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Effects of seasonality on visual aesthetic preference

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ABSTRACT
Seasonality is a typical feature of landscapes in temperate regions. Seasonality's effects on visual aesthetic quality (VAQ) are widely recognised but not well understood. To address this gap, 10 sample sites were selected to represent the diversity of urban green spaces in Xuzhou, eastern China, which has a typical temperate monsoon climate. Photographs of the 10 sites were acquired in eight typical months to capture seasonality. Online surveys were used to evaluate the VAQ of the photographs. The mean value of the coefficient of variation of 16 landscape characteristics of a site during the seasons was used to represent seasonal diversity. The results indicated that: (1) the autumn landscape was the most preferred, and the winter landscape was the least preferred; (2) there was a significantly inverted U-shaped relationship between year-round VAQ and seasonal diversity. This is the first study to define seasonal diversity and its effect on VAQ.

KEYWORDS
Seasonality; landscape preference; seasonal diversity; urban green space

1. Introduction

Visual aesthetic quality (VAQ) is widely recognised as an ecosystem service (Gobster et al., 2007). Existing literature indicates that a location with high scenic beauty generally has positive impacts on human health and well-being (Kaplan & Kaplan, 1989; Ryan et al., 2010; Thompson, 2011; Wang & Zhao, 2020). Viewing beautiful scenery is thought to be an important incentive to conduct outdoor activities (Tyrväinen, Silvennoinen, & Hallikainen., 2017). Beautiful landscapes can also attract tourists (Lothian, 1999) and promote the development of local economies. Furthermore, VAQ may be an indicator of ecological quality (Gobster, 1999; Zhao, Wang, Luo, Xing, & Sun, 2017); thus, VAQ is closely related to sustainable ecosystem services. Therefore, many researchers have investigated methods for improving VAQ (e.g. Chen, Xu, & Devereux, 2016; Jiang, Larsen, Deal, & Sullivan 2015a; Liu et al., 2021; Xu, Zhao, Huang, & Hu, 2018).

Seasonality is a typical feature of landscapes in temperate regions and describes the variations occurring at regular intervals during a year, such as weekly, monthly, or quarterly. However, most previous works on landscape aesthetics ignored or deliberately avoided seasonality (Zhao, Huang, Tang, & Li, 2020) and evaluated the aesthetic value of a landscape in a specific season, typically in summer (Wang, Jiang, & Lu 2021; Xu et al., 2018; Yao et al., 2012; Zhao, Luo, Wang, & Cai, 2013). Seasonality strongly influences the visual appearances of urban green spaces, especially in temperate regions (Dodgshon & Olsson, 2007; Fry, Tveit, Ode, & Velarde, 2009; Paddle & Gilliland, 2016; Wang & Zhao, 2020). Annual herbaceous plants germinate in spring,

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and deciduous woody and perennial herbaceous plants emerge from dormancy and leaf out. Throughout spring and summer into autumn, plants bloom at different times for varying durations. During autumn, the foliage of deciduous trees and herbaceous plants changes colours, and in winter, deciduous trees lose their leaves, and herbaceous plants wither. Stobbelaar and Hendriks (2007) suggested that seasonal aspects were an important component of aesthetic valuation. A study conducted in Pennsylvania and New York showed a significant difference in scenic beauty between landscapes in early summer and late summer, and those in late summer and autumn (Kuper, 2013). Gramann and Rudis (1994) claimed that summer views of forest landscapes were preferred to winter views (no snow cover) due to the greenery in summer. In contrast, Tyrväinen et al., (2017) concluded that forest landscapes in winter were considerably more beautiful than in summer due to the snow views. Sonntag-Öström et al. (2015) suggested that forests in spring had more positive effects on people's perception than in autumn due to less light and fewer colours in autumn. However, Kuper (2018) concluded that the respondents rated autumn-coloured landscapes significantly higher than landscapes with foliated trees.

The signs of seasonality depend on the features of the landscape elements. Vegetation and water are considered the most important features indicating seasonality (Ai, Shi, Yin, & Huang, 2015; Kuper, 2013; Tveit, 2009). Deciduous plants show periodic changes from growth to dormancy during a year, causing prominent changes in the landscape in colour, shape, texture and permeability during the seasons. For example, plants are green which is a symbol of vivid and vigorous lives that makes summer the most preferred season (Eroğlu, Müderrisoğlu, & Kesim, 2012; Morckel, 2015), whereas winter has the lowest landscape quality due to the lack of green (Eroğlu et al., 2012). In addition, a location appears to be much more open after deciduous trees have lost their leaves. Water is another key element of 'ephemera' identified by Tveit, Ode and Fry (2006) as one of the nine concepts that potentially affecting on VAQ. The water level, velocity, and contaminant concentration are affected by the seasons (Ai et al., 2015). For instance, a landscape usually has a higher water level in the wet season, resulting in a higher proportion of water in the landscape. On the other hand, water changes into ice in freezing conditions, resulting in different impression on observers due to seasonality. The different landscape features may exhibit various degrees of change during the seasons. Deciduous trees are more changeable than evergreen trees; shallow water changes into ice faster than deep water in freezing conditions, leading to significant seasonal changes. Therefore, landscapes with different features exhibit different seasonal changes. However, to the authors' best knowledge, no study has investigated the effects of the extent of seasonal changes on VAQ.

The importance of urban green spaces has attracted increasing attention due to rapid global urbanisation. Urban green spaces not only provide locations for recreational activities, physical exercise, and mental stress relief (Bonnie & Mak, 2018; Jiang, Schmillen, & Sullivan, 2019; Jiang, Zhang, & Sullivan 2015b) but are also increasingly seen as the places for urban residents to enjoy beautiful sceneries (Arnberger & Eder, 2011), motivating people to engage in physical activities (Rogge, Nevens, & Gulinck, 2007). Therefore, VAQ is an essential factor in the design of urban green spaces. Regardless of the seasons, residents use green spaces year-round. Thus, building urban green spaces with a high year-round VAQ is more important than a high VAQ only in a specific season. However, to the authors' knowledge, no study has focussed on improving the year-round VAQ of urban green spaces.

In summary, the effects of seasonality on VAQ have not been analysed systematically and previous works did not reach an agreement on this issue. Our understanding of the seasonal beauty of landscapes is limited, and guidance is lacking for seasonal landscape design. Furthermore, existing literature on seasonality has mainly focussed on forests, whereas few studies considered urban green spaces. Therefore, a deeper understanding is required of the effects of seasonality on VAQ of urban green spaces and the public's preferences regarding seasonal changes. The results of this study are expected to contribute new knowledge to seasonal landscape design.

2. Methods

2.1. Sites and photographs

Xuzhou is a medium-sized city in eastern China. It is located at 34.27 degrees north latitude and has a temperate monsoon climate and distinct seasonal variations. The weather is changeable in spring, hot and rainy in summer, cool in autumn and cold in winter. After a comprehensive survey, 10 sample sites were selected to reflect the diversity of urban green spaces in Xuzhou. Photographs were used as surrogates for real landscapes. This method has been widely used in previous studies on landscape preference evaluation (e.g. Liu et al., 2021; Wang, Zhao, & Liu, 2016; Xu et al., 2018; Yao et al., 2012) and its reliability has been demonstrated (Palmer & Hoffman, 2001). Each site was photographed at a two-month interval during the year as suggested by Stobbelaar, Hendriks, and Stortelder (2004) to depict the landscape changes during the seasons. Due to more rapid changes in landscapes in spring and autumn, the interval was shortened to one month in these seasons. Thus, each site was photographed in January, March, April, May, July, September, October, and November, respectively, from April 2017 to March 2018 (see Appendix). Photographs were taken by the first author on clear or relatively cloudless days at the beginning of each month, from 9 am to 11 am and from 14 pm to 16 pm at eye level (about 152 cm above the ground). At each site, the photographer stood at the same marked position using the same angle to shoot the eight photographs to ensure that all photographs of the site covered the same area. No humans or animals were part of the photographs to prevent drawing attention away from the landscape. Snow views were excluded from the photographs because snow is rare in Xuzhou. Winter is the dry season, and it is not very cold (the average temperature in winter is 5 °C), if snow falls, it melts quickly. Finally, 80 photographs were collected (eight photographs of each site) (see Appendix).

2.2. Seasonal diversity measurement

In this study, seasonal diversity was defined as the extent of the objective landscape changes during the seasons; the higher the value, the more changes occurred in a landscape during the seasons. The landscape characteristics of the photographs were evaluated to quantify seasonal diversity.

Although water and vegetation are directly influenced by seasonal changes, other features of a landscape may be indirectly impacted, such as 'perceived biodiversity' (leafless trees and withered herbaceous plants in winter maybe reduce the perceived biodiversity), 'visual scale' (luxuriantly green plants in summer can create more close spaces), 'percentage of land covered by buildings' (luxuriant trees block some parts of buildings, reducing the perceived coverage of buildings), and 'type of topography' (deciduous plants growing at the foot of a hill conceal undulating topography in summer). Therefore, 16 landscape characteristics were selected by analysing the seasonal characteristics of the landscapes and referring to the landscape characteristics identified by existing literature (Arriaza, Cañas-Ortega, Cañas-Madueño, & Ruiz-Aviles 2004; Wang & Zhao, 2019; Zhao, Luo, Wang, & Cai, 2013). Because some landscape characteristics include terminologies difficult for ordinary people to understand, college students majoring in landscape architecture were invited to evaluate the 16 landscape characteristics of each photograph according to the scales shown in Table 1.

The 80 images were divided into eight groups, where each group included the 10 photographs taken in the same month at the 10 sites. The purpose was to minimise the participants' fatigue and ensure that the participants did not think that some photographs were the same. The landscape characteristics of each group were evaluated by seven college students. Fifty-six college students participated in the evaluation of the landscape characteristics. The average

Table 1. Measurement of landscape characteristics.

Landscape characteristics	Scores
View scale	Closed space = 1; slightly open space = 2; semi-open space = 3; open space = 4
Number of colours	One =1; two = 2; three = 3; four or more = 4
Percentage of land covered by woody plants	No vegetation = 1; <35% = 2; 36–70% = 3; 71–100% = 4
Vegetation type	No vegetation = 1; grasses or(and) shrubs = 2; trees or trees with grasses = 3; mixed vegetation = 4
Configuration of vegetation	No vegetation = 1; orderly configuration = 2; semi-natural configuration = 3; natural configuration = 4
Growth status of vegetation	No vegetation = 1; poor = 2; moderate = 3; good = 4
Perceived biodiversity	No vegetation or single = 1; low = 2; moderate = 3; high = 4
Percentage of land covered by herbs	No herbs = 1; <35% = 2; 36–70% = 3; 71–100% = 4
Percentage of land covered by water	No water = 1; <35% = 2; 36–70% = 3; 71–100% = 4
Visual naturalness of water	No water = 1; orderly form = 2; semi-natural form = 3; natural form = 4
Accessibility of water	No water = 1; difficult to access = 2; moderate access = 3; easy to access = 4
Quality of water	No water = 1; low = 2; moderate = 3; good = 4
Percentage of water covered by aquatic plants	No aquatic plants = 1; <35% = 2; 36–70% = 3; 71–100% = 4
Water form	No water = 1; no ice = 2; some ice = 3; all ice = 4
Percentage of land covered by buildings	No building =1; <35% = 2; 36–70% = 3; 71–100% = 4
Type of topography	Almost flat = 1; slightly undulating = 2; moderately undulating = 3, strongly undulating = 4

score of the seven students was calculated to represent the landscape characteristics of a photograph. The coefficient of variation (CV), which is the ratio of the standard deviation to the average value (Everitt & Skrondal, 2002), was used to measure the extent of change in each landscape characteristic during the eight months. The CV can measure the change degree of data while excluding the influence of different average values. The average score of the CV of the 16 landscape characteristics of a site during eight months represented seasonal diversity of the site.

2.3. Aesthetic preference evaluations

Online surveys were used to collect the VAQ data. This method provides easier to access to respondents and costs less than face-to-face surveys. Its reliability has been evidenced by previous research (Roth, 2006; Xu et al., 2018). The online surveys included eight questionnaires; each questionnaire included a group of photographs. Eight postgraduates were responsible for the eight questionnaires, and snowball sampling was used to invite participants. The eight postgraduates were asked not to invite participants in their common circles of friends to prevent one participant from responding to two or more questionnaires. Finally, 563 valid questionnaires were received from 236 males and 327 females. The breakdown for the eight questionnaires was 61 (25 males), 78 (30 males), 74 (37 males), 71 (31 males), 75 (28 males), 64 (27 males), 61 (25 males), and 79 (33 males) participants.

The online surveys were carried out from April to May 2018. Participants were asked to watch the photographs on a computer or laptop with a screen size of at least 12 inches and imagine that they were in the scene shown in the photographs. They were asked to choose a number from a seven-point Likert-type scale ranging from '1 = not at all' to '7 = very beautiful', according to their perceptions. Before submission, participants could change their ratings for any image. It took an average of 1.5 min to complete the questionnaire that included 10 photographs.

2.4. Statistical analysis

The interclass reliability of the aesthetic preference scores in the eight questionnaires was tested using SPSS 21.0 software. Subsequently, one-way ANOVA was conducted to analyse the effects of seasonality on VAQ. Curve estimation regression analysis was used to determine the relationship between seasonal diversity and year-round VAQ.

3. Results

3.1. Reliability

The interclass reliabilities of landscape preferences were calculated. Cronbach's Alpha for the preference score in January, March, April, May, July, September, October, and November, was 0.926, 0.905, 0.884, 0.853, 0.914, 0.931, 0.817, and 0.930, respectively. If Cronbach's Alpha $>$ 0.801, the reliability is very high (Palmer & Hoffman, 2001). Thus, the landscape preference scores could be used with confidence.

3.2. VAQ in different seasons

The landscape preference scores of the photographs are listed in Table 2. Based on the average scores in the eight months, the landscapes in September (average score = 4.72) and November (average score = 4.73) were considered the two most beautiful scenes, whereas the landscape in January (average score = 4.14) was ranked the lowest. In addition, the one-way ANOVA results showed a significant difference in the VAQ among the eight months ($F = 0.479$; Sig = 0.001), indicating that seasonality had a significant influence on VAQ.

3.3. Seasonal diversity

The seasonal diversity values for the 10 sample sites are presented in Figure 1. Sites 1, 2, 6, 8, and 9 which represented landscapes with deciduous plants and/or herbaceous plants and/or water bodies possessed higher seasonal diversity than the other five sites. Sites 4, 5, and 7 represented landscapes with more pavement, and Sites 3 and 10 showed landscapes with more evergreens (see Appendix). This result implies that seasonal diversity is not only related to the type of landscape element (natural elements or man-made elements) but also to the properties of natural elements, such as evergreen or deciduous trees and herbaceous or woody plants.

3.4. Seasonal diversity in relation to year-round VAQ

The year-round VAQ of a site was determined by the mean score of the landscape preference in eight months. The results of the curve estimation regression analysis using year-round VAQ as the dependent variable and seasonal diversity as the independent variable showed no significant relationship between year-round VAQ and seasonal diversity (R^2 = 0.421, adjusted R^2 = 0.256,

Table 2. Mean scores of the landscape preference of the photographs taken at 10 sites during eight months.

	Jan.	Mar.	Apr.	May	July	Sep.	Oct.	Nov.	Mean	S.D.
Site 1	3.77	4.29	4.92	4.27	4.57	4.81	3.96	4.73	**4.42**	0.41
Site 2	4.50	4.18	5.07	4.55	4.54	5.04	4.48	5.04	**4.68**	0.33
Site 3	3.90	4.07	4.26	4.52	4.25	4.44	4.32	4.65	**4.30**	0.24
Site 4	3.54	3.76	4.30	4.19	4.02	4.48	4.14	4.64	**4.13**	0.36
Site 5	3.75	3.94	4.36	3.67	3.76	4.15	3.84	4.34	**3.98**	0.27
Site 6	4.06	4.67	5.00	4.89	4.20	4.63	3.82	4.39	**4.46**	0.41
Site 7	4.17	4.54	4.67	4.13	4.25	4.56	4.32	4.85	**4.44**	0.26
Site 8	4.50	4.39	4.47	4.81	4.82	5.00	4.71	4.56	**4.66**	0.21
Site 9	4.62	4.73	5.18	4.75	5.22	5.27	4.55	5.09	**4.93**	0.29
Site 10	4.63	4.50	4.73	4.84	4.64	4.81	4.57	4.96	**4.71**	0.15
Mean	**4.14**	**4.31**	**4.69**	**4.46**	**4.43**	**4.72**	**4.27**	**4.73**		
S.D.	0.40	0.32	0.34	0.39	0.42	0.33	0.32	0.26		

Note: The bold characters are to highlight the average value within eight months of each sample (the bold column), and highlight the average value of 10 samples in each month (the bold row).

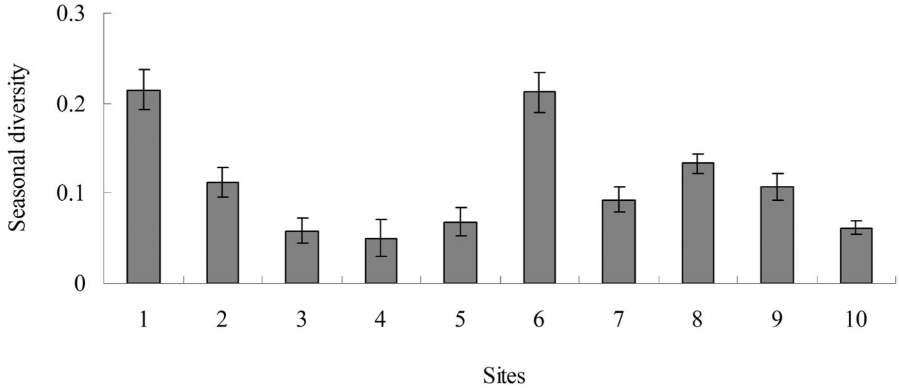

Figure 1. Seasonal diversity (±standard error) for the 10 sample sites.

$F = 2.547$, $p = 0.147$). After carefully checking the photographs, it was found that the photograph taken in January at Site 10 included more snow views than the other sites (see Appendix) because dense evergreen trees blocked the sun, causing the snow to melt more slowly than at the other sites. Snow views can improve VAQ significantly (Tyrväinen et al., 2017) (see Table 2, the year-round VAQ of Site 10 was second-highest among the 10 sites, while its VAQ in January was the highest). The snow views at Site 10 were an accidental factor and should have been excluded from the experiment. Accidental factors can cause outliers in the data (Aggarwal, 1988). Therefore, Site 10 was identified as an outlier in this study. After excluding this outlier, a significant inverted U-shaped relationship was observed between seasonal diversity and year-round VAQ ($R2 = 0.661$, adjusted $R2 = 0.548$, $F = 5.845$, $p = 0.039$), suggesting that moderate seasonal diversity resulted in the highest year-round VAQ (Figure 2).

4. Discussion

4.1. Landscape preference across seasons

This study highlights the significant impact of seasonality on the VAQ of urban green spaces in a temperate region. Autumn has the highest preference rating, and winter has the lowest. This result concurs with the findings of Hyunjin and Yue (2019) who found that a Korea streetscape with a background of maple or ginkgo in autumn was preferred to the same scene in winter. Landscapes in autumn have rich colours in Xuzhou (see Appendix). Existing literature suggests that the richness of colours can enhance the ratings of perceived beauty (Wang & Zhao, 2017), and autumn-coloured foliage has a positive impact on preference (Kuper, 2020a,b). On the other hand, research indicates that one reason for low preference ratings in winter is the lack of greenery (Eroğlu et al., 2012; Wang & Zhao, 2020). The dull scenes in winter imply the lack of productiveness with potentially adverse effects on humans. Humans have developed an intuitive preference for environments with a high potential for providing food, water and security throughout evolutionary time (Appleton, 1975). Autumn is the harvest season in Xuzhou when the ripened foods are eaten by human and attract animals that are potential prey for humans. However, Eroğlu et al. (2012) believed that summer was the most preferred season due to vivid and lush plants in Turkey's Black Sea region. Jauhiainen and Mönkkönen (2005) indicated that very few respondents liked autumn, the wettest time of year in Finland. The inconsistent results can possibly be explained by the different climates and moisture conditions in different regions. The summers in the Black Sea region are warm and comfortable, but in Xuzhou where the present study was conducted, the summers are hot and wet, but the climate is cool and comfortable in autumn, which is why it is called 'fresh autumn' by Chinese people. Therefore,

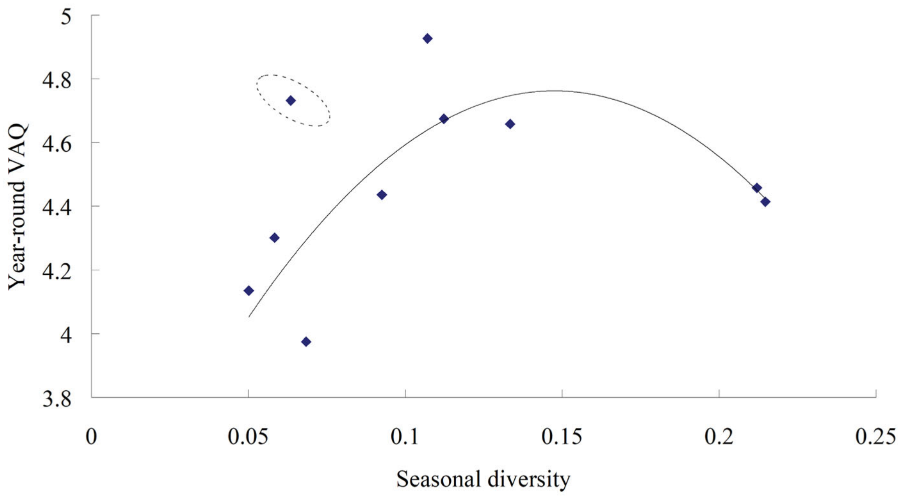

Figure 2. Relationship between seasonal diversity and year-round VAQ (the outlier is inside the dashed line).

the participants' evaluations of the seasonal landscapes maybe closely related to the climate experienced by the participants.

4.2. Seasonal diversity and VAQ

Despite the fact that Jauhiainen and Mönkkönen (2005) concluded that a vast majority of Finish respondents 'mostly' to 'fully' agreed that they liked seasonal changes, to the authors' best knowledge, this paper is the first study to define and quantify seasonal diversity. The present study indicates that a landscape possessing moderate seasonal diversity has the highest year-round VAQ. During evolution, natural elements in temperate regions, such as vegetation, have adapted to the distinct seasonal variations and change substantially during the seasons, resulting in relatively high seasonal diversity. In contrast, artificial elements such as paved areas, buildings, and artworks hardly change during the seasons. Therefore, introducing an appropriate number of artificial elements into natural environments can lead to moderate seasonal diversity. In a natural setting, artificial objects, representing 'cues to care', usually imply a safe environment (Zhao & Huang, 2021), inducing a higher VAQ according to the 'prospect–refuge' theory (Appleton, 1975). The coexistence of natural and artificial elements in a landscape not only provides opportunities for people to come into contact with nature, which has been demonstrated to enhance the public's well-being (e.g. Morita et al., 2007; Park et al., 2011; Zhao et al., 2018) but also reduces the potential negative effects associated with nature such as fear (Lorenc, 2012) and the presence of harmful creatures (mosquitoes, rats, ticks, etc.) (Lohmus & Balbus, 2015). On the other hand, moderate seasonal diversity can also be achieved through the combination of various natural elements, which have different seasonal changes (Kuper, 2020b). For example, evergreens typically exhibit subtle visual changes throughout the year, whereas deciduous plants have more pronounced seasonal changes. Herbaceous plants often grow rapidly in spring and summer but wither in autumn and may disappear in winter; thus they show more pronounced changes during the seasons than woody plants. Therefore, moderate seasonal diversity is also characterised by diverse plant species, implying high biodiversity in the environment, which is favourable for human survival and reproduction (Lindemann-Matthies, Junge, & Matthies, 2010). As a result, moderate seasonal diversity results in a high preference rating.

4.3. Application for seasonal landscape design

Although ephemera is an indispensable factor influencing landscape quality (Tveit et al., 2006), existing literature on landscape preference typically regards landscapes as being static (Arriaza et al., 2004; Liu et al., 2021; Xu et al., 2018). This study highlights the essential effects of seasonality on VAQ. Therefore, understanding the natural rhythm of seasonality can help designers and policy-makers implement dynamic landscape planning and design, which has been generally neglected in the academic circle and practical applications. We not only desire a beautiful landscape for a certain period, but it is more important to have a landscape with high aesthetic quality during the entire. Therefore, seasonality should be considered in the design of urban green spaces.

Moderate seasonal diversity should be stressed in landscape design. Elements that exhibit more seasonal changes should be included in locations with low seasonal diversity, and elements with less seasonal changes should be utilised in a landscape with high seasonal diversity. Specifically, an appropriate proportion of squares, buildings, and paths is recommended to reduce the seasonal diversity of natural environments. Incorporating evergreen plants into environments with substantial seasonal changes produces moderate seasonal diversity. However, if the seasonal diversity of a landscape is lower than moderate, some elements that provide change during the seasons should be incorporated. For example, planting deciduous and/or herbaceous plants in urban squares dominated by artificial elements substantially increases seasonal diversity, thereby improving year-round beauty.

5. Limitations and future research

This study was conducted in a localised region with relatively few sample sites. Despite the strengths of this study, such as quantifying seasonal diversity and finding that moderate seasonal diversity leads to the highest year-round VAQ, there are several limitations. Therefore, researchers and practitioners should exercise caution in any attempt to generalise the results and apply them in practice. However, these limitations also inspire future studies. First, people's perceptions of the beauty of a landscape depend on the physical features of the landscape and the perceptual processes (Daniel, 2001). Thus, the social demographics of the participants, such as gender, age, educational background, and living environment, have a remarkable impact on aesthetic preference (Howley, 2011; Howley, Donoghue, & Hynes, 2012; Wang & Zhao, 2017). This study does not disclose the demographic variables of the participants, except for gender, which may decrease the generalisability. For example, if the participants were divided by age, the relationship between seasonal diversity and year-round VAQ may differ between older and younger participants. Therefore, we encourage researchers to investigate the effects of the demographic variables of participants on VAQ in different seasons. Second, urban green spaces are regularly maintained, such as covering grassy area to encourage seed sprouting in spring, trimming plants in summer, picking ripened fruits in autumn, and mowing the lawn in the growing seasons; these actions disturb the natural seasonal rhythm of landscapes. However, this study did not consider the effect of landscape maintenance. Researchers should analyse the effect of landscape maintenance on seasonal changes and, in turn, on seasonal diversity. The result may provide a new approach to achieve moderate seasonal diversity. Third, seasonal changes are closely linked to a region's climate; thus, seasonal changes might have different influences on VAQ in different regions. This study was conducted in Xuzhou, a city with a typical temperate monsoon climate; therefore, the results may not be applicable to other climatic regions. Similar experiments are recommended in various climatic regions with distinct seasonal variations. Fourth, studies have shown that the evaluation date could influence preference ratings. For example, Palmer (1990) indicated that respondents rated the scenic value of summer scenes significantly higher than autumn scenes for an evaluation date in March; however, the ratings did not differ when the evaluation was conducted in summer or autumn. The explanation by the author was that the respondents looked more forward to summer in March because they had grown weary of winter and desired foliaged trees. Schloss, Nelson, Parker, Heck, and Palmer (2016) also found that the colour preferences of the respondents depended on the season. In this study, the VAQ was evaluated from late spring to early summer. It is assumed that the preference score may be different if the VAQ evaluation was conducted in another season. Therefore, it is recommended to collect VAQ data in different seasons to avoid the bias of the evaluation date, especially for evaluating seasonal landscapes. Finally, air pollution was not considered when taking photographs. Existing literature has demonstrated that air pollution affected the sky colour and visibility (Hyslop, 2009), thereby affecting visitors' experiences (Chawla, Keena, Pevec, & Stanley, 2014; Hajrasouliha, 2017). Zhao et al. (2020) observed that air pollution had a non-negligible effect on aesthetic preference assessment. Air pollution is typically more severe in winter than in the other seasons in Xuzhou due to coal-fired heating, which may be another reason for the lowest VAQ in winter. Investigating the effects of air pollution on VAQ is a very interesting research topic, which possibly builds a close ties between landscape aesthetics and ecology, thereby guiding a multifunctional landscape design. For example, a landscape provides high ecological quality that benefits people's physical health and an attractive environment that reduces people's stress levels to improve their psychological health (Zhao et al., 2017). However, our understanding of this issue is limited; thus, future studies on this topic are encouraged.

6. Conclusions

Beautiful scenery is a crucial element of attracting visitors to destinations. Temperate regions have distinct seasonal variations, and it is essential to understand how seasonality affects VAQ. This study explores the effects of seasonality on aesthetic preference in a typical temperate region. The results indicate that the autumn landscape is the most preferred, and the winter landscape is the least preferred. The landscape with moderate seasonal diversity has the highest year-round VAQ. To the authors' best knowledge, this is the first study to define and quantify seasonal diversity. We provide a new method for seasonal landscape research. The results can help designers and managers design the landscape with a moderate level of seasonal diversity. Suggested measures include incorporating elements with greater seasonal changes into landscape with low seasonal diversity and utilising features with less seasonal changes in landscapes with high seasonal diversity.

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