's highest level of education is senior high school	0	1	0.339	0.474
College	Dummy variable = 1 if respondent's highest level of education is bachelor	0	1	0.453	0.498
Postgraduate	Dummy variable = 1 if respondent's highest level of education is Master degree and above	0	1	0.082	0.275
Moderate health condition	Dummy variable = 1 if respondent has visited doctor 6 to 10 times in the past tear	0	1	0.391	0.489
Great health condition	Dummy variable = 1 if respondent has visited doctor 2 to 5 times in the past tear	0	1	0.055	0.228
Secure health condition	Dummy variable=1 if respondent has visited doctor never or once in the past year	0	1	0.011	0.106
Extroversion	Dummy variable = 1 if respondent answers "yes"	0	1	0.293	0.456
Emotional stability	Dummy variable = 1 if answer "yes"	0	1	0.222	0.416
Openness to experience	Dummy variable = 1 if answer "yes"	0	1	0.142	0.349
Agreeableness	Dummy variable = 1 if answer "yes"	0	1	0.533	0.499
Conscientiousness	Dummy variable = 1 if answer "yes"	0	1	0.206	0.405
Downtown area	Dummy variable=1 if living in urban area	0	1	0.806	0.396
Living time (short-term)	Dummy variable = 1 if living for 2 to 5 years	0	1	0.135	0.342
Living time (medium)	Dummy variable = 1 if living for 5 to 10 years	0	1	0.142	0..349
Living time (long-term)	Dummy variable = 1 if living for 10 to 20 years	0	1	0.343	0.475
Living time (Permanently)	Dummy variable = 1 if living for 20 years and above	0	1	0.211	0.408
Proximity to coastline (<3 km)	Dummy variable = 1 if living within 3 km of coastline	0	1	0.428	0.495
Proximity to coastline (3–5 km)	Dummy variable = 1 if living within 3–5 km of coastline	0	1	0.407	0.492
Proximity to coastline (5–10 km)	Dummy variable = 1 if living within 5–10 km of coastline	0	1	0.114	0.319
Proximity to square or park (<1 km)	Dummy variable = 1 if living within 1 km of square or park	0	1	0.586	0.493
Proximity to square or park (1–3 km)	Dummy variable = 1 if living within 1–3 km of square or park	0	1	0.263	0.441
Proximity to square or park (3–5 km)	Dummy variable = 1 if living within 3–5 km of square or park	0	1	0.112	0.316

Omitted variables due to "dummy variable trap": Female (if a respondent is female) ; Unmarried (if a respondent is unmarried); Primary education (if the respondent's highest level of education is primary school); Severe health condition (if a respondent has visited doctor for more than 10 times in past year); Suburban area (if living in suburban area); Living time (temporary) (if living in Dalian from six months to two years); Proximity to coastline (>10 km) (if living over 10 km away from coastline); Proximity to square or park (>5 km) (if living over 5 km away from the a square or park).

3.2. Model Results

Results of alternative ordered probit models are presented in Table 3 for convenient comparisons. Let us start with Model 1 in Table 4. It can be seen that residents' perception of the urban landscape quality exerts a significant influence on their life satisfaction. The higher is the quality of the landscape, the happier is the resident's life. This finding is very much consistent with previous studies, where the size of public green space in urban area was found to have a positive effect on the people's life satisfaction [45,51,78]. Models 2–4 are structured by adding several additional variables to the baseline Mode 1, including income, residence and individual social characteristics. The results show that the effect of the urban landscape quality on life satisfaction remains statistically significant ($\alpha \leqslant 0.01$). According to Model 2 in Table 4, the level of household income also contributes to a higher life satisfaction. Accordingly, households with different levels of income exhibit different levels of willing-to-pay for the urban landscape quality enhancement [45,62]. More detailed explanations on these results are arranged at the end of this section.

Note that the value of the adjusted-R^2 is improved from 0.056 to 0.106 after adding the spatial variables to Model 2 (see results for Model 3). Obviously, this improvement of the adjusted-R^2 implies that spatial amenities play a marked role in enhancing people's life well-being in Dalian (Table 4, Column 6). Specifically, people who reside in the urban area are much happier than those who live in the suburban area [79]. By contrast, the length of settlement imposes a negative effect on people's life satisfaction, i.e., that the longer is a resident living in Dalian, the less happy he or she is. Through the process of the authors' communication with the survey respondents, we have noticed that, as people resided in the same place for a longer period, they tended to have a deeper understanding of the surrounding environment, thus became more sensitive to the problems of the landscape changes in Dalian. Consequently, those long time residents aspire to improve the landscape quality [80]. In addition, the presence of ocean, square and park are also able to improve people's life well-being and so is the proximity to the coastline according to the regression model results. Specifically, people who live in less than 3 km away from the coastline feel much happier than ones who live more than 3 km away from the coastline area ($\alpha \leqslant 0.01$). With regard to the square attribute, it seems that the closer a person lives to a square area, the happier he or she is. For example, people who live in a location within 1 km distance from a square are happier than those who live more than 3 km from a square. Moreover, those living between 1 km and 3 km from a square also display more satisfaction with their life, although the regression coefficient becomes smaller.

From Column 8 in Table 4, the life satisfaction appears to have a U-shaped relation with the age variable, where life satisfaction reaches rock bottom as people attain to middle age. This is perhaps because middle-age people normally have to face more life challenges coming from multiple aspects including job security, taking care of family members, social peer pressure, etc. which also explains why the residents' marital status is negatively correlated with their life satisfaction. As to education, better educated people are happier in their life than those who received less education. One intuitive reason is that better educated people can earn higher salary and have a higher social status, which can further contribute to one's life satisfaction. To measure the effect of personal attributes, we introduced the concept of the big-five personal characteristics to mitigate the downward bias of the income coefficient estimate. The results indicate that an extraverted person seems more likely to report a higher level of life satisfaction than does an introverted person. A similar result was found in Powdthavee's (2010) study [81]. Along the same line, Augusto et al. (2010) reported that people with characteristics of extroversion and openness tend to exhibit a higher level of life satisfaction [82].

Table 4. Estimated the influence on life satisfaction under different ordered probit models.

Variable Name	Probit Model 1		Probit Model 2		Probit Model 3		Probit Model 4	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Urban landscape quality	0.149 ***	0.033	0.162 ***	0.034	0.169 ***	0.004	0.183 ***	0.038
Household income (ln)			0.451 ***	0.072	0.558 ***	0.076	0.649 ***	0.084
Downtown area					0.307 **	0.138	0.317 **	0.145
Living time (short-term)					−0.476 **	0.198	−0.587 ***	0.207
Living time (medium)					−0.656 ***	0.196	−0.586 ***	0.205
Living time (long-term)					−0.601 ***	0.165	−0.510 ***	0.176
Living time (Permanently)					−0.631 ***	0.178	−0.659 ***	0.203
Proximity to coastline (<3 km)					0.535 ***	0.255	0.515 ***	0.265
Proximity to coastline (3–5 km)					0.727 **	0.257	0.738 **	0.267
Proximity to coastline (5–10 km)					0.265	0.288	0.170	0.300
Proximity to square or park (<1 km)					0.749 ***	0.289	0.631 **	0.297
Proximity to square or park (1–3 km)					0.575 **	0.299	0.480 *	0.308
Proximity to square or park (3–5 km)					0.202	0.320	0.231	0.327
Age							−0.053 **	0.027
Age Squared							0.001 ***	0.0002
Male							−0.136	0.114
Married							−0.407	0.191
Number of Children							−0.039	0.129
Lower secondary							0.457	0.401
Higher secondary							0.274	0.279
College							0.434	0.384
Postgraduate							0.787 *	0.426
Moderate health condition							0.073	0.123
Great health condition							−0.379	0.265
Secure health condition							−0.598	0.524
Extroversion							0.393 ***	0.138
Emotional stability							−0.081	0.148
Openness to experience							0.350 **	0.165
Agreeableness							−0.007	0.127
Conscientiousness							0.063	0.142
Number of observations	437		437		437		437	
Pseudo R^2	0.019		0.056		0.106		0.160	
Log likelihood	−521.25		−501.41		−475.13		−446.26	

Note: * Significant at the 0.1 level, ** significant at the 0.05 level, *** significant at the 0.01 level.

3.3. Valuing Urban Landscape

Following the procedure described in Equation (3), the average willingness-to-pay in terms of annual household income is estimated to be ¥24,579.5 for a one-unit improvement of the urban landscape quality, which accounts for about 28.20% of the household annual income. According to the 2010 Dalian census data, the city's total population was about 6.69 million. On average, there are 2.63 people per household. This can be translated into a gross of ¥64.64 billion economic value of the urban landscape in Dalian City. The estimated results obtained from Equations (5) and (6) show that one standard deviation (1.55) improvement of the urban landscape quality would be able to yield ¥30.86 of compensating variation (CV) and ¥47.78 of equivalent variation (EV), which imply that an individual is willing to sacrifice approximately ¥30.86 of annual income to maintain, at the initial level of welfare, the status-quo of the landscape quality. Alternatively, an individual would demand a ¥47.78 annual household income increase as compensation for landscape quality deterioration. Thus, the EV is nearly 1.55 times higher than CV. This difference reflects that the lost value induced from environmental damage is considerably larger than the value gained from environmental quality improvement. Thus, it seems more important to prevent landscape resources from deteriorating than to improve it to a better condition, suggesting that most people uphold a risk adverse attitude toward landscape resource protections.

Ambrey and Fleming (2010) found that respondents were willing-to-pay approximately AUD $14,000 of their households' annual income to obtain a one-level improvement on scenic amenity in Australia, which accounted for about 28.04% of the household annual income [45]. This means that our finding on economic value of overall landscape quality improvement in Dalian is comparable with neighboring Australia in terms of the ratio of the average WTP and household income. The bottom line is that all those findings suggest the fact that quality of landscape plays an indispensable role in contributing to people's life wellbeing. Similarly, McLeod (1984) demonstrated a house asset that approximates to rivers, parks, and highways could be sold for much higher prices than one with no such features [83]. Among others, the river view was found to be extremely important in raising the house selling prices, and it could account for 28% of the total housing sale value. Jim and Chen (2010) found that a park close to the residence can raise the property values by 16.88%. In a nutshell, there is plenty of evidence suggesting that the level of household income and life satisfaction exhibit a causal relationship, which could render a downward bias for income coefficient estimate. This may imply that our residents' WTP estimate for the quality of landscape is a conservative estimate and the true value of the landscape could be even higher [27].

4. Discussion

4.1. Heterogeneity Analysis

As indicated by Ambrey and Fleming's (2011) studies, assuming the urban landscape is a normal good, people's marginal willingness-to-pay will increase along with their income enhancement [37]. One way to test this proposition is to examine whether the level of WTP for landscape quality improvement rises as the household's income increases To conduct this test, we categorized the household income into four groups based on the sequential order from the minimum level of income to the highest level of income: the lowest income group (the bottom 25% observations), lower income group (25–50% observations), middle income group (50–75% observations), and the high income group (75% and higher observations). Then, we reran the regression models using different income-based subsample data. The estimated results are presented in Table 5.

Table 5. Comparing the WTP for the landscape quality improvement under different income groups.

Variable	Min-Income	Low-Income	Middle-Income	High-Income
Household income	1.39 *** (0.31)	2.30 ** (1.21)	1.71 ** (1.35)	0.92 ** (0.41)
Urban landscape quality	0.17 ** (0.09)	0.26 ** (0.11)	0.29 ** (0.11)	0.34 *** (0.09)
Setting information	YES	YES	YES	YES
Individual characteristics	YES	YES	YES	YES
Number of observations	101	116	124	96
Pseudo R^2	0.35	0.31	0.22	0.34
Log likelihood	−90.21	−91.77	−76.26	−82.63
WTP	3776.96	6415.56	15,633.74	68,133.36
CV	5332.85	9121.66	21,309.04	80,394.34
EV	6445.974	10,868.51	27,715.64	142,561

Note: **, *** are statistical significance level at 0.05 and 0.01, respectively.

As shown in Table 5, again, the urban landscape quality imposes a statistically significant positive effect on the residents' life satisfaction under each income group. However, the households with a higher income are willing to pay more for enhancing urban landscape quality than are the lower income household, which implies that higher income residents are keener to their surrounding environmental quality and view the nearby landscape quality as one of the important contributors to their subjective well-being. For example, with one-level increase of landscape quality, the average WTP of the high-income group reaches ¥68,133.36, which is about four times as much as the WTP paid by the middle income group, and five times that paid by the low-income group.

These results suggest that household income is a major factor contributing to the value of the urban landscape [62]. However, ironically, as we said before, household income could be a "double-edged sword" in terms of the implications for urban landscape management. On the one land, people are willing to pay more money for the urban landscape improvement as their income improves. This can motivate city governments or resource management agencies to appropriate more financial resources for urban landscape protection. On the other hand, as household income increases, so does the housing market demand, which may spark the local governments' interest in allocating more land resources to real estate development. Thus, it is up to the government to conduct careful assessments on the role that household income plays in landscape planning and management decisions.

4.2. Marginal Return of Enhancing the Urban Landscape Quality

Through the descriptive statistics presented in Table 2, it can be seen that the mean score of the urban landscape is 6.48. In Table 6, we disaggregated urban landscape into five categories (very low, low, medium, high and very high) using the urban landscape scores. To quantify the marginal effect of the urban landscape quality change on resident's life happiness, Equation (2) was re-estimated and the results are presented in Table 6. It shows that all urban landscape variables are statistically significant, except for the very high level of urban landscape, and, at the same time, the model's explanatory power is marginally improved. This suggests that residents are more sensitive to the discomfort caused by the low level of the urban landscape quality, thus they are prone to hold a negative emotion toward landscape quality deterioration. Table 7 shows that a higher level of willingness to pay (¥106,725.40) is estimated as the quality of landscape quality is shifted from the very low level to the low level. As the quality of urban landscape rises, the resident's WTP diminishes gradually. This implies that residents who reside in low quality landscape areas uphold a stronger desire to improve the landscape quality.

Table 6. Disaggregated Ordered Probit model results.

Variable Name	Ordered Probit Model (S.E.)
Low level of the urban landscape	0.79 *
$(3 < s_i \leqslant 6)$	(0.44)
Medium level of the urban landscape	1.41 ***
$(6 < s_i \leqslant 8)$	(0.44)
High level of the urban landscape	1.51 ***
$(8 < s_i \leqslant 9)$	(0.45)
Very high level of the urban landscape	0.92
$(9 < s_i \leqslant 10)$	(0.53)
Number of observations	437
Log likelihood	−440.69
Pseudo R^2	0.171

Note: *, *** are statistical significance level at 0.1 and 0.01, respectively. Omitted case: very low level of urban landscape $(1 < s_i \leqslant 3)$.

Table 7. WTP for the alternative levels of the scenic amenity enhancement.

	Low	Medium	High	Very high *
Move from very low to:	106,725.40	189,689.40	202,979.71	124,445.93
Move from low to:		82,963.92	96,254.26	17,720.45
Move from medium to:			13,290.34	−65,243.5
Move from high to:				−78,533.8

Note: * This result is not statistically significant.

5. Conclusions

Sustainable landscape ecosystem can have tremendous benefits to people's life. One of the important challenges becomes how to effectively monetize those benefits in a systematic manner. To answer this question, in this study, we adopted a novel method, the so-called life satisfaction approach, to estimate the economic values of the urban landscape. In the process, two focus group discussions and the fuzz AHP method were used to identify critical urban landscape attributes, which were then used in our household survey questionnaire design. A large scale household survey was implemented for data collection in Dalian City, China. The survey questions covered information of the local residents' life satisfaction as well as a range of social demographic factors of local households including personal traits and spatial factors that could potentially play a role in explaining the people's life satisfaction.

The empirical results showed that dwelling's spatial location and landscape characteristics in Dalian City imposed a significant effect on the resident's life satisfaction. Likewise, multiple socio-economic and socio-demographic factors, such as age, income and personal traits, also exert considerable influence on people's life well-being. On average, one local household in Dalian City was estimated to have ¥24,579.5 of implicit willingness to pay per year for one-unit improvement of the urban landscape quality. By extrapolating this per household annual WTP to the entire number of households in Dalian City, the total economic value of the urban landscape can reach ¥64.64 billion. Additionally, proximity to the coast or square (or park) also positively contributes to the local people's life happiness. Thus, people who live near the coast or a square (park) enjoy a better life quality. Specifically, people who lived within one kilometer or less away from the square location appear to have a better life satisfaction than those who resided more than three kilometers away from a square.

It is interesting to note that the urban landscape belongs to a normal good, which is proven by its positive income elasticity, meaning that higher income earners are willing to pay more for landscape quality improvement than lower income earners. However, the marginal value of the urban landscape enhancement appears to be diminishing, which complies with the law of diminishing marginal utility.

The findings of this study may carry some profound empirical implications for the urban land use planning and landscape management decisions.

First, the information of residents' life satisfaction should be used as an important reference for government land use planning, such as allocating land space for construction of squares, parks, roads, coastal lines, green land, etc. The government must make a long run land use strategy by consulting with local residents, and even outsiders, to ensure a sustainable landscape development. Some red lines should to be drawn with regard to those key public land use areas. For example, adequate land areas to be used for building lawns, parks, traffic roads, pedestrians or sidewalks must be set aside to ensure that nobody can seize those land areas for any other purpose. Those rules and regulations should become the city laws through official legislation processes. The current situation of concession of the sidewalks for motor vehicle road construction must be changed to secure that the residents have a reasonable space for walking, as well as for bicycle trails.

Second, the estimated landscape and its various attribute values should be used as important information for benefit–cost analysis for future land exploration projects in the city including house construction, deforestation and various types of land reclamation activities. Our analysis indicates that the equivalent variation (EV) is 1.6 time the compensating variation (CV), which implies that the economic value loss from the city's landscape damage is much larger than the benefit accrued by landscape protection. This may suggest that it is necessary for the Dalian City government to give a second thought to its landscape management over the last decades. Just because some bad landscape management has occurred already does not justify dismissing the wrongdoing revelation. In this regard, it is foreseeable that the economic benefit generated from the real estate development in Dalian City over the past decades might be considerably offset by the city's landscape losses.

Finally, it is merited for this study to send out a long overdue warning to the city government: the misuse of the land resources must be openly recognized and subsequently corrected. From now on, the city governments should pay high attention to executing economic valuation studies for all future urban land use plans. Meanwhile, the current marine land reclamation and deforestation activities must be stopped as soon as possible.

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