JOURNAL OF ENVIRONMENTAL ENGINEERING AND LANDSCAPE MANAGEMENT
ISSN 1648–6897 print/ISSN 1822-4199 online
2013 Volume 21(2): 123–132
doi:10.3846/16486897.2012.695738

CORRELATIONS BETWEEN AESTHETIC PREFERENCES OF RIVER AND LANDSCAPE CHARACTERS

Jingwei Zhao[a, b], Pingjia Luo[b], Ronghua Wang[c], Yongli Cai[a]
[a] *School of Resources and Environment, East China Normal University, Shanghai, China*
[b] *School of Art and Design, China University of Mining and Technology, Xuzhou, China*
[c] *School of Urban and Environmental Science, Xuzhou Normal University, Xuzhou, China*

Submitted 28 Jun. 2011; accepted 11 May 2012

Abstract. Some landscape characters put great influences on the aesthetic preferences of a river. Finding out these characters will provide for river landscape design and management with explicit keystones. In this paper, 23 sample areas of rivers were selected in Xuzhou, China, and 15 landscape characters of rivers were identified. The photos taken at the sample areas were as stimuli, and undergraduate students were respondents. The results demonstrate that the aesthetic preferences of photos judged one-by-one and judged together receive similar results; the preference scores of deflective views are significantly higher than the ones of opposite views; for urban rivers, "river accessibility" and "number of colours" are reliably positive predictors to aesthetic preferences, "wood diversity index" and "plants on water" are negative ones; for rural rivers, "coverage of riparian vegetation", "perspective" and "wood diversity index" are reliably positive predictors to aesthetic preferences.

Keywords: river; aesthetic preferences; landscape characters; landscape management.

Reference to this paper should be made as follows: Zhao, J.; Luo, P.; Wang, R.; Cai, Y. 2013. Correlations between aesthetic preferences of river and landscape characters, *Journal of Environmental Engineering and Landscape Management* 21(2): 123–132. http://dx.doi.org/10.3846/16486897.2012.695738

Introduction

Water is not only the base of all lives but also an important element of the landscape, and it is beneficial to improving landscape quality (Kaltenborn, Bjerke 2002; Laumann *et al.* 2003; Nasar, Li 2004; Regan, Horn 2005). Litton (1977) claimed in his visual assessment of river landscape: "Water in the landscape tends to be dominant because of its visibility, its movement, reflections, and color, its consequent contrasts to adjacent earth surfaces". River is an invaluable treasure bestowed by nature. From ancient times to now, people settle themselves along a river which provides material supplies and spiritual enjoyment for them. Now, more and more people view a river as a preferred place for leisure and entertainment (Pfluger *et al.* 2010). In China, with the rapid development of the economy, creating an agreeable environment and constructing leisure places for residents are important issues for the government. Accordingly, river landscape planning and management receive extensive consideration. However, what kinds of river landscape do people enjoy? What are the merits and demerits of current river landscape? How do we improve the river landscape? Only after these questions are answered satisfactorily can the river landscape be planned and managed with explicit keystones.

Landscape quality assessment is widely employed to analyze landscape, further providing for landscape planning and management. Identifying landscape characters and exploring their influences on landscape quality are a method applied in landscape assessment by many researchers (Arriaza *et al.* 2004; Bulut, Yilmaz 2008; Yao *et al.* 2012). The psychophysical paradigm of landscape assessment attempts to establish quantitative relationships between the subject's judgments and specific objective attributes of a landscape (Daniel 2001). However, on the one hand, some specific attributes have broad meanings which are difficult to measure by an objective method such as "number of colors" which was as a landscape character in several studies (Arriaza *et al.* 2004; Yao *et al.* 2012); color measurement depends greatly on the resolution. On the other hand, the determination of some specific objective attributes is costly and requires sufficient manpower. In this paper, for the characters difficult or costly to be measured objectively, we introduce a subjective judgment based on the descriptive method (Arriaza *et al.* 2004; Bulut, Yilmaz 2008); objective measurement is employed for the characters easy to be measured.

For river landscape, some studies involved the relationships between aesthetic preferences and landscape characters such as degree of wilderness (De Groot, Van den Born 2003; Hagerhall *et al.* 2004; Junker, Buchecker 2008), water flow (Pflüger *et al.* 2010), riparian vegetation, and the river's plain form (Meitner 2004). These studies, however, mainly involved one or a few landscape

Corresponding author. Jingwei Zhao.
E-mail: zhaojingwei74@yahoo.com.cn

characters. Their guides to river landscape management are limited. If we could reveal the interactions of more landscape characters and aesthetic preferences, it would be beneficial to river landscape planning and management greatly.

In this paper, 11 landscape characters (Table 1) were used for a subjective survey, and another 4 characters (river width, riparian width, wood diversity index and grass diversity index) were measured objectively. This paper studied the relationships between the 15 landscape characters and aesthetic preferences, which might guide river landscape planning and management.

Table 1. Scale of measurement of landscape characters

Landscape characters	Scores
Plain form of river	Regular form = 1; semi-natural form = 2 ; natural form = 3
Plants on water	None = 1; A few = 2; More = 3
River accessibility	Difficult to access = 1; Moderate to access = 2; Easy to access = 3
Plants on river side	None = 1; A few = 2; More = 3
Types of riparian vegetation	No plants = 1; Grasses or (and) shrubs = 2; trees = 3;
Coverage of riparian vegetation	0–35% = 1; 36–70% = 2; 71–100% = 3
Types of bank	Orderly hard bank = 1; Orderly soil bank = 2; Natural bank = 3
Buildings	None = 1; A few = 2; More = 3
Number of colors	One or two = 1; Three or four = 2; Five or more = 3
Degree of wilderness	Artificial environment is dominant = 1; Artificial and natural environment are joint = 2; Natural environment is dominant = 3
Perspective (mountain and (or) sky in view)	None or difficult to see = 1; Small impact to river landscape = 2; Great impact to river landscape = 3

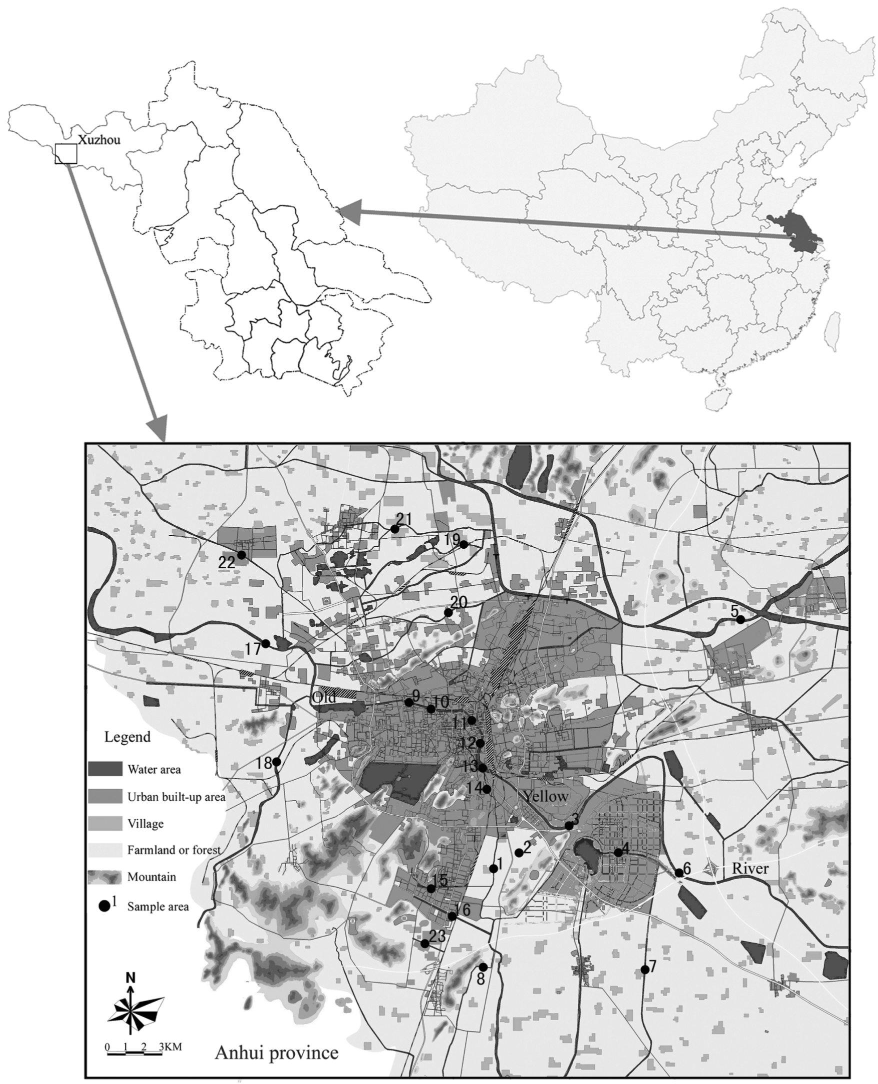

Fig. 1. Location of Study area

1. Materials and methods

1.1. Study area

Xuzhou is located in the northwest of Jiangsu province, China, between 33°43′N and 34°58′N latitudes and between 116°22′E and 118°40′E longitudes (Fig. 1). Its climate is a typical warm humid monsoon with an average annual temperature of 14 °C and rainfall of 860 mm; its rainfall is mainly from June to September, which accounts for about 56 percent of the total rainfall.

The study area, including the urban area of Xuzhou and its surroundings, covers about 1,231 km^2 (Fig. 1). Old Yellow River is the trunk of a local water system which comprises other numerous natural rivers and canals. The flows of almost all rivers are regulated by water gates, which wave severely according to the rainfall in different seasons. In the rainy season, especially after heavy rain, most rivers have high flow because of the fully open of water gates. However, in the seldom rainy period (from October to next May), the water gates are usually closed or opened a little, the river flow is so low that people almost not see it with their eyes. The main problems concerning river landscape are water pollution, simplicity of riparian vegetation, weakness of riparian ecological functions and quick change of river landscape.

1.2. Sample areas

The selection of sample areas was based on an overall investigation of the rivers in the study area, which ensured to cover the main rivers. The total of 23 sample areas was selected, including 13 urban rivers and 10 rural rivers (Fig. 1).

1.3. Objective measurement of four landscape characters

1.3.1. Biodiversity

From the center of each sample area, within 500 m extension along the river on two opposite directions, respectively, 5 squares, each 100 m^2, were setup randomly, in which woody species and individual number of each species were numbered, respectively. On each square, three small squares (1×1 m) were setup along a diagonal (Fig. 2), and in each small square, herb species were identified and the individual number of each species was measured.

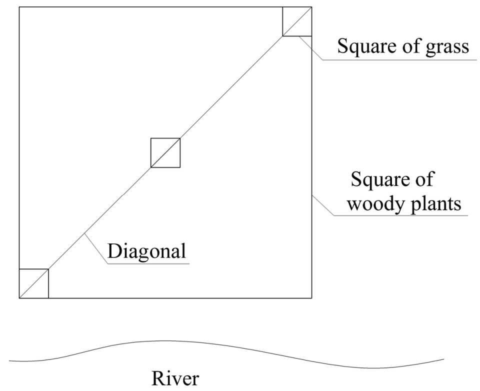

Fig. 2. Sketch map of vegetation square

The Shannon – Wiener index was adopted in this paper, its formula is:

$$H = -\sum_{i=1}^{s} \frac{N_i}{N} \log_2 \frac{N_i}{N}, \quad (1)$$

H: value of Shannon–Wiener diversity index, S: number of plant species, N_i: individual number of the *i*th species, N: totally individual number of all species. Biodiversity indexes of woody plants and grass were calculated, respectively. On each sample area, wood diversity index took the average of 5 squares and grass diversity index took the average of 15 small squares.

1.3.2. River width and riparian width

River width refers to the width of the water body of a river. The center line of each sample area is a point for measurement. From the point, along the river, extending 100 m in two opposite directions, respectively, the two sites are the other two points for measurement. River width takes the average of the three measures.

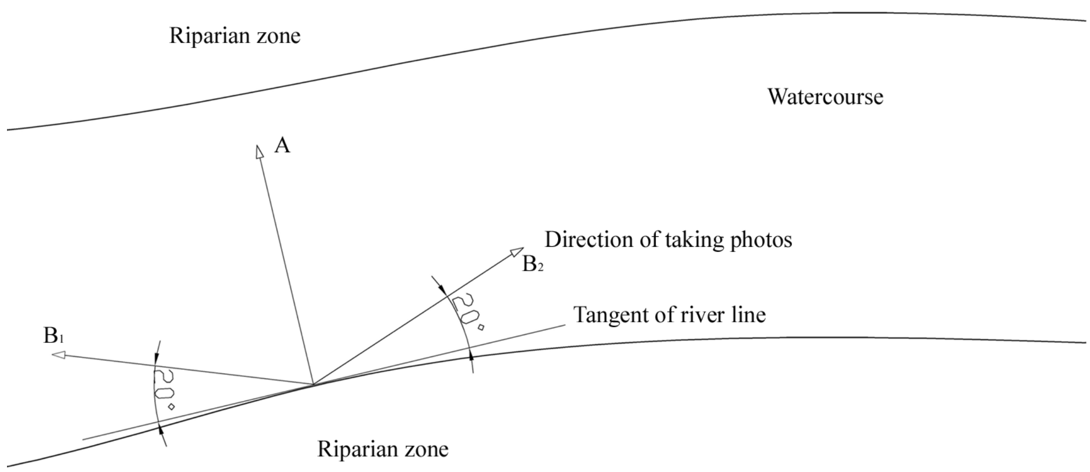

Fig. 3. Directions of taking photos

Table 2. The demographic properties of respondents

			Group 1 (67 persons in total)	Group 2 (212 persons in total)	
				Aesthetic assessment	Landscape character judgment
Valid questionnaires (person)			61	174	157
Response rate			91%	82%	74%
Sex	Male	Number	24	77	65
		Percentage	39%	44%	41%
	Female	Number	37	97	92
		Percentage	61%	56%	59%
Place of residence	City	Number	35	101	86
		Percentage	57%	58%	55%
	Country	Number	26	73	71
		Percentage	43%	42%	45%
Discipline background			Landscape architecture, art design or related	Landscape architecture, art design or related	
Average ages (years)			21.19	21.07	20.89

Measurement points of riparian width are the same as the points of river width. Riparian width takes the average of three measures, too. Identification of riparian boundary is the premise for measurement of riparian width, but it is still no criteria for it. This paper adopted two methods to determine riparian boundary.

(1) For the river with a levee, we take the centerline of levee as riparian boundary because the inner land of the levee allows frequent flooding, which is consistent with the definition of riparian zone (Gregory *et al.* 1991).

(2) For the river without levee, we take the zone, near the river, being different from surrounding land-use as the riparian zone.

1.4. Stimuli for aesthetic assessment and landscape characters judgment

Photos are the stimuli for aesthetic assessment and landscape characters judgment. Photos were taken, in a clear or less cloudy day, from 10 a.m. to 4 p.m., in the seldom rainy period at local (May 2010) to eliminate the river flow's influence on aesthetic preferences. In order to improve representation for the real landscape, three photos were taken on each sample area (Fig. 3. A: opposite view, B_1 and B_2: deflective views), and 69 photos were gathered. The equipment is Olympus (SP800) digital camera.

1.5. Survey of observers' preferences and landscape characters judgment

1.5.1. Respondents

Undergraduate students from China University of Mining and Technology were invited to this trial, and all students volunteered. Yao *et al.* (2012) concluded that there was no significant difference between undergraduate students and the public for aesthetic assessment, and Stamps (1999) suggested that students can substitute for the public in landscape assessment. The students were divided into two groups. A student only attended a group assessment. The demographic properties of respondents are shown in Table 2.

1.5.2. The first group assessment

Three photos, taken in the same sample area, were stuck to one slide. The total of 23 slides was used for evaluation of aesthetic preferences. The arrayed order of slides was random. Aesthetic preferences were divided into 7 ranks (scores): 1: extremely unbeautiful; 2: very unbeautiful; 3: unbeautiful; 4: moderate; 5: beautiful; 6: very beautiful; 7: extremely beautiful (Hands, Brown 2002). The slides were projected on a white screen and played twice. The first was shown fast so that the pictures provided a general impression to the respondents; the second was for 10s per slide, in which the respondents should give an evaluation of a slide.

1.5.3. The second group assessment

This assessment contained two steps. The first step was aesthetic preferences assessment. The 69 photos were arranged randomly, and each photo was done a slide. The method was the same as the first group. The scores of a sample area took the average scores of three photos belonging to it. The second step was landscape characters judgment according to Table 1. Table 1 was tabled after consulting 3 experts in landscape architecture.

The 23 slides used in the first group assessment were stimuli, the slides were played twice, the first was fast; for the second time, we played next slide only after all of the respondents completed landscape characters judgment of a slide.

1.6. Data analysis

Data analysis used SPSS 17.0 software. One-way ANOVA analysis was used to check the differences between the photos judged one-by-one and judged together, opposite views and deflective ones, respect-tively. Correlation analysis and stepwise multiple linear regression analysis were conducted to explore the relationships between landscape characters and aesthetic preferences.

Fig. 4. The photos of two sample areas with the highest preference scores (1st sample area (top), 7th sample area (bottom))

Fig. 5. The photos of two sample areas with the lowest preference scores (2nd sample area (top), 12th sample area (bottom))

2. Results

2.1. Overall evaluation of the photos

The average preference scores of 23 sample areas are 3.93, closing to "moderate" level, of which the aesthetic preferences of two sample areas are below "unbeautiful" level, eight sample areas between "unbeautiful" and "moderate" levels, and thirteen sample areas between "moderate" and "beautiful" levels; all sample areas fail to meet "very beautiful" and "extremely beautiful" levels (Table 3). Figs 4 and 5 are the photos of two sample areas with the highest and lowest scores, respectively.

2.2. The comparison between the photos of judged one-by-one and judged together

By one-way ANOVA analysis, the aesthetic preferences of photos judged one-by-one and judged together received similar result ($P = 0.337$).

Table 3. Preference scores of rural and urban rivers

Rural rivers		Urban rivers	
Sample area	Scores	Sample area	Scores
1	4.97	2	2.82
5	4.01	3	3.58
6	4.02	4	4.44
7	4.73	9	3.36
8	3.51	10	3.80
17	4.29	11	3.54
18	3.32	12	2.95
19	4.42	13	4.27
20	4.02	14	3.26
21	4.71	15	4.12
		16	3.56
		22	4.27
		23	4.19
Average	4.22	Average	3.70
Standard deviation	0.54	Standard deviation	0.53

2.3. Influence on aesthetic preferences by directions of taking photos

As shown in Fig. 3, one photo is opposite view (A) and two photos are deflective views (B_1, B_2). According to the results of the second group evaluation (scores of deflective view take the average of two deflective photos), scores of deflective views are higher than that of opposite views in 16 sample areas (Fig. 6). Average scores of all opposite views are 3.82, lower than average scores of deflective views, which are 4.26. By one-way ANOVA analysis, the preference scores of opposite and deflective views are significantly different (P = 0.045).

2.4. Correlations between aesthetic preferences and landscape characters

By one-way ANOVA analysis, the preference scores of rural rivers are significantly higher than the ones of urban rivers (P = 0.030), and nine of 15 characters are significantly different between the two groups. They are "plain form of river" (P = 0.000), "plants of river side" (P = 0.000), "coverage of riparian vegetation" (P = 0.000), "types of bank" (P = 0.000), "buildings" (P = 0.000), "number of colors" (P = 0.000), "degree of wilderness" (P = 0.000), "perspective" (P = 0.013) and "river width" (P = 0.001). The result of hierarchical cluster analysis (Fig. 7) is parallel to the classification by the place of residence of 23 sample areas (Table 3), which shows the heavy influence on river landscape by urbanization.

Several studies implied that different landscape types may lead to different relationships between landscape characters and aesthetic preferences (Arriaza *et al.* 2004; Yao *et al.* 2012). We studied the relationships in two groups (urban and rural rivers), respectively.

2.4.1. Correlation analysis

The correlations between aesthetic preferences and landscape characters are shown in Table 4. For rural rivers, aesthetic preferences increase with "perspective" and "wood diversity index", decrease with "plants on water", and the other characters have no statistically significant correlations with aesthetic preferences. For urban rivers, aesthetic preferences have significant positive correlations with "river accessibility", "types of bank", "number of colors" and "degree of wilderness", and significant negative correlations with "plants on water" and "buildings".

2.4.2. Stepwise multiple linear regression analysis

The significant correlations are further described using stepwise multiple linear regression analysis with 15 characters as independents and aesthetic preferences as dependent. The significant predictors emerged from the multiple regressions are presented in Table 5. To verify the model, the normality of the residuals, analysis of variance and multi-collinearity were examined. The results of the Kolmogorov-Smirnov test indicated that the residuals followed a normal distribution (for urban rivers, Kolmogorov-Smirnov Z = 0.695, P = 0.720 > 0.05; for rural rivers, Kolmogorov-Smirnov Z = 0.445, P = 0.989 > 0.05). Variance analysis results revealed a linear correlation between landscape characters and aesthetic preferences (for urban rivers, F = 92.130, P = 0.000; for

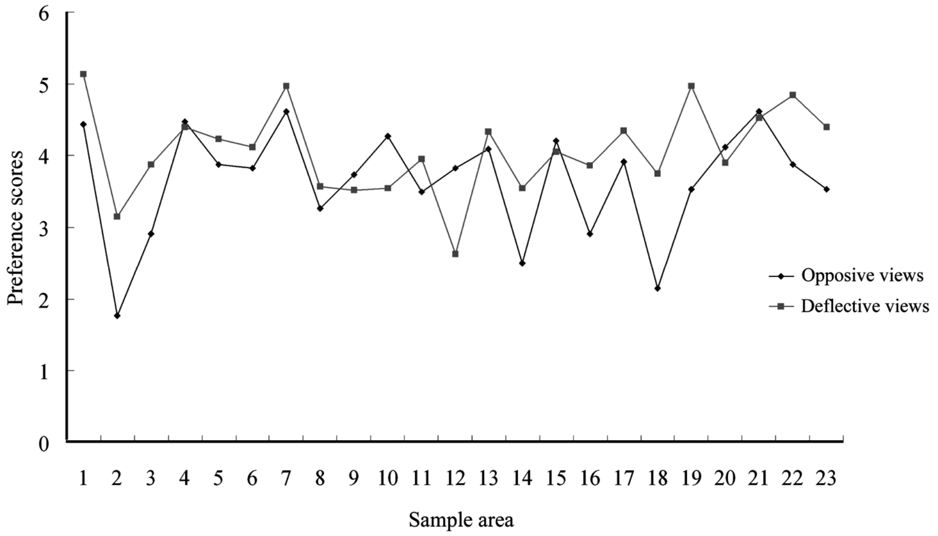

Fig. 6. Aesthetic preferences of photos taken from two directions

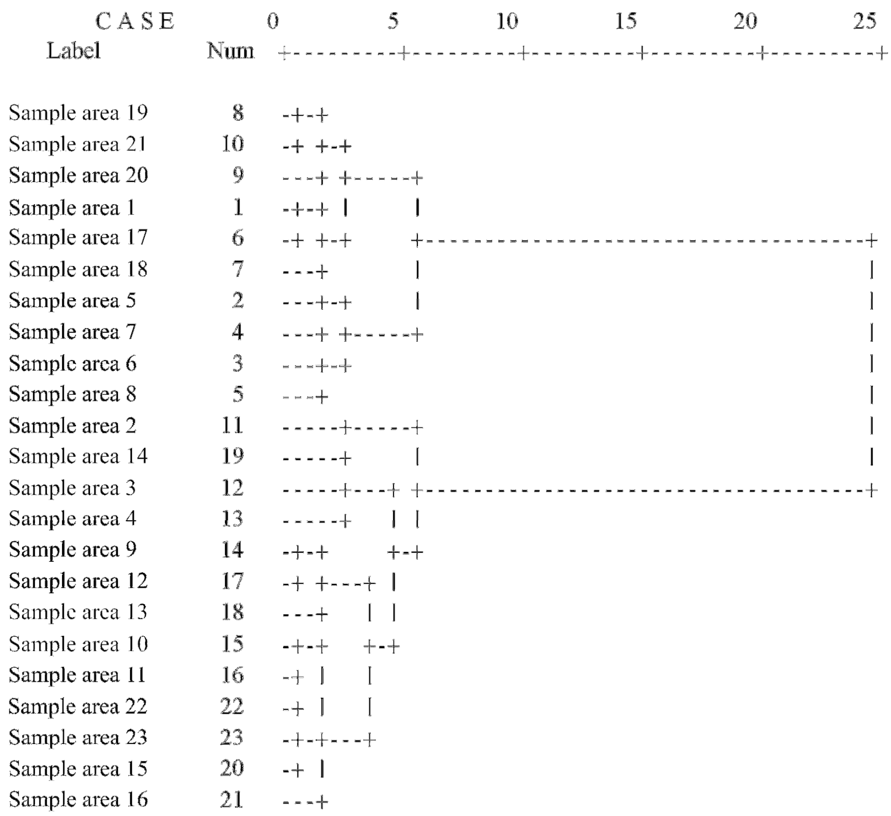

Fig. 7. Cluster analysis of all sample areas

Table 4. Correlations between aesthetic preferences of rivers and landscape characters

		PFR	PW	RA	PRS	TRV	CRV	TB	B	NC	DW	P	Riv. W	Rip. W	WDI	GDI
AP (Rural rivers)	Spearman rho	–0.305	–0.687[a]	0.620	0.125	0.178	0.599	–0.111	–0.018	0.012	–0.288	0.758[a]	0.426	0.222	0.656[a]	0.442
	Sig. (2-tailed)	0.392	0.028	0.056	0.732	0.623	0.067	0.761	0.960	0.973	0.419	0.011	0.220	0.538	0.039	0.200
AP (Urban rivers)	Spearman rho	0.130	–0.589[a]	0.895[b]	0.262	0.204	0.255	0.699[b]	–0.601[a]	0.594[a]	0.596[a]	0.551	0.360	0.438	–0.385	0.027
	Sig. (2-tailed)	0.672	0.034	0.000	0.387	0.503	0.401	0.009	0.030	0.032	0.032	0.051	0.226	0.135	0.194	0.929

a: Correlation is significant at the 0.05 level. b: Correlation is significant at the 0.01 level.

AP: Aesthetic preferences, PFR: Plain form of river, PW: Plants on water, RA: River accessibility, PRS: Plants on river side, TRV: Types of riparian vegetation, CRV: Coverage of riparian vegetation, TB: Types of bank, B: Buildings,

NC: Number of colors, DW: Degree of wilderness, P: Perspective, Riv. W: River width, Rip. W: Riparian width, WDI: Wood diversity index, GDI: Grass diversity index.

Table 5. Significant predictors for the preferences emerging from stepwise multiple linear regressions for landscapes of two

Dependent	Independent	Unstandardized Beta	Standardized Beta	t	Sig.	Collinearity statistics	
						Tolerance	VIF
Aesthetic preferences (adjusted $R^2 = 0.968$) (urban rivers)	(constant)	2.484		8.925	0.000		
	River accessibility	0.543	0.589	9.489	0.000	0.690	1.450
	Wood diversity index	–0.269	–0.365	–6.845	0.000	0.935	1.069
	Plants on water	–0.256	–0.307	–5.258	0.001	0.781	1.280
	Number of colors	0.331	0.167	2.762	0.025	0.726	1.377
Aesthetic preferences (adjusted $R^2 = 0.938$) (rural rivers)	(constant)	–1.795		–2.451	0.050		
	Coverage of riparian vegetation	1.848	0.594	6.958	0.000	0.952	1.050
	Perspective	1.109	0.482	5.453	0.002	0.886	1.128
	Wood diversity index	0.362	0.388	4.287	0.005	0.848	1.179

rural rivers, F = 46.087, P = 0.000). Menard (1995) reported that a tolerance value of less than 0.2 indicates a multi-collinearity problem. The minimum tolerance values in our model are 0.690 (urban rivers) and 0.848 (rural rivers). Alternatively, according to the findings of Arriaza *et al.* (2004), VIF (variance inflation factor) exceeding 10 implies a possible multi-collinearity problem. In our model, the maximum value are 1.450 (urban rivers) and 1.179 (rural rivers). Therefore, there is no multi-collinearity problem in our model. In a word, with t-test and significance-test (Table 5), our model is reliable.

In Table 5, we found the significant predictors were different between the urban and rural rivers. For urban rivers, the strongest predictor is "river accessibility", moderate predictors are "wood diversity index" and "plants on river", "number of colors" is a weaker predictor. For rural rivers, "coverage of riparian vegetation" and "perspective" are the strong predictors to aesthetic preferences, and "wood diversity index" is the weak one.

3. Discussion

3.1. Differences between urban and rural rivers

In China, human takes a great influence on the urban river landscapes which are endowed with functions of beautification, sightseeing and recreation by landscape design. The rural rivers mainly play the function of economy, rarely being conducted special landscape design and management. However, the preference scores of rural rivers are higher than the ones of urban rivers, which should arouse our reconsiderations for current river landscape design. The rapid urbanization process of China has lasted for decades, and this process would continue for a long time, with which a large number of rural rivers would be turned into urban rivers. If these river landscapes are changed by current landscape design and management, their aesthetic preferences would be debased. It is the time to bridge the landscapes of urban and rural rivers; the beauty of rural rivers should be conserved when new functions are given by urbanization.

3.2. Correlation analysis and linear regression analysis

Correlation analysis, in general, is the base of linear regression analysis, but their results are not always coincident (Arriaza *et al.* 2004; Sevenant, Antrop 2009). In this paper, for urban rivers, the characters of "river accessibility", "plants on water" and "number of colors" are further demonstrated that they are significant predictors for aesthetic preferences by stepwise linear regression analysis (Table 5). However, "types of bank", "buildings" and "degree of wilderness" which are significantly correlated with aesthetic preferences in Table 4 are removed, and "wood diversity index" which is not significant characters to aesthetic preferences in correlation analysis, becomes a significant predictor in regression analysis. The reason may be the interaction of characters. Correlation analysis only checks the single relationship between a character and preferences and does not involve the interaction of characters, but the regression analysis gives consideration on the two aspects. Table 5 is the results of removing multi-collinearity by stepwise multiple linear regression analysis.

For rural rivers, the significant predictors of correlation analysis and regression analysis are different. The reason is the same as one of urban rivers.

3.3. Predictors to aesthetic preferences

Many landscape characters can influence aesthetic preferences. For a real landscape, however, only a few characters play a leading role to aesthetic preferences. In Table 5, four landscape characters of urban rivers and three landscape characters of rural rivers are reliable predictors to aesthetic preferences. And except for "wood diversity index", the aesthetic preferences of urban and rural rivers have different predictors. This shows that different types of landscape can lead to different predictors.

Biodiversity is one of the key problems of ecology, and biodiversity conservation is one of the main targets of landscape planning and management. Concerning the correlations of biodiversity and aesthetic preferences, Junge *et al.* (2009) concluded that people kept positive reactions towards biodiversity in agricultural land. Lindemann-Matthies *et al.* (2010) studied mountain landscape in Switzerland, and demonstrated that people preferred the landscape with abundant species. These findings are parallel to our result for rural rivers, but opposite to our result for urban rivers where "wood diversity index" is a negative predictor for aesthetic preferences (Table 5). The reasons might be that urban rivers, influenced heavily by humans, present regular appearances, but the trees with high diversity have various configurations which are least harmonious to the regular appearances of rivers. That is to say, biodiversity is not a steady predictor for aesthetic preferences.

3.4. River landscape management

The predictors emerging from stepwise multiple linear regressions (Table 5) could enlighten river landscape management. For urban rivers, it is necessary to take down the barrier of accessing rivers, such as upright banks. We can increase the number of colors by plant selection and color design of buildings near rivers. Riparian plants should be managed well. For example, clearing up dead trees and decaying woods and thinning the bush layer are of benefit to aesthetic preferences (Tyrvainen *et al.* 2003). Of course, clear water is extremely important to all river landscape. A large amount of aquatic plants may pollute water, especially the phytoplankton which can be reduced by ecological restoration of the riparian zone (Andrea *et al.* 2009) or by human power.

In landscape management of rural rivers, we should enhance the coverage of riparian vegetation, providing a good physical environment for people. And the visual scale should be enlarged, which keeps mountain and sky in the domain of people's view. At present, most riparian vegetations in rural riparian zone are plantation for timber, which species are very simple, leading to monotonous looks and lower ecological service. Enhancing diversity of plants can serve not only ecological goal, but also visual quality.

3.5. Multi-photos as stimuli for landscape evaluation

According to stimulus, landscape assessment can be divided into two types: indirect assessment by photos and direct assessment on site. Both of them have their two sides. The former possesses the advantages of fast progression, low cost and comparing multiple landscapes simultaneously, but takes the disadvantages such as not fully reflecting the real landscape (Palmer, Hoffman 2001), the great influence on pictures by photographers and photographic equipments (Yamashita 2002). The latter can present the landscape more comprehensively and objectively to the observers, but the difficulties of organizing personnel, high cost and low efficiency are the most challenging to this method (Meitner 2004). In the previous studies, the assessment by photos has been widely used (Arriaza *et al.* 2004; García Moruno *et al.* 2006; Roth 2006; Bernasconi *et al.* 2009; Canas *et al.* 2009; Pflüger *et al.* 2010).

Evaluations of three photos together and one-by-one show no observable difference in our paper, and the former can moderate the shortages of indirect assessment, which implies that, in future study, we could carry out landscape assessment through many photos or even animation (Lim *et al.* 2006).

Conclusions

1. As a whole, river landscape quality of Xuzhou is low, only close to "moderate" level.

2. The aesthetic preferences of photos judged one-by-one and judged together are not statistically different, while the preference scores of rural rivers are significantly higher than the ones of urban rivers, and the preference scores of deflective views are significantly higher than the ones of opposite views.

3. For urban rivers, "river accessibility" and "number of colors" are positive predictors to aesthetic preferences, but "wood diversity index" and "plants on water" are negative ones. For rural rivers, "coverage of riparian vegetation", "perspective" and "wood diversity index" are reliably positive predictors to aesthetic preferences.

Acknowledgements

We would like to thank the hundreds of anonymous respondents for landscape assessment. This research was supported by the National Nature Science Foundation of China (50908225).

References

Andrea, G.; Veronique, V.; Lorenzo, B.; Willy, B.; Peter, A. V. 2009. Model-based assessment of shading effect by riparian vegetation on river water quality, *Ecological Engineering* 35(1): 92–104. http://dx.doi.org/10.1016/j.ecoleng.2008.09.014

Arriaza, M.; Canas-Ortega, J. F.; Canas-Madueno, J. A.; Ruiz-Aviles, P. 2004. Assessing the visual quality of rural landscapes, *Landscape and Urban Planning* 69(1): 115–125. http://dx.doi.org/10.1016/j.landurbplan.2003.10.029

Bernasconi, C.; Strager, M. P.; Maskey, V.; Hasenmyer, M. 2009. Assessing public preferences for design and environmental attributes of an urban automated transportation system, *Landscape and Urban Planning* 90(3–4): 155–167. http://dx.doi.org/10.1016/j.landurbplan.2008.10.024

Bulut, Z.; Yilmaz, H. 2008. Determination of landscape beauties through visual quality assessment method: a case study for Kemaliye (Erzincan/Turkey), *Environmental Monitoring and Assessment* 141(1–3): 121–129. http://dx.doi.org/10.1007/s10661-007-9882-0

Canas, I.; Ayuga, E.; Ayuga, F. 2009. A contribution to the assessment of scenic quality of landscapes based on preferences expressed by the public, *Land Use Policy* 26(4): 1173–1181. http://dx.doi.org/10.1016/j.landusepol.2009.02.007

Daniel, T. C. 2001. Whither scenic beauty? Visual landscape quality assessment in the 21st century, *Landscape and Urban Planning* 54(1–4): 267–281. http://dx.doi.org/10.1016/S0169-2046(01)00141-4

De Groot, W. T.; Van den Born, R. J. G. 2003. Visions of nature and landscape type preferences: an exploration in The Netherlands, *Landscape and Urban Planning* 63(3): 127–138. http://dx.doi.org/10.1016/S0169-2046(02) 00184-6

García Moruno, L.; Hernández Blanco, J.; Ayuga, F. 2006. Analysis of the materials and exterior texture of agro-industrial buildings: a photo-analytical approach to landscape integration, *Landscape and Urban Planning* 74(2): 110–124. http://dx.doi.org/10.1016/j.landurbplan.2004.10.007

Gregory, S. V.; Swartson, F. J.; Mckee, W. A.; Cummins, K. 1991. An ecosystem perspective of riparian zones, *Bioscience* 41(8): 540–551. http://dx.doi.org/10.2307/1311607

Hagerhall, C. M.; Purcell, T.; Taylor, R. 2004. Fractal dimension of landscape silhouette outlines as a predictor of landscape preference, *Journal of Environmental Psychology* 24(2): 247–255. http://dx.doi.org/10.1016/j.jenvp.2003.12.004

Hands, D. E.; Brown, R. D. 2002. Enhancing visual preference of ecological rehabilitation sites, *Landscape and Urban Planning* 58(1): 57–70. http://dx.doi.org/10.1016/S0169-2046(01)00240-7

Junker, B.; Buchecker, M. 2008. Aesthetic preferences versus ecological objectives in river restorations, *Landscape and Urban Planning* 85(3–4): 141–154. http://dx.doi.org/10.1016/j.landurbplan.2007.11.002

Junge, X.; Jacot, K. A.; Bosshard, A.; Lindemann-Matthies, P. 2009. Swiss people's attitudes towards field margins for biodiversity conservation, *Journal for Nature Conservation* 17(3): 150–159. http://dx.doi.org/10.1016/j.jnc.2008.12.004

Kaltenborn, B. P.; Bjerke, T. 2002. Associations between environmental value orientations and landscape preferences, *Landscape and Urban Planning* 59(1): 1–11. http://dx.doi.org/10.1016/S0169-2046(01)00243-2

Laumann, K.; Garling, T.; Stormark, K. M. 2003. Selective attention and heart rate responses to natural and urban environments, *Journal of Environmental Psychology* 23(2): 125–135. http://dx.doi.org/10.1016/S0272-4944(02) 00110-X

Lim, E. M.; Honjo, T.; Umeki, K. 2006. The validity of VRML images as a stimulus for landscape assessment, *Landscape and Urban Planning* 77(1–2): 80–93. http://dx.doi.org/10.1016/j.landurbplan.2005.01.007

Lindemann-Matthies, P.; Briegel, R.; Schüpbach, B.; Junge, X. 2010. Aesthetic preference for a Swiss alpine landscape: The impact of different agricultural land-use with different biodiversity, *Landscape and Urban Planning* 98(2): 99–109. http://dx.doi.org/10.1016/j.landurbplan.2010.07.015

Litton, R. B. 1977. River landscape quality and its assessment, in *Proceedings of the Symposium on River Recreation Management and Research*. General Technical Report NC-28. North central Forest Experiment Station, US Department of Agriculture forest service, 46–54.

Meitner, M. J. 2004. Scenic beauty of river views in the Grand Canyon: relating perceptual judgments to locations, *Landscape and Urban Planning* 68(1): 3–13. http://dx.doi.org/10.1016/S0169-2046(03)00115-4

Menard, S. 1995. *Applied logistic regression analysis. Sage University paper series on quantitative applications in the social sciences*. Thousand Oaks: Sage, 7–106.

Nasar, J. L.; Li, M. H. 2004. Landscape mirror: the attractiveness of reflecting water, *Landscape and Urban Planning* 66(4): 233–238. http://dx.doi.org/10.1016/S0169-2046(03)00113-0

Palmer, J. F.; Hoffman, R. E. 2001. Rating reliability and representation validity in scenic landscape assessments, *Landscape and Urban Planning* 54(1–4): 149–161. http://dx.doi.org/10.1016/S0169-2046(01)00133-5

Pflüger, Y.; Rackham, A.; Larned, S. 2010. The aesthetic value of river flows: an assessment of flow preferences for large and small rivers, *Landscape and Urban Planning* 95(1–2): 68–78. http://dx.doi.org/10.1016/j.landurbplan.2009.12.004

Regan, C. L.; Horn, S. A. 2005. To nature or not to nature: associations between environmental preferences, mood states and demographic factors, *Journal of Environmental Psychology* 25(1): 57–67. http://dx.doi.org/10.1016/j.jenvp.2005.01.001

Roth, M. 2006. Validating the use of Internet survey techniques in visual landscape assessment – an empirical study from Germany, *Landscape and Urban Planning* 78(3): 179–192. http://dx.doi.org/10.1016/j.landurbplan.2005.07.005

Sevenant, M.; Antrop, M. 2009. Cognitive attributes and aesthetic preferences in assessment and differentiation of landscapes, *Journal of Environmental Management* 90(9): 2889–2899. http://dx.doi.org/10.1016/j.jenvman.2007.10.016

Stamps, A. E. 1999. Demographic effects in environmental aesthetics: a meta-analysis, *Journal of Planning Literature* 14(2): 155–175. http://dx.doi.org/10.1177/08854129922092630

Tyrvainen, L.; Silvennoinen, H.; Kolehmainen, O. 2003. Ecological and aesthetic values in urban forest management, *Urban Forestry Urban Greening* 1(3): 135–149. http://dx.doi.org/10.1078/1618-8667-00014

Yamashita, S. 2002. Perception and evaluation of water in landscape: use of Photo-Projective Method to compare child and adult residents' perceptions of a Japanese river environment, *Landscape and Urban Planning* 62(1): 3–17. http://dx.doi.org/10.1016/S0169-2046(02)00093-2

Yao, Y.; Zhu, X.; Xu, Y.; Yang, H.; Wu, X.; Li, Y.; Zhang, Y. 2012. Assessing the visual quality of green landscaping in rural residential areas: the case of Changzhou, China, *Environmental Monitoring and Assessment* 184(2): 951–967. http://dx.doi.org/10.1007/s10661-011-2012-z

Jingwei ZHAO. PhD candidate at School of Resources and Environment, East China Normal University. He has a master's degree in landscape architecture from Nanjing Forestry University. His research interests include the landscape design and ornamental plants.

Pingjia LUO. Associate Professor at School of Art and Design, China University of Mining and Technology, and a master's degree in art design from Jiangnan University. Her research interests are mainly in landscape restoration of abandoned fields.

Ronghua WANG. Lecturer at School of Urban and Environmental Science, Xuzhou Normal University. Has a master's degree in horticulture from Nanjing Forestry University. Her research interest is ornamental plants.

Yongli CAI. Professor from School of Resources and Environment, East China Normal University. He has a doctor's degree in ecology. His research interests include landscape ecology and ecological restoration.