Tian, Yuqing; Wu, Hongjuan; Zhang, Guangshi; Wang, Luocen; Zheng, Duo; Li, Sen. 2020. **Perceptions of ecosystem services, disservices and willingness-to-pay for urban green space conservation.**

The definitive version was published in *Journal of Environmental Management*, 260, 110140. https://doi.org/10.1016/j.jenvman.2020.110140

Title

Perceptions of ecosystem services and disservices and willingness-to-pay for urban green space conservation

Authors & Affiliations

Yuqing Tian[1], Hongjuan Wu[1,*], Guangshi Zhang[1], Luocen Wang[2], Duo Zheng[1], Sen Li[1,3,4*]

1 School of Environmental Science and Engineering, Huazhong University of Science and Technology, Wuhan, 430074, P.R.China

2 Department of Statistics, University of Michigan, Ann Arbor, MI 48109-1107, USA

3 UK Centre for Ecology & Hydrology, Wallingford, OX10 8BB, UK

4 Environmental Change Institute, University of Oxford, Oxford, OX1 3QY, UK

E-mail addresses

Yuqing Tian: up.tyq@qq.com

Hongjuan Wu: hongjuanwu@hust.edu.cn

Guanshi Zhang: guanshi@hust.edu.cn

Luocen Wang: luocen@umich.edu

Duo Zheng: zhengd@hust.edu.cn

Sen Li: senli@hust.edu.cn

Corresponding author: Hongjuan Wu (hongjuanwu@hust.edu.cn); Sen Li (senli@hust.edu.cn)

Highlights

- An extensive survey with 3000 residents from three major cities in central China was conducted.
- Residents reported an averaged willingness-to-pay (WTP) of 202.4 (CNY/person/year) for urban green space (UGS) conservation.
- Perceptions of UGS's ecosystem services and disservices had positive and negative causal impacts on WTP.
- Residents with lower socioeconomic status (SES) and higher frequency of UGS visits had greater WTP.
- Impacts of perceptions, frequency of visits, and SES on WTP varied between cities.

Abstract

While planning and management of urban green space (UGS) remain primarily driven by policymakers and expert knowledge, increasing attention has been paid to the general public's perception of and demand for UGS. This study was conducted to provide price-related outcomes to support UGS-related decision making and achieve an improved understanding of the causal relationships underpinning the residents' willingness-to-pay (WTP) for UGS conservation. An extensive survey with 3000 urban residents from three provincial capital cities in central China (i.e., Wuhan, Changsha and Nanchang) was conducted. We applied structural equation modelling to examine a range of hypothetical causal relationships among residents' perceptions about ecosystem services/disservices provided by UGS, frequency of UGS visits, socioeconomic status (SES) and WTP for the conservation of five different types of UGS. We found that residents had an average WTP of 202.4 CNY or 30.6 USD per year cross UGS types, with the attached green space having the greatest WTP (223.0 CNY or 33.7 USD per year), followed by park (215.4 CNY or 32.6 USD year), square (201.7 CNY or 30.5 USD year), suburban ecological (190.1 CNY or 28.7 USD year) and protective (182.0 CNY or 27.5 USD year) green spaces. Perceptions of UGS's ecosystem services had a positive causal impact on WTP, while perceptions of ecosystem disservices would have a negative impact. The frequency of UGS visits was found to amplify WTP at a limited level. It could further heighten and diminish the perceptions of ecosystem services and disservices. Participants with higher SES typically had greater perceptions of UGS's ecosystem services and WTP. Finally, we found that the structure of the causal relationships on WTP varied between cities, highlighting the importance of considering the fine-level impacts of biophysical environment jointly. Our results could help urban planners to understand better the ways urban green space was perceived and anticipate the likely effects of changing spatial patterns of UGS on the benefits and nuisances experienced by the general public.

Keywords: Urban green space, ecosystem services and disservices, willingness-to-pay, perceptions, frequency of visit, socioeconomic status

1. Introduction

Yet rapid urbanisation has put urban ecosystem under the pressure of habitat fragmentation, biodiversity loss and environmental pollution. Cities depend on urban ecosystems and their components to sustain long-term supports for life, health, security, social capitals and other important aspects of human well-being (Bolund and Hunhammar, 1999; Costanza et al., 2006; EEA, 2011; Odum, 1989; Tzoulas et al., 2007). Understanding the relationships between urban lifestyles and the ecological processes of the urban ecosystem has, therefore, been regarded as a key challenge of cites striving toward their sustainable development goals.

The urban ecosystem services usually refer to the benefits provided by urban ecosystems and their components (Andersson et al., 2007; Gómez-Baggethun and Barton, 2013; TEEB, 2010). Urban green space (UGS) is a crucial component of the urban ecosystem, which plays a fundamental role in securing storage and controlled release of urban water flows (Bolund and Hunhammar, 1999; Higgens et al., 1997; Pataki et al., 2011; Zhang and Muñoz Ramírez, 2019). UGS could regulate local temperature by providing shaded and humid environments (Hardin and Jensen, 2007) to help mitigate urban heat island effect (Gunawardena et al., 2017), and purify the air through removing particulate matters such as PM10 (Escobedo et al., 2008; Matos et al., 2019). UGS provides biodiversity hotspot for important bird and bee species, thereby supports pollination and seed dispersal. Moreover, people could gain physical and mental health benefits from UGS, as UGS has been served as a popular venue for physical exercises which also provides tranquillity for improved restfulness, mental health, and cognitive development (Ko and Son, 2018; Li et al., 2016; Nesbitt et al., 2017; Ngulani and Shackleton, 2019). On the other hand, some functions of the ecosystem may be economically or socially harmful, or even life-threatening, and these negative impacts are so-called ecosystem disservices (Dunn et al., 2010; Escobedo et al., 2011; Lyytimäki et al., 2008). For example, developing plant roots or grazing animals may damage pavements and vegetation planted for agricultural use or landscaping purposes, leading to economic loss (Lyytimäki and Sipilä, 2009; Tyrvainen, 2001). Densely vegetated UGS may provide shaded and concealed spots for crime, or cause mental stress to some residents walking at night (Tandogan and Ilhan, 2016). Moreover, UGS could be developed into habitats or shelters of harmful wild animals and vectors of diseases (e.g. flies, mosquitoes, ticks, fleas and bedbugs) (Dunn et al., 2010; Li et al., 2018; Zhang et al., 2019a). Being aware of the full repertoire of UGS's ecosystem services and disservices is thus vital for policymakers to understand the likely consequences of changes in urban ecosystems.

When setting goals for urban sustainability, evaluation of public expectation on the capability of the urban ecosystem is often helpful (Lyytimäki, 2015). Most ecosystem services of UGS can be regarded as non-marketed goods, and their value can be approximated using the survey-based contingent valuation methods (Song et al., 2015). Through constructing a hypothetical market of trading for goods or quality, people's maximum willingness-to-pay (WTP) for improvements in different aspects of the environment could be investigated. Since it provides price-related outcomes of people's expectation, such a method has been widely used in business, social, and regional studies (Ao et al., 2010; Kamri, 2013; Lo and Jim, 2010; Platania and Rizzo, 2018; Yang and Zou, 2009). While the shreds of evidence on the WTP for ecosystem services have been increasingly available (Cheng et al., 2019; Costanza et al., 2017; Jónsson and Davíðsdóttir, 2016), its applications for the ecosystem services of UGS in China have been rare, with Jim and Chen (2006), Song et al. (2015) and Lo and Jim (2010) being notable exceptions. People's perception is known to influence WTP for a variety of goods and services (Barnes-Mauthe et al., 2015; Kenter et al., 2016). Perception of ecosystem services can be shaped by past experiences, environmental awareness, and socio-economic status such as gender, age, income, cultural background, and knowledge level (Coles and Bussey, 2000; Dobbs et al., 2014; Gobster, 1998; Hung,

2010; Lyytimäki, 2015; Marisa et al., 2018; Neuvonen et al., 2007; Riechers et al., 2018; Tyrväinen et al., 2014). Ecosystem disservices often relate to decreased aesthetic, economic and health-related human well-being and involved in driving the perceived harms and nuisances of nature (von Döhren and Haase, 2015), which could potentially impact on the way UGS is experienced, used, valued and managed (Lyytimäki, 2015). Planning and management of UGS in China have been driven by policymakers and expert knowledge, while the general public's perception of UGS and their WTP for UGS's ecosystem services have received little attention. This is partly owing to the fact that relevant information is somewhat limited, though it has been regarded as valuable to understand and take into account residents' perception and WTP in public administration (Howley, 2011).

Structural equation modelling (SEM) is a widely applied method of analysing structural relationships which enables to test hypothetical causal dependencies between a range of variables simultaneously (Loehlin, 2004; Porritt et al., 2014). SEM composites of two main components: the measurement model of the relations between latent variables and their indicators, and the structural model showing potential causal dependencies between endogenous and exogenous variables. Malabe et al. (2000) proposed that SEM could enable to examine fundamental and theoretical issues at a depth greater than what traditional statistical methods could achieve. Recent findings have revealed the challenges to studying the relationships between perceptual, socioeconomic and geographic variables and the use of UGS, because of interdependencies, lack of conceptual models and empirical evidence (Schindler et al., 2018). While SEM could serve to narrow down the gaps, as it is an advanced quantitative tool to enable to examine the soundness of conceptual models composite of hypothetical interdependencies, in particular, the causal chains, among a range of variables.

This study was based on first-hand data collected from an extensive survey on residents' perceptions of and WTP for the ecosystem services of UGS in three provincial capital cities (Wuhan, Changsha, and Nanchang) in central China. The three cities have been recently centred by several key national programmes (e.g. the Yangtze River Middle Reaches Megalopolis Development plan released by the State Council of the People's Republic of China in 2015, and Yangtze River Protection strategy proposed by the central Chinese government in 2018) aiming to establish a certain number of projects to promote integrated urban-rural development and to conserve and restore local ecosystems for the protection of Yangtze River. There is a general need for improved evidence on how the region's urban ecosystems could be valuated so that benefits of potential ecosystem conservation and restoration practices can be illustrated. A high population density and limited land resource have exerted tremendous pressure on the establishment of new urban ecosystems in these cities (Zhang et al., 2019b). It thus is important to understand the exiting demand pattern for ecosystem services to support well-targeted conservation and restoration plans in these urban areas (Chen, 2010; Shan, 2011).

Our main objectives were to (i) investigate the differences in residents' WTP for UGS conservation in

Chinese megacities, (ii) examine the possible causal relationships among WTP, residents' perception of UGS's ecosystem services and disservices, UGS use and individual socioeconomic status. SEM was applied to examine the hypothetical causal relationships driving the WTP. Our analysis focused on the significance and magnitude of the influence of perception of UGS's ecosystem services and disservices on WTP, and the capability of residents' UGS visits and socioeconomic status in modifying the relationships between perceptions and WTP. This paper sought to improve WTP evidence for China and provide useful information for designing practices to reduce environmental externalities of urban ecosystems.

2. Conceptual framework

Several conceptual models on the factors influencing the causalities between WTP and UGS were developed, each of which was tested later by structural equation modelling to investigate its statistical significance.

The basic theoretical model (M0) was on the relationships among residents' WTP for UGS improvement and their perceptions about the ecosystem services and disservices related to UGS. Based on the theory of planned behaviour model, attitudes are drivers of intention which is necessary to carry out a specific and reasoned behaviour (Ajzen, 1991). Attitude is closely related to perception by which individuals produce a meaningful experience of the world based on prior experiences (Pickens, 2005). Previous studies on the influence of attitudinal factors on the WTP for the conservation of natural resources have suggested that people have a positive attitude towards natural conservation would be more willing to pay for it (Bernath and Roschewitz, 2008; Cooper et al., 2004; Lopez-Mosquera et al., 2014). It is likely that people's perception of UGS's ecosystem services and disservices, which could produce benefits and nuisances, would positively or negatively impact their attitudes towards UGS and the amount of money they would pay for UGS's improvement. Thus, we hypothesised that residents' perception of the ecosystem services of UGS would heighten their WTP for the improvement of UGS (H0a). In contrast, the perception of the ecosystem disservices would lower their WTP (H0b) (Williams, 2011). Moreover, as ecosystem services and disservices are often formed based on the same set of ecosystem characteristics, ecological functions or species groups (Campagne et al., 2018), we hypothesised that there could be a correlation between perceptions of ecosystem services and disservices (H0c).

The extended theoretical model (M1) included the impact of frequency of UGS visits on the relationships between WTP and UGS. Previous UGS use is known to influence the WTP for UGS conservation. Frequency of visits was selected as it is commonly used as an indicator of accessibility, which is of spatial planners' interests (Neuvonen et al., 2007; Song et al., 2015). It is also related to the individual's socioeconomic status and the quality and location of UGS (Akpinar, 2016). Following the findings by Song et al. (2015), we hypothesised that the frequency of visits could positively impact the

WTP for UGS conservation (H1a). With an increased frequency of visits, people might believe that the activities they perform in UGS are beneficial for their physical and mental health (Lo and Jim, 2010), and tend to spend more money for improving UGS (Ko and Son, 2018; Obeng and Aguilar, 2018). However, a higher visiting frequency might expose people to greater risks of mosquito bites, pollen hypersensitivity, and injuries caused by falling leaves and trunks (Dunn et al., 2010; Lyytimäki, 2015). Thus, we hypothesised that a higher frequency of visits would heighten some residents' perceived ecosystem services from UGS (H1b) and may also influence the perception of UGS's ecosystem disservice (H1c).

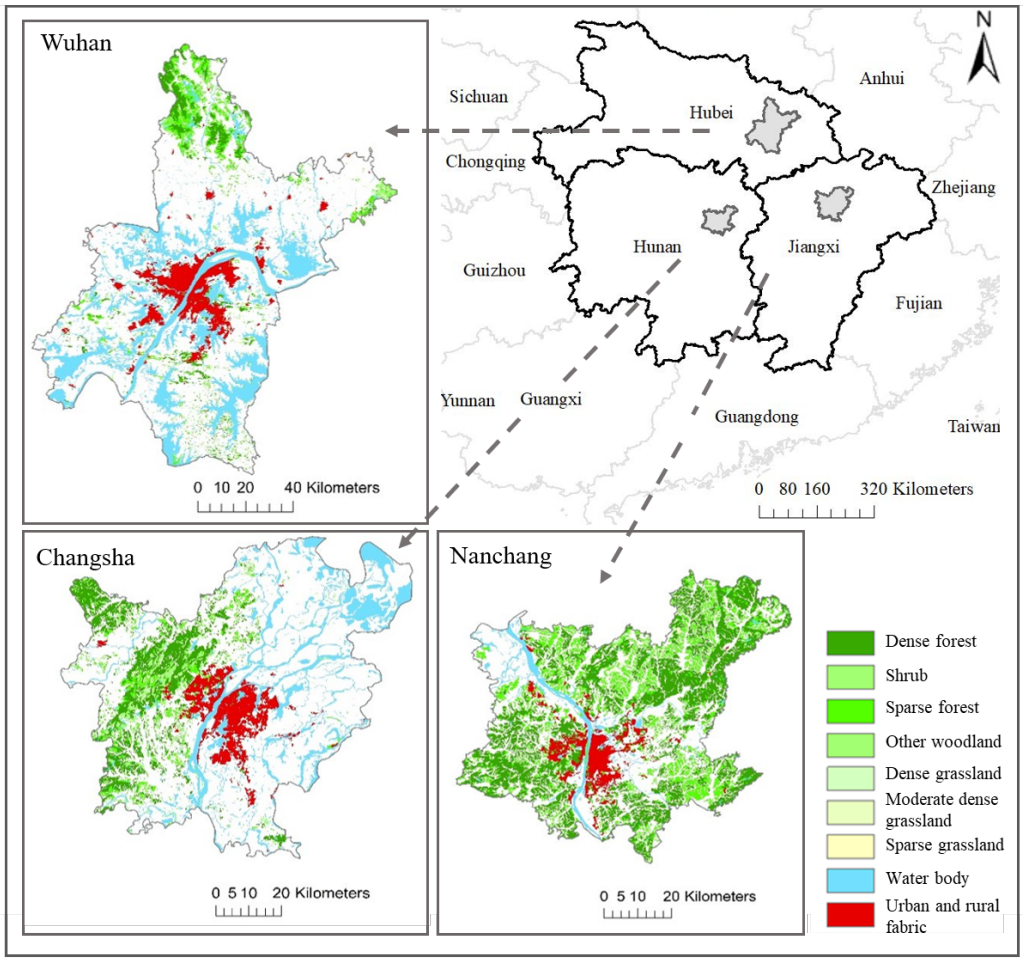
The further extended theoretical model (M2) sought to examine how individual socioeconomic status (SES) may modify the structure of M1. SES may reflect an individual's capability to access new knowledge, leverage available resource and filter useful information, which could potentially influence decision-making. We hypothesised that socioeconomic status (SES), e.g. income, occupation and education of an individual, could change her/his WTP (H2a). Payment originates from income so that the amount of income often directly affects residents' ability to pay. It has been widely evidenced that occupation, education and income could strongly influence people' WTP for the conservation of natural resources in China (Chen and Jim, 2010; Kamri, 2013; Lo and Jim, 2010; Song et al., 2015). SES is a determinant of lifestyle which is regarded as a key to distinguish demand and receipt of certain kinds of ecosystem services and disservices within a population (Lyytimäki et al., 2008), resulting in different perceptions of UGS's ecosystem services (H2b) and disservices (H2c). It is likely that in large Chinese cities, people with high SES would have to spend most of their time in office, leaving limited time for outdoor recreation (Wang, 2019; Zhang, 2019). We thus hypothesised that SES might impact on UGS visitation rate (H2d).

3. Material and methods

3.1 Study area

The Yangtze River Basin accounts for about 21% of China's total area. As of 2016, it sustained more than 40% of China's population and produced more than 40% of China's GDP. Moreover, the population is highly clustered in the Yangtze River Basin, especially in the Yangtze River Delta and around provincial capital cities. Wuhan, Changsha, and Nanchang are the core cities in the Middle Reaches of the Yangtze River and typical large cities in the Yangtze River Basin, are selected as the research areas (Figure 1). As the capitals of the three adjacent provinces in central China, they share similar socioeconomic and cultural backgrounds and several geographical characteristics with many other medium-/large-sized cities over the region. They are less hilly, located by rivers, and all have many lakes and limited green space in the central urban area but the decent extent of vegetation coverage at the urban fringe.

(a)



(b)

Indicators	Wuhan	Changsha	Nanchang	Total
Coverage of green spaces	39.47%	41.5%	42.08%	41.02%
Area (sp.km)	8569	3946	5456	17971
Population (10000 persons)	1089.29	473.17	461.17	2023.63
GDP (100 million CNY)	13410.34	8092.86	4354.99	25858.19

Figure 1. Land cover patterns and basic information of the study area: Wuhan, Changsha, and Nanchang.

3.2 Data collection

An online survey was conducted in November 2018 to investigate the urban residents' perception of ecosystem services and disservices urban green space (UGS) could provide in Wuhan, Changsha and Nanchang and their willingness-to-pay (WTP) for the conservation of different types of UGS. A questionnaire was designed in collaboration with Suzhou Zhongyan Network Technology Co., Ltd., a professional online survey service provider maintaining a giant participant pool of around 45 million people (who are active users of Tabao.com, the leading online shopping/trading website in China). This pool covers almost every city in mainland China. The company adopts strict privacy protection regulations for personal information and uses incentives to stimulate participation, which aids the

reduction of potential bias. In this study, a total of 3000 completed questionnaires were collected, with 1000 from Wuhan, 1000 from Changsha, 1000 from Nanchang. We sought to achieve a reasonable representation of the residents in these three cities via controlling the distribution of the socioeconomic variables of the survey participants. The variables collected were summarised and defined in supplemental Table S1.

In the questionnaire, we firstly provided a classification of UGS proposed by the Ministry of Housing and Urban-Rural Development in China (the 'Chinese Urban Green Space Classification Standard', No. CJJT 85-2017):

a) *Park green space [G1]*: which consists of city and district level parks, and other types of park/garden including zoological garden, botanical garden, historical garden, heritage park, theme park, etc.

b) *Protective green space [G2]*: includes green spaces built to prevent accesses to specific building or public facilities, such as sanitary equipment, road and railway lines, power stations, etc.

c) *Square green space [G3]*: green belts and plants in urban squares.

d) *Attached green space [XG]*: which connects to urban construction lands, such as residential, commercial, industrial and transportation lands, etc.

e) *Suburban ecological green space [EG]*: which consists of suburban recreational vegetated areas (forests, wetland parks) and ecological lands for conservation and green production/business.

An example photo for each UGS type was provided to the participants for better distinguishing different UGS types (Figure 2). Then, the participants were asked (i) to rate their perceived capabilities of a specific type of UGS to provide different ecosystem services (i.e., climate regulation, air quality regulation, erosion prevention, habitat services, and cultural and amenity services) and ecosystem disservices (i.e., damage to infrastructure, plant allergies or poisoning, disease transmission, and risk to human safety) on a scale of 1 to 5, with five being having the most potent capability of providing the specific services; (ii) to report annual frequency of visits to different types of UGS; (iii) to estimate their WTP to support the conservation and improvement of different UGS types, and select reasons if they opt not to pay; and (iv) to provide personal socioeconomic information on gender, age, family members, education, occupation, and income.

The list of ecosystem services and disservices were initially selected based on existing articles (Gómez-Baggethun and Barton, 2013; von Döhren and Haase, 2015; Xie et al., 2017) and then shortlisted for the ones most relevant to the region by the 50 students taking the 2018/2019 undergraduate course "Environmental Planning and Management" at Huazhong University of Science and Technology in Wuhan. Those students mostly come from central China and familiar with study areas. We gave lectures

on ecosystem services and disservices beforehand on the same course so that the students could have basic knowledge on the topic when conducting the shortlisting exercise.

To approximate as much practical information as possible, we used two types of questions to collect data on WTP and verify the participants' responses, namely, 'bidding game', and 'payment card' (Bhandari et al., 2016; Loomis et al., 1996). First, the survey participants were asked whether and to what extent they think a particular type of UGS can generate specific ecosystem services and disservices. Second, we created a hypothetical situation (e.g., how much would you like to pay for the conservation of UGS in your city?) and a starting point of 200 CNY/year was provided, and the participants were asked if they would bid for it. Most previous studies estimated a range of 10 to 210 CNY/year range of WTP for UGS in China (Chen and Qi, 2018; Jim and Chen, 2006). Such a starting point at the upper range was selected based on (i) a comparison between the per capita income of the case areas and the places investigated in the literature, and (ii) the previous estimations that the ecosystem services of UGS were approximately 99 to 310 CNY/year in the case areas (Wu, 2012; Xiao et al., 2017). For the propose of reducing the time required to complete the questionnaire, the participants were not allowed to bid for a WTP lower than the starting point. Third, to reduce the effect of the starting point, no matter whether they would bid or not, the participants were asked to provide the maximum amount of money they would pay for local UGS conservation. If they reported not willing to pay for UGS conservation, then they were asked to either select reasons from a list or explain their reasons directly.

Figure 2. Five types of urban green space used in this study. (a)Park green space [G1], (b) Protective green space [G2], (c)Square green space [G3], (d)Attached green space [XG], (e)Suburban ecological green space [EG].

3.3 Data analysis

Following the two-step approach for practical structural equation modelling (SEM) recommended by Anderson and Gerbing (1988), a confirmatory factor analysis (CFA) was conducted firstly with IBM SPSS AMOS (version 23). This step was to test whether measurement models of perceptions of UGS's ecosystem services and disservices and socio-economic status (SES), or the relationships among the latent and manifest variables, were consistent with our hypothesis. Perceptions of UGS's ecosystem services or disservices were measured as constructs of perceived capabilities of UGS to provide specific benefits or cause difference nuisances, as listed in Table 1. SES was measured as a construct of education, income and occupation. The categorical occupation data were transformed into ordinal rankings according to the Chinese occupational prestige scores estimated by Zong et al. (2016).

Table 1 Reliability and confirmatory factor analysis

Scales (n=3000)	Mean (S.D.)	β
Perceived UGS's ecosystem services (α=0.821, CR=0.769., AV=0.403)		
I think UGS has regulated the climate of the city	4.10(1.02)	0.75
I think UGS has removed air pollutants	4.02(1.05)	0.65
I think UGS has regulated of water flows and avoided soil erosion	3.95(0.99)	0.64
I think UGS has provided refugia and habitats for plants and animals	3.85(1.04)	0.51
I think UGS has provided cultural and amenity services	4.08(0.95)	0.60
Perceived UGS's ecosystem disservices (α=0.728, CR=0.692, AV=0.360)		
I think UGS has caused damages to infrastructure	2.10(1.00)	0.58
I think UGS has caused plant allergies or poisoning	1.94(0.87)	0.60
I think UGS has provided habitats for disease vectors	2.09(0.92)	0.61
I think UGS has increased the risks of crime and mental diseases	1.91(0.88)	0.61
Socioeconomic status (α=0.591, CR=0.696, AV=0.463)		
Monthly income	7.28(3.00)	0.90
Occupation category	4.57(1.91)	0.68
Education level	3.88(0.52)	0.34

α: reliability (Cronbach's α); S.D: standard deviation; β: standardised regression weight; CR: composite reliability; AV: average variance

In the second step, SEM was performed. SEM is a special form of multivariate analysis and was used to examine the hypothetical causality among multiple variables and how their inter-relationships may play a role in determining a particular outcome, or the WTP in this study. The hypothetical causal relationships were illustrated using a path diagram and analysed for the standardised partial regression coefficients, which can be interpreted as the magnitude of direct causal influence. In this study, SEM was conducted using the IBM SPSS AMOS (version 23). First, we built a basic model (M0) to examine the hypothetical causal relationships between residents' perception of UGS's ecosystem services and disservices, and their impacts on the WTP for improvement on UGS. Second, how the frequency of visits would modify the path structure of M0 was investigated in an extended model (M1). Third, participants' SES was included to achieve a final model (M2) of perception, experience, SES and WTP. An acceptable outcome from SEM practices should both satisfy the theoretical expectations and meet the adequate levels of several specific GOF measures. We refined the models by adding or removing paths to keep the GOF measures at their adequate or recommended levels (see supplemental Table S2

for the GOF outcomes of CFA and SEM; c.f. Lopez-Mosquera et al. (2014), for interpretation of the GOFs suggested for the predictive validity and reliability of the constructs of perceptions and SES; c.f. Li et al. (2017) for the references supporting the adequate levels of the list of GOF measures).

4. Results

4.1 Descriptive analysis of survey outcome

4.1.1 Socioeconomic status of the survey participants

Among the 3000 survey participants, balanced gender distribution was achieved with a slightly higher number of male participants (Table 2). Most participants aged between 21 and 45 (66.4%) and had three members in the family (56.3%). While gender, age and family size did not show a noticeable difference between the three cities. The other characteristics, however, could be distinguished. Regarding education level, 86.6% of the participants in Wuhan stated a university degree or higher, followed by 84.5% in Changsha, and 81.7% in Nanchang. Most participants were blue-collar or white-collar workers (46.0%). Participants' income mostly fell within a range between 4000 and 8999 CNY per month.

Table 2. Socioeconomic characteristics of survey participants.

Socioeconomic variables		Number of participants			Chi-square test	
		Wuhan	Changsha	Nanchang	Cramer's *V*	Probability
Gender	Male	510	502	519	0.014	0.749
	Female	490	498	481		
Age	16-20	67	52	42	0.026	0.400
	21-45	659	659	673		
	46-55	207	220	203		
	>56	67	69	82		
Number of family members	<=3	682	695	643	0.034	0.131
	4	200	184	222		
	>=5	118	121	135		
Education	<=Junior middle school	11	16	38	0.064	0.000

	Senior middle school	123	139	145		
	College	798	794	758		
	>=Master	68	51	59		
	Student	81	68	72		
	Housewife & Retiree	29	36	44		
	Freelance worker	75	82	111		
	Blue- or white-collar worker	462	458	460		
	Governmental officer	31	54	39		
Occupation	Specialist (Engineer, doctor, lawyer, professor, etc.)	82	92	93	0.094	0.000
	Middle-level manager	163	148	102		
	General entrepreneurs	52	40	31		
	Senior officials and business manager	25	22	48		
	<=999	39	42	33		
	1000-1999	44	24	34		
	2000-2999	18	26	31		
	3000-3999	46	70	90		
	4000-4999	120	142	100		
	5000-5999	125	132	141		
Income (CNY per month)	6000-6999	104	91	115	0.109	0.000
	7000-7999	114	124	128		
	8000-8999	120	144	117		
	9000-9999	70	70	86		
	10000-12999	82	66	59		
	13000-14999	63	31	27		
	15000-19999	32	26	22		
	>=20000	23	12	17		

4.1.2 Willingness-to-pay for urban green space conservation

While most of the survey participants (90.7%) reported a WTP greater than zero, the average WTP for UGS conservation was 202.4 CNY or 30.6 USD per year cross UGS types. Apparent differences in the WTPs for UGS types were observed, with the attached green space having the greatest WTP (223.0 CNY or 33.7 USD per year), followed by park (215.4 CNY or 32.6 USD per year), square (201.7 CNY or 30.5 USD per year), suburban ecological (190.1 CNY or 28.7 USD per year) and protective (182.0 CNY or 27.5 USD per year) green spaces. In the same type of UGSs, there were also significant differences in WTP of respondents in three cities (Figure 3). Participants in Nanchang reported relatively higher WTP for protective green spaces (184.9 CNY or 27.9 USD per year), square green space (212.4 CNY or 32.1 USD per year) and attached green space (234.9 CNY or 35.5 USD per year). Participants from Changsha had relatively higher WTP for park green space (222.9 CNY or 33.7 USD per year) and suburban ecological green space (202.0 CNY or 30.5 USD per year). Finally, participants in Wuhan had the lowest averaged WTP across UGS types (185.5 CNY or 28.0 USD per year).

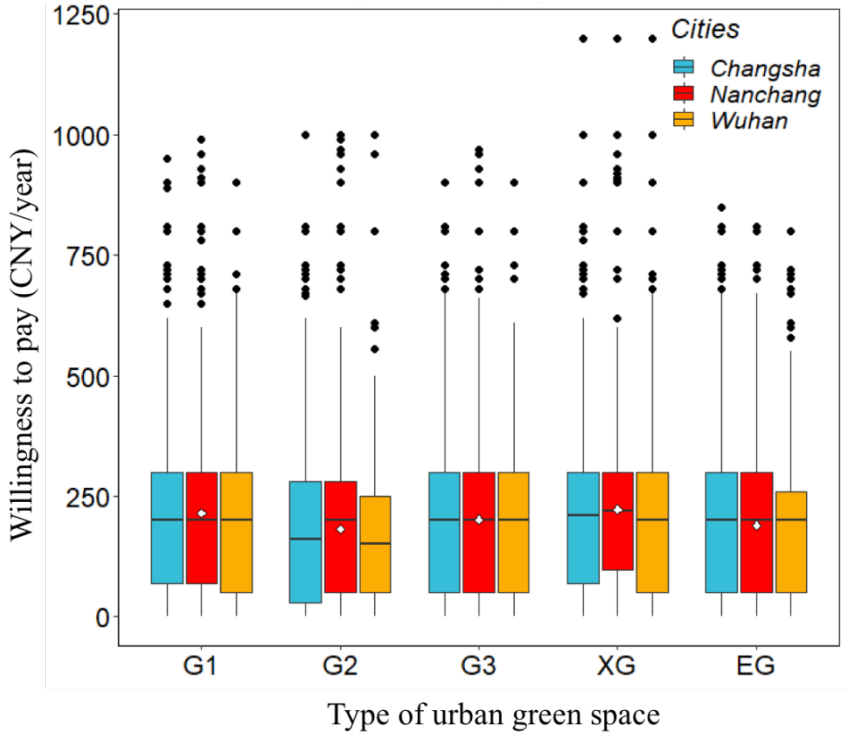


Figure 3. Willingness-to-pay on different types of urban green space distinguished between cities

4.1.3 Perceived ecosystem services and disservices of urban green space

The survey participants perceived high capabilities of UGS in the study areas (an overall score of 4.00

out of 5, Figure 4) to provide several most common types of urban ecosystem services. Climate regulation had the highest score (4.10), followed by cultural and amenity services (4.08), air quality regulation (4.02), erosion prevention (3.95) and habitat services (3.85). Such a ranking of UGS's ecosystem service capabilities applied for all the three cities. For the city-specific capabilities of providing individual ecosystem services, climate regulation was scored the highest (4.16) by participants from Wuhan, and habitat provision had the lowest score (3.73) given by the participants from Changsha.

On the other hand, most participants perceived that UGS had low or minimal capabilities (scored 1 or 2, out of 5) to provide the selected four types of ecosystem disservices, with damage to infrastructure being scored the highest (2.10), followed by disease transmission (2.09), plant allergies or poisoning (1.94), and risk to human safety (1.91). Among the three cities, participants from Wuhan scored relatively higher for disease transmission (2.13) and plant allergies or poisoning (2.03), while those from Changsha and Nanchang scored relatively higher for risk to human safety (1.94) and damage to infrastructure (2.12), respectively.

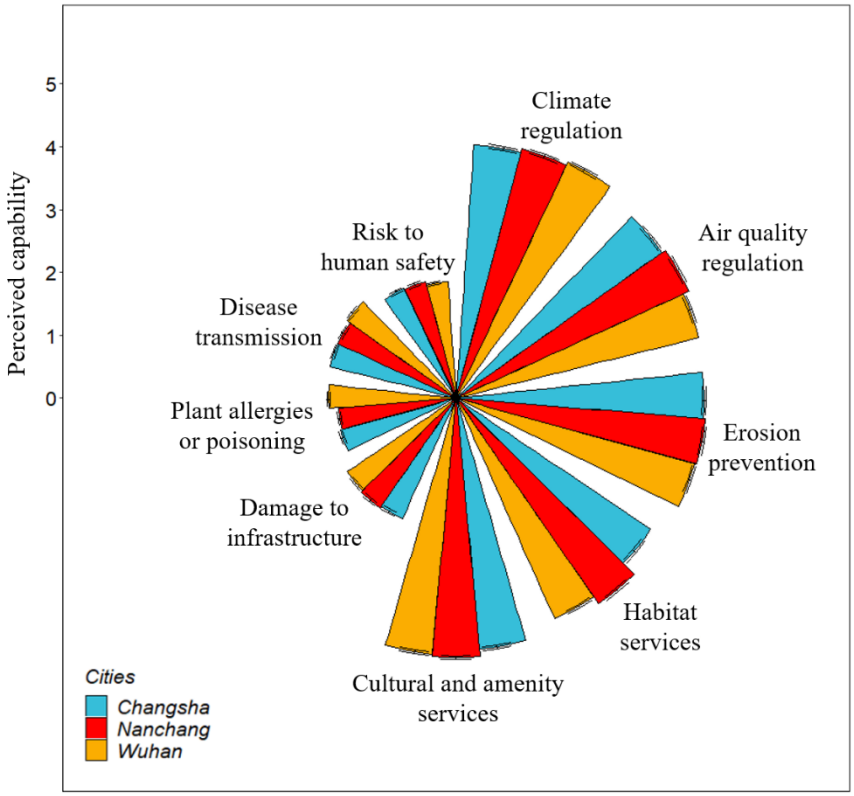


Figure 4. Perceived UGS's capability to provide different ecosystem services and disservices

4.1.4 Frequency of urban green space visits

Most survey participants reported past use of UGS (99.4%). The reported frequencies of UGS visits were significantly different among the types of UGSs (Table 3). The UGS type with the highest average visit rate was attached green space (119.14 times per person per year), followed by protective green space (86.47 times), square green space (33.66 times), park green space (26.94 times), and suburban ecological green space (12.01 times). Such a ranking was the same for all the three cities. Participants in Nanchang reported relatively higher overall UGS visit rate, summed across UGS types.

Table. 3 Frequency of visits in different types of urban green space (UGS)

UGS types	Averaged annual frequency (Standard deviation)	Numbers of samples grouped in different ranges of visit frequency					
		0	1-40	41-80	81-120	121-160	≥161
G1	26.94 (44.00)	35	2500	265	66	44	90
G2	86.47 (130.02)	162	1663	301	136	66	672
G3	33.66 (54.03)	34	2348	314	104	53	147
XG	119.14 (157.47)	48	1530	287	151	74	910
EG	12.01 (13.82)	111	2690	199	0	0	0

4.2 Possible causal relations influencing the willingness-to-pay

4.2.1 The impact of perceived ecosystem services and disservices

All the hypothetical causal relationships in the M0 model were found to be significant, and their coefficients are presented in the path diagram in Figure 5. Perceived ecosystem services (H0a) and disservices (H0b) were found to be positive and negative causes of WTP. However, the magnitudes of these effects were found to be at low levels. Variance in WTP could be explained at a limited level (R squared = 0.02). A significant and negative correlation between perceived UGS's ecosystem services and disservices was identified (H0c).

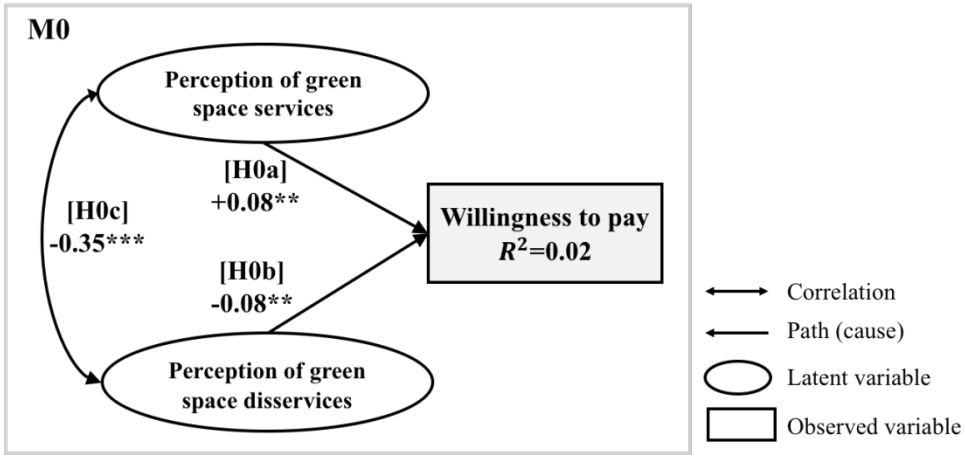


Figure 5. The possible causal relationships between perception and willingness-to-pay

4.2.2 The effects of the frequency of visits

In the M1 model, the hypothetical influence of the frequency of UGS visits on amplifying WTP (H1a) was found significant, albeit limited (coefficient = +0.08, Figure 6). The frequency of UGS visits could heighten the perceived ecosystem services of UGS (coefficient= +0.17) (H1b) while diminishing the perceived ecosystem disservices (coefficient=-0.21) (H1c). The inclusion of frequency of visits changed the hypothetical negative influence of perceived ecosystem disservices on WTP into negligible [H0b].

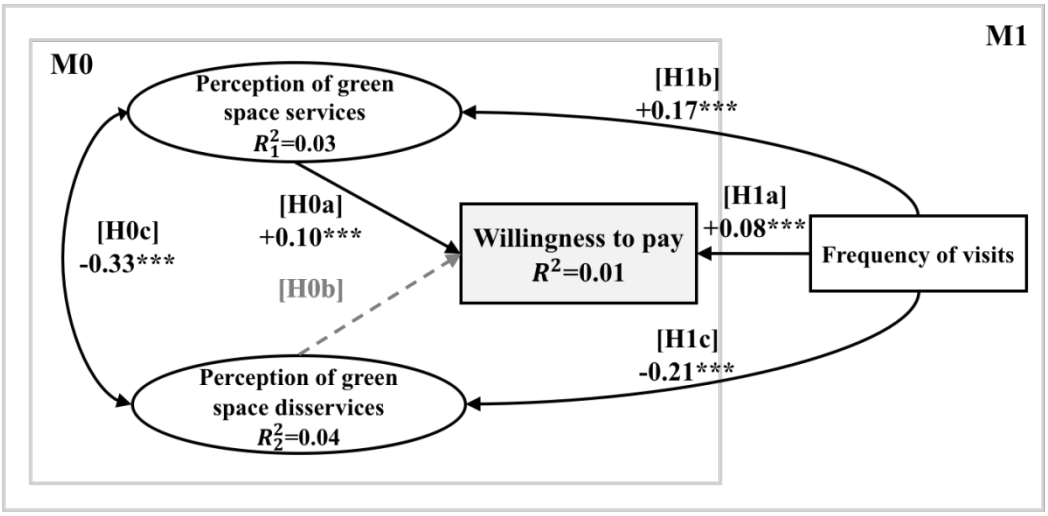


Figure 6. The possible causal relationships between perception, frequency of visits and willingness-to-pay. The dashed path indicates removed hypothetical relationship leading to failed GOF measures.

4.2.3 The role of individual socioeconomic status

In the M2 model, individual socioeconomic status (SES) were found to relate to perception and WTP, and the inclusion of SES could improve the model's explanatory power for WTP to 19% (Figure 7). SES is a latent variable of three indicators, namely, income, occupation category and education level. According to the standardised regression weights achieved in CFA (Table 1), increase in the explanatory power of model on WTP could attribute mostly to income and occupation category, as SES explained 90% and 68% of their total variances. A higher SES was found causal to increased WTP (coefficient = +0.42) (H2a) and heightened individual's perceived ecosystem services of UGS (coefficient= +0.09) (H2b). Besides, the hypothetical influence of SES on the frequency of UGS visits was found insignificant.

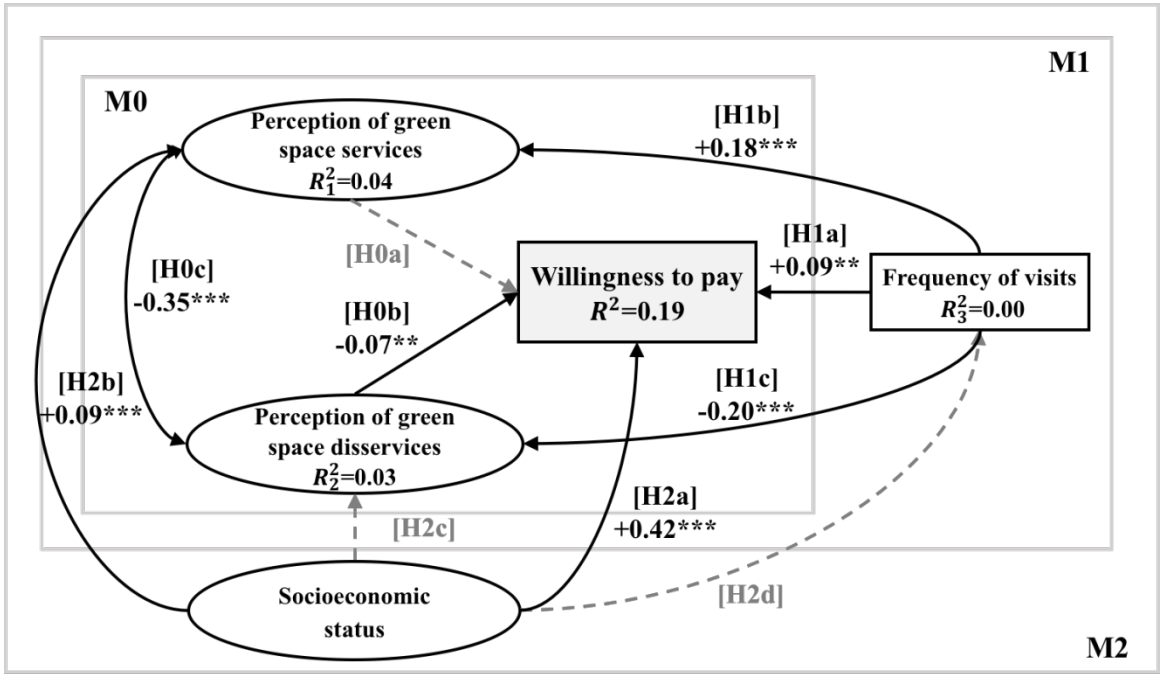


Figure 7. The possible causal relationships between perception, frequency of visits, socioeconomic status and willingness-to-pay. The dashed paths indicate removed hypothetical relationships leading to failed GOF measures.

4.2.4 The structural differences between models for the three cities

The city-specific models were slightly different from each other (Table 4). Regarding the city-specific M0 models, the influence of perceived ecosystem services and disservices of UGS on WTP did not hold for all the cities. For Wuhan, only the perceived ecosystem services of UGS was causal to WTP, and the effect was moderate (+0.21) and stronger its overall effect in M0. For Changsha, only the impact of perceived ecosystem disservices of UGS on WTP was found influential (-0.25). While for Nanchang, neither of them was significant. In the city-specific M1 models, the frequency of UGS visits seemed incapable of causing changes in WTP in Changsha. In the city-specific M2 models, we further identified

448 a marginal negative influence of the SES on the frequency of UGS visits (coefficients = -0.12) for
449 Changsha.

450

451 **Table.4** Main coefficients of path and correlations: comparison between the city-specific models

Model	Hypothesis	Paths			Covariances			
					Total	Wuhan	Changsha	Nanchang
M0	H0a	PES	→	WTP	+0.08***	+0.21***	/	/
	H0b	PED	→	WTP	-0.08***	/	-0.25***	/
	H0c	PES	↔	PED	-0.35***	-0.29***	-0.38***	-0.43***
M1	H0a	PES	→	WTP	+0.10***	+0.20***	/	/
	H0b	PED	→	WTP	/	/	-0.19***	/
	H0c	PES	↔	PED	-0.33***	-0.27***	-0.38***	-0.41***
	H1a	FV	→	WTP	+0.08***	+0.08*	/	+0.17***
	H1b	FV	→	PES	+0.17***	+0.17***	+0.17***	+0.20***
	H1c	FV	→	PED	-0.21***	-0.16***	-0.22***	-0.19***
M2	H0a	PES	→	WTP	/	0.13***	/	/
	H0b	PED	→	WTP	-0.07***	/	-0.18***	/
	H0c	PES	↔	PED	-0.35***	-0.26***	-0.36***	-0.41***
	H1a	FV	→	WTP	+0.09***	+0.10**	/	+0.17***
	H1b	FV	→	PES	+0.18***	+0.18***	+0.18***	+0.20***
	H1c	FV	→	PED	-0.20***	-0.16***	-0.23***	-0.20***
	H2a	SES	→	WTP	+0.42***	+0.41***	+0.33***	+0.50***
	H2b	SES	→	PES	+0.09***	+0.13***	+0.12**	/
	H2c	SES	→	PED	/	/	/	/
	H2d	SES	→	FV	/	/	-0.12***	/

452 PES: perceived ecosystem services; PED: perceived ecosystem disservices; WTP: willingness-to-pay; FV: frequency of visits;
453 SES: socio-economic status.

454 *** P<0.001 ** P<0.01 * P<0.05;

5. Discussion

5.1 Willingness-to-pay and reasons not to pay

This study applied contingent valuation method (CVM) and, for the first time in big cities in central China, estimated the WTP for the improvement and conservation of UGS (including the park, protective space, square, attached, and suburban ecological green spaces). The resulted WTP of 202.4 CNY/year was higher than but comparable to many relevant studies conducted in China. For example, Song et al. (2015) estimated an average WTP of 81.8 CNY per year for the conservation of UGS in Jinan city. Lo and Jim (2010) found that people in Hongkong had a WTP of 77.4 HKD per household for UGS conservation (approx. 75.7 CNY using the exchange rate in 2010). The annual average WTP for forest parks' conservation was found to be 13.8 CNY in Fuzhou city (Chen and Qi, 2018). Jim and Chen (2006) reported a slightly higher annual WTP of 208.8 CNY in Guangzhou city. The WTP estimated in our study was also higher than many relevant studies conducted in other countries, which mostly fall within a range equivalent to 10 to 2010 CNY per year (Lopez-Mosquera et al., 2014; Majumdar et al., 2011). It should be noted that the changing inflation or exchange rates may also cause the differences between WTP estimations on these studies. It seemed that residents in central China had relatively stronger WTP for protecting urban ecosystems, both domestically and internationally, which was likely to be a consequence of China's recent political foci on environmental and ecological conservation (e.g., Ecological Redline Policy, Yangtze River Protection Strategy, Construction of Ecological Civilization, *etc.*).

Only 9.3% of respondents stated not willing to pay for UGS conservation, and this rate was lower than several other studies. For example, 79% of the respondents stated a zero value for WTP for urban green areas in Valencia (Spain) (Saz-Salazar and Rausell-Köster (2008), 66% of respondents were found not willing to pay for an urban park in Pamplona (Spain) (Lopez-Mosquera et al., 2014). In results not shown here, the main reasons for not paying for UGS conservation were that 'I don't think the improvement on UGS needs to be paid' (selected by 44% of the participants gave reasons), 'I have paid enough taxes and administrative fees, and these should already cover the charges for the improvement on UGS' (selected by 29%), 'I don't think the payment can be used effectively' (selected by 12%), 'I am not interested in issues with UGS' (selected by 9%), and 'I have no money to pay for UGSs (selected by 6%)'. The main reasons were similar to those found in Lopez-Mosquera et al. (2014) in which respondents opted not to pay for UGS conservation felt that they had already spent enough tax or expressed concerns about how their money would be used.

When looking at the provisioning of ecosystem services of UGS in general, human well-being (including economic, social, and personal well-being) is based on benefits derived from the people's

actual use of ecosystem services and goods (Burkhard et al., 2012). Such an actual use of ecosystem goods and services is the demand side of this supply-demand chain (EEA, 2010). Without personal beneficiaries, ecosystem functions and processes are not services (Fisher et al., 2009). Our results on WTP for UGS conservation contributed to improved understanding of the relationships among the variables which may influence the demand side, or the personal use, of UGS's ecosystem services. Other important factors shaping the personal use may include spatial pattern of UGS and the accessibility to those areas (Arcaute et al., 2018; Li et al., 2015).

5.2 Perception, urban green space use and socioeconomic status as drivers of willingness-to-pay

Previous studies which explored the impacts of perception and were related to ecosystem services were limited to cultural ecosystem services or the valuation of green spaces (Aoshima et al., 2018; Ko and Son, 2018; Riechers et al., 2016). This study added novel evidence into this filed with a more comprehensive classification of UGS types and more detailed categories of ecosystem services associated with UGS. Another original contribution was that we adopted an integrated view to jointly consider UGS's capabilities of providing ecosystem services and delivering ecosystem disservices. Our results could help urban managers and planners to understand better the ways UGS was perceived and anticipate the likely effects of changing UGS spatial patterns on the benefits and nuisances experienced by the general public (Lyytimäki, 2015; Villa et al., 2014).

While most SEM studies focused on model fit measures solely, neglecting the R-squared would cause readers being misinformed about the predictive power of variables. The WTP for UGS conservation was found weakly predicted (low R-squared values) by the simple models with the perception of ecosystem (dis)services or/and frequency of UGS visits for the WTP (in M0 and M1). However, when taking into account individual's socioeconomic status (in M2), the R-squared achieved 0.19 which is comparable to 0.13 - 0.28 for the WTP for marine biodiversity in Barbados (Schuhmann et al., 2013), 0.16 - 0.18 for the WTP for environmental management in China (Zhai and Suzuki, 2008) and 0.14 - 0.16 for the WTP for risk reduction of road transportation in Spain (Lera-López et al., 2012). Moreover, gender, age and the number of family members were not included because they were found not to be predictors of socioeconomic status in the confirmatory factor analysis. These variables were found only weakly associated with WTPs for different UGS types (Spearman's Rho < 0.29 in all cases).

A high proportion of respondents of the survey participants (97.4%) had UGS visiting experience, suggesting a good level of development of accessible green infrastructure in the study area. Similar to Neuvonen et al. (2007) and Jim and Chen (2006), the attached green space was found to be the most accessible UGS type. By contrast, suburban ecological green space received low visit rates as they were usually distant from urban centres and lacked visitor supporting facilities. The averaged frequency of park green space visits was about twice a month, which was lower compared with findings of other

cities, for example, Song et al. (2015) reported 47% of respondents in Jinan visited UGS weekly. In line with previous studies (Jim and Chen, 2006; Song et al., 2015), our analysis disclosed that the frequency of UGS visits could be a determinant of the WTP of UGS conservation. Finally, SES was found to positively influence WTP, which accorded well with the findings in Mandeville (USA) (Lorenzo et al., 2000) and Jinan (Wang and Zhang, 2009). However, the magnitude of the relationship between the SES and WTP seemed to differ geographically, and its impacting factors remained unclear, for which future studies are recommended.

5.3 Implications, limitations and recommendations

Several implications for promoting WTP for UGS conservation and management could be suggested. Practices towards the enhancement of residents' knowledge on the benefits UGS could provide (perception of ecosystem services) may be an effective way to promote WTP for UGS conservation. Mitigating the health risks related to UGS and, thus, preventing residents from ecosystem disservices could be further useful. The quality of the UGS which was frequently accessed by residents with relatively lower SES could be prioritised, as such places were more likely to be associated with higher perceived ecosystem disservices. Besides, the urban design aimed at improving the accessibility of UGS would be beneficial as it may increase the frequency of UGS visits and, thereby, promote WTP.

Several limitations of SEM and the present study merit attention as they serve to guide the interpretation of results and the appropriate use of the analytic approach. Based on these limitations, several recommendations could be drawn. First, although SEM helped to suggest one explanation for the causal relationships among variables, this does not infer that other potential explanations, which could fit the data equally well or even better, are not possible. This issue has been extensively discussed in the literature. Readers interested in this, as well as other shortcomings of SEM, are referred to the discussion by Tomarken and Waller (2003); Tomarken and Waller (2005).

Second, while we aimed at compiling a large sample size for an understudied region, the direct and straightforward CVM was used to get WTP outcomes to approximate values of UGS's ecosystem services. There is a continuous debate over the suitability of CVM for environmental planning, as the method is prone to many sources of bias related to information, starting point, instrument, hypothesis, and strategic response (Brookshire, 1976; Moser and Dunning, 1986). For example, in this study, the starting point of 200 CNY/year seemed to be too optimistic, as most participants reported a WTP lower than it. A more comprehensive pre-testing of starting points per region and UGS type might be helpful in the future study to reduce the potential bias. However, CVM remains a widely used approach to achieve a monetary estimation of ecosystem services (Harrison et al., 2018), because it captures rich socioeconomic information relevant to designing conservation policies, in particular when WTP outcomes are viewed as attitudes rather than as economic preferences (García-Llorente et al., 2011). It

is further argued that CVM is useful in increasing the 'visibility' of nature in valuation and helpful in detecting and communicating changes in the provision of ecosystem services (Castro et al., 2016). Future studies may find the decision tree approach proposed by Harrison et al. (2018) useful in guiding the selection of monetary techniques for estimating economic values for ecosystem services.

Third, although consistent with current GOF recommendations, the relatively low R-squared value for WTP suggested a need to improve methods for WTP estimation further to include a more comprehensive set of predictors and use methods allow exploration of non-linear relations. Future research is encouraged towards an improved understanding of the impacts of biophysical environment on the WTP. For example, studies on whether/how the spatial characteristics such as landscape composition and configuration at a fine level (e.g., the district level) would impact the WTP for UGS conservation are needed, as these factors are known to influence the actual visitation pattern in UGS (Li et al., 2015). Moreover, further investigations on the individual-level perceptual drivers of WTP are helpful to build a complete picture of the mechanisms underpinning residents' perception. This could include comprehensive studies covering one or more aspects on determinants of the 'unwillingness to pay' for UGS conservation and its relationships to WTP, for example, the price-related value of UGS (Depietri et al., 2016; Wang, 2000), the influence of payment methods on WTP (Ma, 1999), how media could be used to heighten perception (Lyytimäki, 2014), and how stakeholders could get involved in the promotion of WTP and implementation of UGS conservation practices (Luyet et al., 2012).

Last but not least, the causal models on residents' perceptions, frequency of UGS visits, SES and WTP for the conservation of UGS developed in this study are transferable to future studies with related purposes in other cities in China and the world. However, the conclusions drawn from the present SEM practice may be only applicable to the large cities in central China. The three cities explore in this study are typical large cities in the Yangtze River Basin (a region covers 17 provincial-level divisions) with relatively higher population and GDP and priorities being put onto the conservation and improvement of local ecosystems. As the capitals of the three adjacent provinces in the Middle Reaches of the Yangtze River, they share a number of geographical characteristics with many other cities over the region. Future studies were encouraged to adopt an improved WTP estimation method, as suggested previously, to cover a broader range of the cities both inside and outside the region to help understand the geographically varying relationships between the WTP and its determinants.

6. Conclusions

Urban residents from central China perceived high levels of ecosystem services and low levels of ecosystem disservices provided by UGS. Most of the participants (90.7%) reported that they were willing to pay for UGS conservation at relatively high levels (202.4 CNY or 30.6 USD/person/year). Perception, use of UGS and socioeconomic status could contribute to a causal model of WTP, but the

model's explanatory power was found to be low. The structure (paths and coefficients) of the causal model varied between the three cities, suggesting that other city-specific factors were likely to impact individual WTP.

Acknowledgement

The authors would like to thank the two reviewers for their constructive comments and suggestions that helped to improve the manuscript. This research has received funding from the Innovative Foundation of Huazhong University of Science and Technology under grant agreement number 2018KFYYXJJ133.

References

Ajzen, I., 1991. The theory of planned behavior. Organizational Behavior and Human Decision Processes 50, 179-211.

Akpinar, A., 2016. How is quality of urban green spaces associated with physical activity and health? Urban Forestry & Urban Greening 16, 76-83.

Anderson, J.C., Gerbing, D.W., 1988. Structural equation modeling in practice A review and recommended two-step approach. Psychological Bulletin 103, 411-423.

Andersson, E., Barthel, S., Ahrné, K., 2007. Measuring social-ecological dynamics behind the generation of ecosystem services. Ecological Applications 17, 1267–1278.

Ao, C.L., Li, Y.J., Feng, L., Jiao, Y., 2010. Evaluating the non-use value of Sanjiang wetland based on contingent valuation method. Acta Ecologica Sinica 30, 6470–6477.

Aoshima, I., Uchida, K., Ushimaru, A., Sato, M., 2018. The influence of subjective perceptions on the valuation of green spaces in Japanese urban areas. Urban Forestry & Urban Greening 34, 166-174.

Arcaute, E., Le Texier, M., Schiel, K., Caruso, G., 2018. The provision of urban green space and its accessibility: Spatial data effects in Brussels. Plos One 13, e0204684.

Barnes-Mauthe, M., Oleson, K.L.L., Brander, L.M., Zafindrasilivonona, B., Oliver, T.A., van Beukering, P., 2015. Social capital as an ecosystem service: Evidence from a locally managed marine area. Ecosystem Services 16, 283-293.

Bernath, K., Roschewitz, A., 2008. Recreational benefits of urban forests: explaining visitors' willingness to pay in the context of the theory of planned behavior. Journal of Environmental Management 89, 155-166.

Bhandari, P., Kc, M., Shrestha, S., Aryal, A., Shrestha, U.B., 2016. Assessments of ecosystem service indicators and stakeholder's willingness to pay for selected ecosystem services in the Chure region of Nepal. Applied Geography 69, 25-34.

Bolund, P., Hunhammar, S., 1999. Ecosystem services in urban areas. Ecological Economics 29, 293-301.

Brookshire, D.S., 1976. The valuation of aesthetic preferences. Journal of Environmental Economics and Management, 325-346.

Burkhard, B., Kroll, F., Nedkov, S., Müller, F., 2012. Mapping ecosystem service supply, demand and budgets. Ecological Indicators 21, 17-29.

Campagne, C.S., Roche, P.K., Salles, J.-M., 2018. Looking into Pandora's Box: Ecosystem disservices assessment

and correlations with ecosystem services. Ecosystem Services 30, 126-136.

Castro, A.J., Vaughn, C.C., García-Llorente, M., Julian, J.P., Atkinson, C.L., 2016. Willingness to pay for ecosystem services among stakeholder groups in a South-Central U.S watershed with regional conflict. Journal of Water Resources Planning and Management 142, 05016006.

Chen, B., Qi, X., 2018. Protest response and contingent valuation of an urban forest park in Fuzhou City, China. Urban Forestry & Urban Greening 29, 68-76.

Chen, W.Y., Jim, C.Y., 2010. Resident motivations and willingness-to-pay for urban biodiversity conservation in Guangzhou (China). Environmental Management 45, 1052-1064.

Chen, X., 2010. Assessment on ecotourism resources of Yuelu Mountain scenic area. Agricultural University of Hunan.

Cheng, X., Van Damme, S., Li, L., Uyttenhove, P., 2019. Evaluation of cultural ecosystem services: A review of methods. Ecosystem Services 37, 100925.

Coles, R.W., Bussey, S.C., 2000. Urban forest landscapes in the UK- progressing the social agenda. Landscape and Urban Planning 52, 181-188.

Cooper, P., Poe, G.L., Bateman, I.J., 2004. The structure of motivation for contingent values: a case study of lake water quality improvement. Ecological Economics 50, 69-82.

Costanza, R., de Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., Farber, S., Grasso, M., 2017. Twenty years of ecosystem services: How far have we come and how far do we still need to go? Ecosystem Services 28, 1-16.

Costanza, R., Mitsch, W.J., Day Jr., J.W., 2006. A new vision for New Orleans and the Mississippi delta: applying ecological economics and ecological engineering. Frontiers in Ecology and the Environment 4, 465–472.

Depietri, Y., Kallis, G., Baró, F., Cattaneo, C., 2016. The urban political ecology of ecosystem services: The case of Barcelona. Ecological Economics 125, 83-100.

Dobbs, C., Kendal, D., Nitschke, C.R., 2014. Multiple ecosystem services and disservices of the urban forest establishing their connections with landscape structure and sociodemographics. Ecological Indicators 43, 44-55.

Dunn, R.R., Davies, T.J., Harris, N.C., Gavin, M.C., 2010. Global mapping of ecosystem disservices: The unspoken reality that nature sometimes kills us. Biotropica 42, 555-557.

EEA, 2010. Ecosystem accounting and the cost of biodiversity losses. The case of coastal Mediterranean wetlands. EEA Technical report No 3/2010.

EEA, 2011. Green infrastructure and territorial cohesion, The concept of green infrastructure and its integration into policies using monitoring systems. EEA Technical report No 18/2011.

Escobedo, F.J., Kroeger, T., Wagner, J.E., 2011. Urban forests and pollution mitigation: analyzing ecosystem services and disservices. Environmental Pollution 159, 2078-2087.

Escobedo, F.J., Wagner, J.E., Nowak, D.J., De la Maza, C.L., Rodriguez, M., Crane, D.E., 2008. Analyzing the cost effectiveness of Santiago, Chile's policy of using urban forests to improve air quality. Journal of Environmental Management 86, 148-157.

Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystem services for decision making. Ecological Economics 68, 643-653.

García-Llorente, M., PEZ, B.M.N.-L., DI´AZ, S., MONTES, C., 2011. Can ecosystem properties be fully translated into service values?An economic valuation of aquatic plant services. Ecological Applications 21, 3083-3103.

Gobster, P.H., 1998. Urban parks as green walls or green magnets Interracial relations in neighborhood boundary parks. Landscape and Urban Planning 41, 43-55.

691 Gómez-Baggethun, E., Barton, D.N., 2013. Classifying and valuing ecosystem services for urban planning.
692 Ecological Economics 86, 235-245.

693 Gunawardena, K.R., Wells, M.J., Kershaw, T., 2017. Utilising green and bluespace to mitigate urban heat island
694 intensity. Science of the Total Environment 584-585, 1040-1055.

695 Hardin, P.J., Jensen, R.R., 2007. The effect of urban leaf area on summertime urban surface kinetic temperatures:
696 A Terre Haute case study. Urban Forestry & Urban Greening 6, 63-72.

697 Harrison, P.A., Dunford, R., Barton, D.N., Kelemen, E., Martín-López, B., Norton, L., Termansen, M., Saarikoski,
698 H., Hendriks, K., Gómez-Baggethun, E., Czúcz, B., García-Llorente, M., Howard, D., Jacobs, S., Karlsen,
699 M., Kopperoinen, L., Madsen, A., Rusch, G., van Eupen, M., Verweij, P., Smith, R., Tuomasjukka, D., Zulian,
700 G., 2018. Selecting methods for ecosystem service assessment: A decision tree approach. Ecosystem Services
701 29, 481-498.

702 Higgens, S.I., Turpie, J.K., Costanza, R., Cowling, R.M., Le Maitre, D.C., Marais, C., Midgley, G.F., 1997. An
703 ecological simulation model of mountain fynbos ecosystems: dynamics, valuation and management.
704 Ecological Economics 22, 155-169.

705 Howley, P., 2011. Landscape aesthetics: Assessing the general publics' preferences towards rural landscapes.
706 Ecological Economics 72, 161-169.

707 Hung, R., 2010. Journeying between home and nature Ageo-phenomenological exploration and its insights for
708 learning. Environmental Value 19, 233-251.

709 Jim, C.Y., Chen, W.Y., 2006. Recreation–amenity use and contingent valuation of urban greenspaces in
710 Guangzhou, China. Landscape and Urban Planning 75, 81-96.

711 Jónsson, J.Ö.G., Davíðsdóttir, B., 2016. Classification and valuation of soil ecosystem services. Agricultural
712 Systems 145, 24-38.

713 Kamri, T., 2013. Willingness to Pay for Conservation of Natural Resources in the Gunung Gading National Park,
714 Sarawak. Procedia - Social and Behavioral Sciences 101, 506-515.

715 Kenter, J.O., Jobstvogt, N., Watson, V., Irvine, K.N., Christie, M., Bryce, R., 2016. The impact of information,
716 value-deliberation and group-based decision-making on values for ecosystem services: Integrating
717 deliberative monetary valuation and storytelling. Ecosystem Services 21, 270-290.

718 Ko, H., Son, Y., 2018. Perceptions of cultural ecosystem services in urban green spaces: A case study in Gwacheon,
719 Republic of Korea. Ecological Indicators 91, 299-306.

720 Lera-López, F., Faulin, J., Sánchez, M., 2012. Determinants of the willingness-to-pay for reducing the
721 environmental impacts of road transportation. Transportation Research Part D: Transport and Environment
722 17, 215-220.

723 Li, S., Colson, V., Lejeune, P., Speybroeck, N., Vanwambeke, S.O., 2015. Agent-based modelling of the spatial
724 pattern of leisure visitation in forests: A case study in Wallonia, south Belgium. Environmental Modelling &
725 Software 71, 111-125.

726 Li, S., Colson, V., Lejeune, P., Vanwambeke, S.O., 2016. On the distance travelled for woodland leisure via
727 different transport modes in Wallonia, south Belgium. Urban Forestry & Urban Greening 15, 123-132.

728 Li, S., Juhasz-Horvath, L., Harrison, P.A., Pinter, L., Rounsevell, M.D.A., 2017. Relating farmer's perceptions of
729 climate change risk to adaptation behaviour in Hungary. Journal of Environmental Management 185, 21-30.

730 Li, S., Juhasz-Horvath, L., Trajer, A., Pinter, L., Rounsevell, M.D.A., Harrison, P.A., 2018. Lifestyle, habitat and
731 farmers' risk of exposure to tick bites in an endemic area of tick-borne diseases in Hungary. Zoonoses Public
732 Health 65, e248-e253.

733 Lo, A.Y., Jim, C.Y., 2010. Willingness of residents to pay and motives for conservation of urban green spaces in
734 the compact city of Hong Kong. Urban Forestry & Urban Greening 9, 113-120.

735 Loehlin, J.C., 2004. Latent variable models: An introduction to factor, path, and structural equation analysis.

Loomis, J., Brown, T., Lucero, B., Peterson, G., 1996. Improving validity experiments of contingent valuation methods: results of efforts to reduce the disparity of hypothetical and actual willingness to pay. Land Economics, 450-461.

Lopez-Mosquera, N., Garcia, T., Barrena, R., 2014. An extension of the Theory of Planned Behavior to predict willingness to pay for the conservation of an urban park. Journal of Environmental Management 135, 91-99.

Lorenzo, A.B., Blanche, C.A., Qi, Y., Guidry, M.M., 2000. Assessing residents' willingness to pay to preserve the community urban forest: A small-city case study. Journal of Arboriculture 26, 319-325.

Luyet, V., Schlaepfer, R., Parlange, M.B., Buttler, A., 2012. A framework to implement stakeholder participation in environmental projects. Journal of Environmental Management 111, 213-219.

Lyytimäki, J., 2014. Bad nature: Newspaper representations of ecosystem disservices. Urban Forestry & Urban Greening 13, 418-424.

Lyytimäki, J., 2015. Ecosystem disservices: Embrace the catchword. Ecosystem Services 12, 136.

Lyytimäki, J., Petersen, L.K., Normander, B., Bezák, P., 2008. Nature as a nuisance? Ecosystem services and disservices to urban lifestyle. Environmental Sciences 5, 161-172.

Lyytimäki, J., Sipilä, M., 2009. Hopping on one leg – The challenge of ecosystem disservices for urban green management. Urban Forestry & Urban Greening 8, 309-315.

Ma, Z., 1999. An Introduction to the economics of environment and resources. Higher Education Press, Bejing.

Majumdar, S., Deng, J., Zhang, Y., Pierskalla, C., 2011. Using contingent valuation to estimate the willingness of tourists to pay for urban forests: A study in Savannah, Georgia. Urban Forestry & Urban Greening 10, 275-280.

Malabe, Z.a., Summers, J.K., Pugesek, B.H., 2000. Using structural equation modeling to investigate relationships among ecological variables. Environmental and Ecological Statistics 7, 93-111.

Marisa, G., Paulo, A., João, G., J, N.D., Robert, H., Paulo, F.-M., Mario, C., 2018. Assessing how green space types affect ecosystem services delivery in Porto, Portugal. Landscape and Urban Planning 170, 195-208.

Matos, P., Vieira, J., Rocha, B., Branquinho, C., Pinho, P., 2019. Modeling the provision of air-quality regulation ecosystem service provided by urban green spaces using lichens as ecological indicators. Science of the Total Environment 665, 521-530.

Moser, Dunning, 1986. A guide for using the contingent value methodology in recreation studies. National Economics Development Procedures Manual-Recreation.

Nesbitt, L., Hotte, N., Barron, S., Cowan, J., Sheppard, S.R.J., 2017. The social and economic value of cultural ecosystem services provided by urban forests in North America: A review and suggestions for future research. Urban Forestry & Urban Greening 25, 103-111.

Neuvonen, M., Sievänen, T., Tönnes, S., Koskela, T., 2007. Access to green areas and the frequency of visits – A case study in Helsinki. Urban Forestry & Urban Greening 6, 235-247.

Ngulani, T., Shackleton, C.M., 2019. Use of public urban green spaces for spiritual services in Bulawayo, Zimbabwe. Urban Forestry & Urban Greening 38, 97-104.

Obeng, E.A., Aguilar, F.X., 2018. Value orientation and payment for ecosystem services: Perceived detrimental consequences lead to willingness-to-pay for ecosystem services. Journal of Environmental Management 206, 458-471.

Odum, E.P., 1989. Ecology and our endangered life-support systems. Journal of Tropical Ecology 6, 202-202.

Pataki, D.E., Carreiro, M.M., Cherrier, J., Grulke, N.E., Jennings, V., Pincetl, S., Pouyat, R.V., Whitlow, T.H., Zipperer, W.C., 2011. Coupling biogeochemical cycles in urban environments: ecosystem services, green solutions, and misconceptions. Frontiers in Ecology and the Environment 9, 27-36.

Pickens, J., 2005. Attitudes and perceptions, in: Borkowski, N. (Ed.), Organizational Behavior in Health Care pp.

43-76.

Platania, M., Rizzo, M., 2018. Willingness to pay for protected areas: A case of Etna Park. Ecological Indicators 93, 201-206.

Porritt, J.M., Sufi, F., Barlow, A., Baker, S.R., 2014. The role of illness beliefs and coping in the adjustment to dentine hypersensitivity. Journal of Clinical Periodontology 41, 60-69.

Riechers, M., Barkmann, J., Tscharntke, T., 2016. Perceptions of cultural ecosystem services from urban green. Ecosystem Services 17, 33-39.

Riechers, M., Barkmann, J., Tscharntke, T., 2018. Diverging perceptions by social groups on cultural ecosystem services provided by urban green. Landscape and Urban Planning 175, 161-168.

Saz-Salazar, S.d., Rausell-Köster, P., 2008. A Double-Hurdle model of urban green areas valuation: Dealing with zero responses. Landscape and Urban Planning 84, 241-251.

Schindler, M., Le Texier, M., Caruso, G., 2018. Spatial sorting, attitudes and the use of green space in Brussels. Urban Forestry & Urban Greening 31, 169-184.

Schuhmann, P.W., Casey, J.F., Horrocks, J.A., Oxenford, H.A., 2013. Recreational SCUBA divers' willingness to pay for marine biodiversity in Barbados. Journal of Environmental Management 121, 29-36.

Shan, H., 2011. A research on the plan and management of the Wuhan Ma'Anshan forest park. Central China Normal University.

Song, X., Lv, X., Li, C., 2015. Willingness and motivation of residents to pay for conservation of urban green spaces in Jinan, China. Acta Ecologica Sinica 35, 89-94.

Tandogan, O., Ilhan, B.S., 2016. Fear of Crime in Public Spaces: From the View of Women Living in Cities. Procedia Engineering 161, 2011-2018.

TEEB, 2010. The economics of ecosystems and biodiversity ecological and economic foundations, in: Earthscan (Ed.), London.

Tomarken, A.J., Waller, N.G., 2003. Potential problems with "well fitting" models. Journal of Abnormal Psychology 112, 578-598.

Tomarken, A.J., Waller, N.G., 2005. Structural equation modeling: strengths, limitations, and misconceptions. Annual Review of Clinical Psychology 1, 31-65.

Tyrvainen, L., 2001. Economic valuation of urban forest benefits in Finland. Journal of Environmental Management 62, 75-92.

Tyrväinen, L., Ojala, A., Korpela, K., Lanki, T., Tsunetsugu, Y., Kagawa, T., 2014. The influence of urban green environments on stress relief measures: A field experiment. Journal of Environmental Psychology 38, 1-9.

Tzoulas, K., Korpela, K., Venn, S., Yli-Pelkonen, V., Kaźmierczak, A., Niemela, J., James, P., 2007. Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. Landscape and Urban Planning 81, 167-178.

Villa, F., Bagstad, K.J., Voigt, B., Johnson, G.W., Athanasiadis, I.N., Balbi, S., 2014. The misconception of ecosystem disservices: How a catchy term may yield the wrong messages for science and society. Ecosystem Services 10, 52-53.

von Döhren, P., Haase, D., 2015. Ecosystem disservices research: A review of the state of the art with a focus on cities. Ecological Indicators 52, 490-497.

Wang, S., 2000. A comparative study of Marx's Value Theory and Western Value Theory. Journal of Shandong University of Finance, 29-32.

Wang, Y., Zhang, Y.S., 2009. Air quality assessment by contingent valuation in Ji'nan, China. Journal of Environmental Management 90, 1022-1029.

Wang, Z., 2019. Practical Path and Enlightenment of the Development of Income Distribution System in 70 Years,

Yuncheng Daily.

Williams, B.K., 2011. Adaptive management of natural resources-framework and issues. Journal of Environmental Management 92, 1346-1353.

Wu, T., 2012. The research on Landscape pattern and ecosystem service in Changsha. Central South University of Forestry and Technology.

Xiao, Y., Wei, Y., Shan, R., Ma, J., 2017. Ecosystem service assessment and eco-economic harmony index of urban green space in Nanchang. Guangdong Landscape Architecture 39, 32-36.

Xie, G., Zhang, C., Zhen, L., Zhang, L., 2017. Dynamic changes in the value of China's ecosystem services. Ecosystem Services 26, 146-154.

Yang, B., Zou, J., 2009. Residents' willingness to pay for improving environmental quality in Beijing city. China Environmental Science 29, 1209-1214.

Zhai, G., Suzuki, T., 2008. Public willingness to pay for environmental management, risk reduction and economic development: Evidence from Tianjin, China. China Economic Review 19, 551-566.

Zhang, G., Zheng, D., Tian, Y., Li, S., 2019a. A dataset of distribution and diversity of ticks in China. Scientific Data 6, 105.

Zhang, G., Zheng, D., Wu, H., Wang, J., Li, S., 2019b. Assessing the role of high-speed rail in shaping the spatial patterns of urban and rural development: A case of the Middle Reaches of the Yangtze River, China. Science of the Total Environment, 135-399.

Zhang, S., Muñoz Ramírez, F., 2019. Assessing and mapping ecosystem services to support urban green infrastructure: The case of Barcelona, Spain. Cities 92, 59-70.

Zhang, W., 2019. Chinese people work overtime longer than Japanese. What should we do next?, Sino Foreign Management.

Zong, G., LI, P.-d., Sun, C.-c., 2016. Study on ordination and changes of the occupational prestige since the reform and opening-up. Journal of Beijing University of Technology (Social Science Edition) 16.