THE VISUAL PREFERENCE FOR RIVERBED VEGETATION: A CASE STUDY IN CENTRAL TAIWAN

Jinn-Chyi Chen[1], Jheng-Guo Jiang[1], Ji-Shang Wang[2]

[1] Dept. of Environmental and Hazards Resistant Design, Huafan University, New Taipei, Taiwan

[2] Ecological Soil and Water Conservation Research Centre, National Cheng Kung University, Tainan, Taiwan

Abstract

The visual preference influenced by riverbed vegetation was studied in this paper. The study area is located in the Liou River and Ma-Yuan-Tou River in Taichung city, central Taiwan. Five artificialized sections in both rivers were selected as the observation sites to examine the changes in the riverbed. The green looking ratio (GR) was used to evaluate the images of green areas in spaces due to vegetation on the riverbed. Six cognitive factors: naturalness N, vividness V, harmony H, closure CL, continuity CO, and mystery M, were used to discuss the factors associated with visual preference. First, various river landscape images with changes in riverbed vegetation were collected and simulated by image processing. Second, the visual preference and cognitive factors were rated by the questionnaire survey method. A total of 246 valid questionnaires were used. Finally, the visual preference associated with GR and the cognitive factors were analyzed. The results showed that the visual preference P increased with increasing GR, especially when GR > 40%. A higher N, V, and CO, or a lower CL can help promote visual preference.

Keywords: *riverbed vegetation, central Taiwan*

1. INTRODUCTION

Landscape preference refers to the relationship between landscape and viewers. Physical and/or psychological methods are used to explain the beauty of a landscape or to explore differences in personal preference. Visual preference refers to the viewer's overall preference for the environment and is the overall indicator in landscape preference assessments (Bell, 1996). Visual preference for landscapes is influenced by a complex range of psychological, cultural, and environmental factors (Lee, 1979). For a river landscape, the environmental factors include landforms, water forms, and/or vegetation characteristics. Vegetation is one of the important factors in the evaluation of the visual preference for river or water landscapes (Shandas, 2007; Chen and Ho, 2013; Chen and Jiang, 2015). When present along the water's edge, vegetation can also act as a buffer between the stream ecosystem and the surrounding environment (Kenwick et al., 2009; Zhao et al., 2017).

This paper aims to study the visual preference for river landscapes influenced by vegetation changes on the artificialized riverbed. The objectives of this paper are as follows: (1) to investigate the visual preference for riversides constructed with smooth concrete or planting grass bricks; (2) to examine the relationship between visual preference and green-looking areas; and (3) to discuss the visual preference associated with cognitive factors. Visual perception can help designers determine the types of engineering solutions (from a visual perspective) that a popular among viewers, which may be an important consideration in river engineering and river restoration.

2. STUDY AREA

The study area is located in the Ma-Yuan-Tou (MYT) River and the Liou River in Taichung city, central Taiwan (Figure 1). The lengths of the MYT River and Liou River are 8.5 km and 27.6 km, respectively. The two rivers flow across the center of Taichung and were flooded during Typhoon Kalmaegi in 2008. The typhoon caused bridge collapse and failures of revetments and riverbeds. Thus, many engineering works, such as enforcement of revetments and riverbeds, were conducted on the

two rivers after 2008. Because both rivers have high flow velocity (can exceed 6 m/s) during the typhoon season, the riverbeds in the two rivers are mostly constructed with concrete materials for improved safety; specifically, smooth concrete before 2008 while the riverbeds at some sections of the river were replaced with planting grass bricks after 2008. The two major types of riverbed materials used in the MYT River and the Liou River are smooth concrete and planting grass bricks. The riverbed with planting grass bricks can promote natural vegetation growth. Thus, the riverside landscape will vary over time or with changes in water level. The study area focuses on artificialized sections of the two rivers. Two observation sites in the MYT River and three observation sites in the Liou River were selected. These observation sites have riverbeds constructed using the materials ranging from smooth concrete to planting grass bricks.



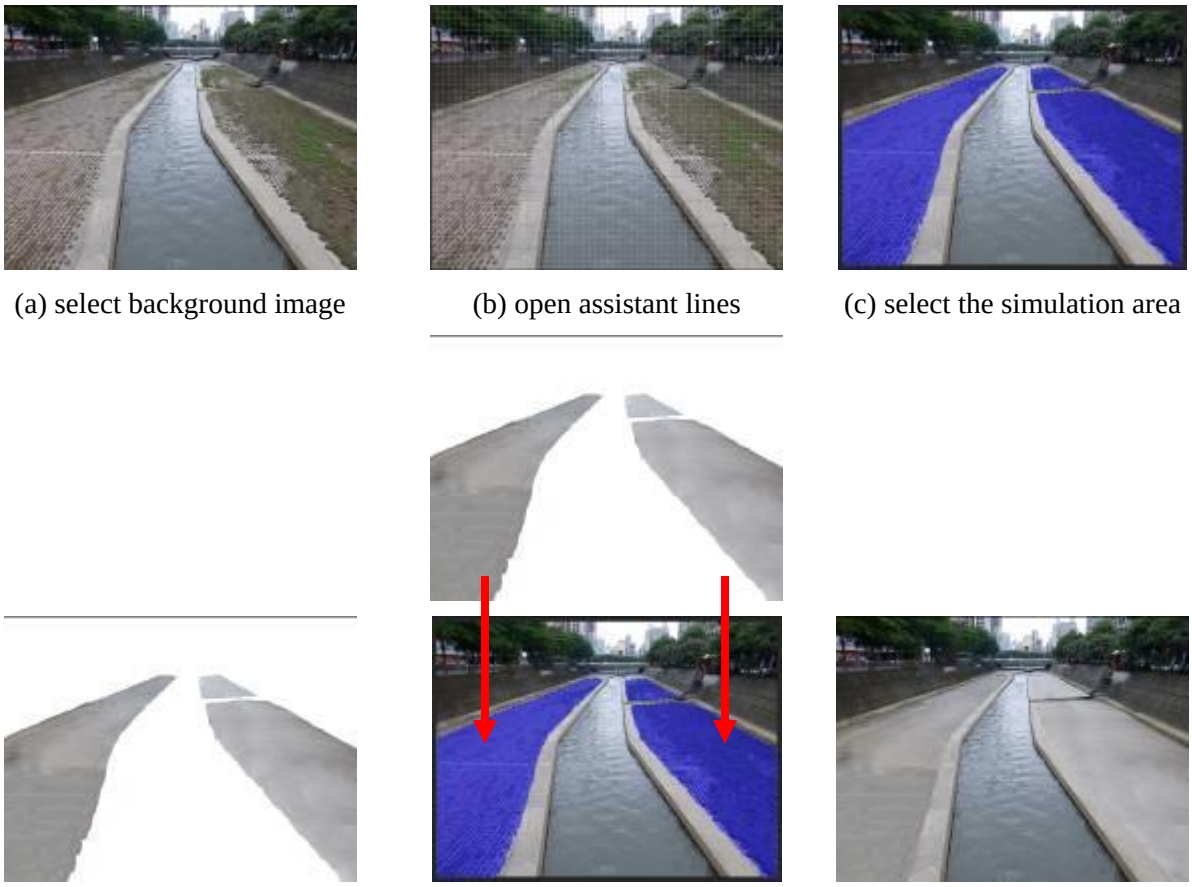
Figure 1. Maps showing the study area and observation sites

3. METHODS

3.1. Image processing

This study is concerned about the changes of in vegetation or materials on the riverbed. Many images were taken from field; however, these images can be affected by environmental factors such as light, weather, and season. In order to avoid image disturbances caused by the environment and focus on the changes in vegetation or materials on the riverbed, the background images were processed using

Adobe Photoshop. Figure 2 shows the image simulation procedure for changes in the riverbed. First, we selected the background image and chose the area of interest on the riverbed (e.g., the bed with planting grass bricks in Figures 2(a)–(c)). Second, the area of interest on riverbed was replaced with the material (e.g., the smooth concrete bed in Figure 2(e)) that we want to discuss. Finally, the image with a smooth concrete bed can be completed (Figure 2(f)).



(a) select background image (b) open assistant lines (c) select the simulation area

(d) choose an interesting material (e) replace the interesting material (f) complete image

Figure 2. Procedures for image simulation: a case for smooth concrete bed

3.2. Calculation of green looking ratio

The green looking ratio (GR) refers to the percentage of green or vegetation area in a visualized space (Ide, 1980). GR can generally be evaluated from an image. In this study, all images were adjusted to have same size of 50 × 37 cm (2560 × 1920 pixels) and these were divided by a grid element of 0.5 × 0.5 cm in order to calculate the green area occupied by the element. Here, GR is calculated by

$$GR = G / G_o \quad (1)$$

where G_o is the area of interest in the space from an image, and G is the visualized green area in the area of interest. For example, the area of interest G_o in this study is the riverbed, as shown by the blue area in Figure 3(a). The vegetation area on riverbed G in Figure 3(b) can be evaluated with the yellow area in Figure 3(c), and GR can be determined by Eq.(1).



(a) Riverbed area from image: G_o (b) Vegetation area on the riverbed from image: G (c) Green looking ratio: G/G_0

Figure 3. The calculation of the green looking ratio ($GR = G/G_o$, where G is the yellow area in (c) and G_o is the blue area in (a))

3.3. Questionnaire survey

A questionnaire survey was conducted to determine the public's visual preference for these images and the cognitive factors affecting visual preference. Six cognitive factors were selected: naturalness, vividness, harmony, closure, coherence, and mystery. A five-point Likert scale was used to evaluate respondents' visual perception of these images. Each image has five options with regard to preference or cognitive factors of the riverside landscape. These options are "very high," "high," "normal," "low," and "very low," which are rated by the scores 5, 4, 3, 2, and 1, respectively. For example, the image's score is 5 when the respondent's visual preference for an image is very high; the image's score is 1 when the respondent's preference for an image is very low. There were 250 respondents, 64% aged 18–25 years and 37% aged 26–50 years. Finally, the degrees of visual preference and the cognitive factors were determined through statistical analysis of image scores, and the relationship between the degrees of visual preference and GR are presented.

4. RESULTS

There are 10 images of river bed vegetation with various GRs for the MYT River, as shown in Figure 4; and 14 images of four sections of the Liou River, as shown in Figure 5. These images were used to conduct the survey and a total of 246 valid samples were collected. The mean value of the visual preference P and the mean value of the cognitive factors (naturalness N, vividness V, harmony H, closure CL, continuity CO, and mystery M) can be determined through statistical analysis of the scores of these samples.

Figure 6(a) shows the mean values of P for the two riverbed materials (smooth concrete and planting grass bricks) without vegetation on the bed (GR = 0). The mean values of P are generally between 2 and 3, the visual preference ranges from normal to low. The preference for smooth concrete beds is higher than that of planting grass bricks bed if there is no vegetation on the riverbed. Figure 6(b) shows the variations in P after vegetation growth on the planting grass bricks bed. The GR corresponds to the vegetation area on the bed. A larger vegetation area on bed will have a higher GR value. The mean value of P tends to increase with increasing GR, especially when GR > 40%. The six cognitive factors associated with GR are shown in Figure 7. Among the six cognitive factors, naturalness N, vividness V, and continuity CO tend to increase, while closure CL tends to decrease with increasing GR, when GR > 40%. The mystery M is unable to show its association with GR. The increasing river bed vegetation, with GR > 40% can be helpful in promoting naturalness and vividness, and the visual preference of the viewer. Figure 8 shows the relationship between the six cognitive factors and visual preference P. This result similar to the GR that corresponds to P. P increases with increasing N, V, H, and CO, or decreasing CL. M is independent of P.



Smooth concrete bed with GR = 0%: h-1 | Planting grass bricks bed with GR = 0% h-2 | Planting grass bricks bed with GR = 11 %: h-3 | Planting grass bricks bed with GR = 25% h-4 | Planting grass bricks bed with GR = 44 %: h-5 | Planting grass bricks bed with GR = 100%: h-6

(a) TK bridge section



Smooth concrete bed with GR = 0%: I-1 | Planting grass bricks bed with GR = 44%: I-2 | Planting grass bricks bed with GR = 88%: I-2 | Planting grass bricks bed with GR = 100%: I-4

(b) WQW road section

Figure 4. Images of river bed vegetation for various green looking ratios (GR) in MYT River



Planting grass bricks bed with GR = 0.04%: i-1 | Planting grass bricks bed with GR = 44%: i-2 | Planting grass bricks bed with GR = 88%: i-3 | Planting grass bricks bed with GR = 100%: i-4

(a) XS bridge section



Smooth concrete bed with GR = 0%: j-1 | Planting grass bricks bed with GR = 0%: j-2 | Planting grass bricks bed with GR = 4%: j-3 | Planting grass bricks bed with GR = 88%: j-4 | Planting grass bricks bed with GR = 100%:j-5

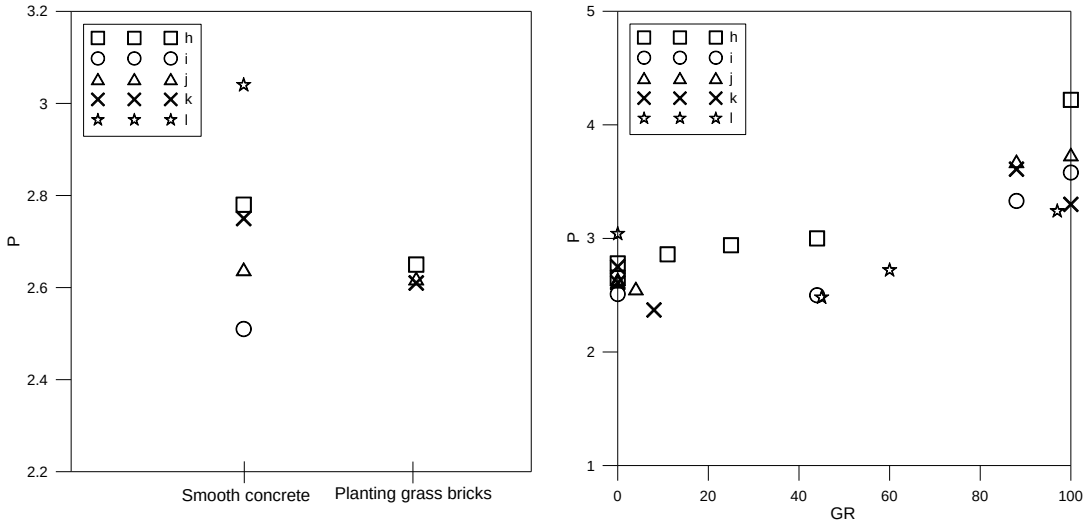
(b) MQ bridge section



Smooth concrete bed with GR = 0%: k-1 | Planting grass bricks bed with GR = 0%: k-2 | Planting grass bricks bed with GR = 8%: k-3 | Planting grass bricks bed with GR = 88%: k-4 | Planting grass bricks bed with GR = 100%: k-5

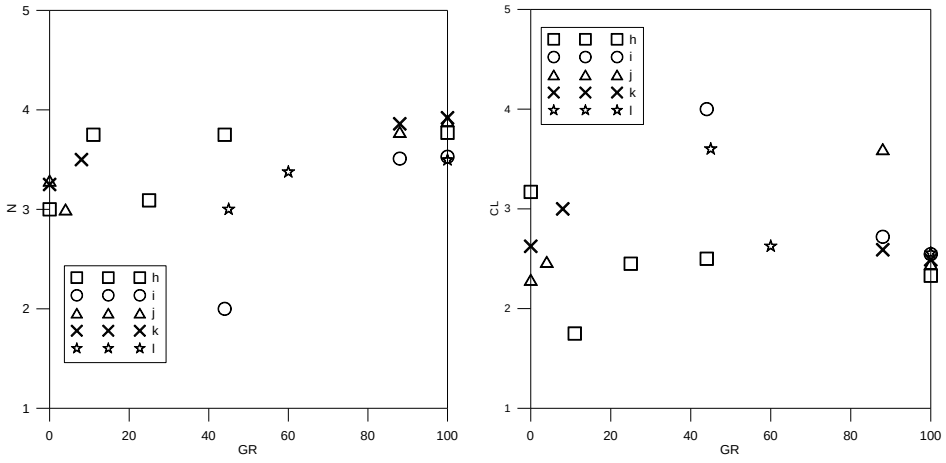
(c) MZ bridge section

Figure 5. Images of river bed vegetation for various green looking ratios (GR) in Liou River

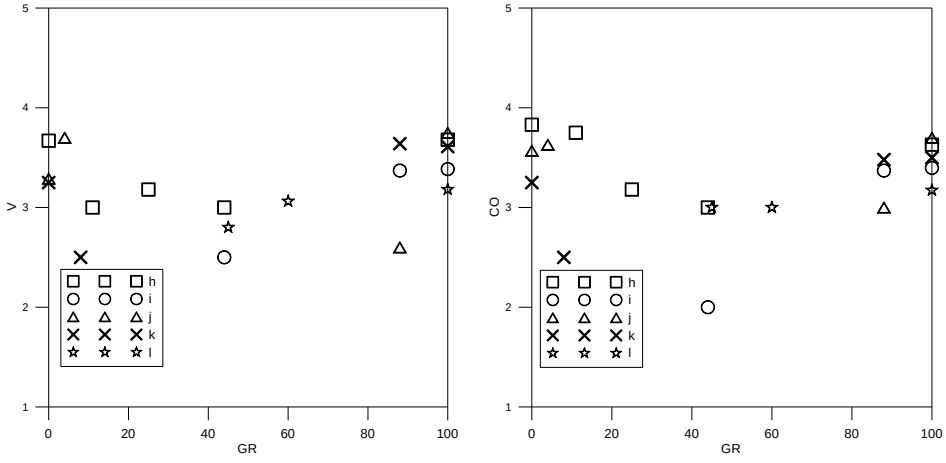


(a) Riverbed material (GR = 0) (b) Changes in green looking ratio (GR)

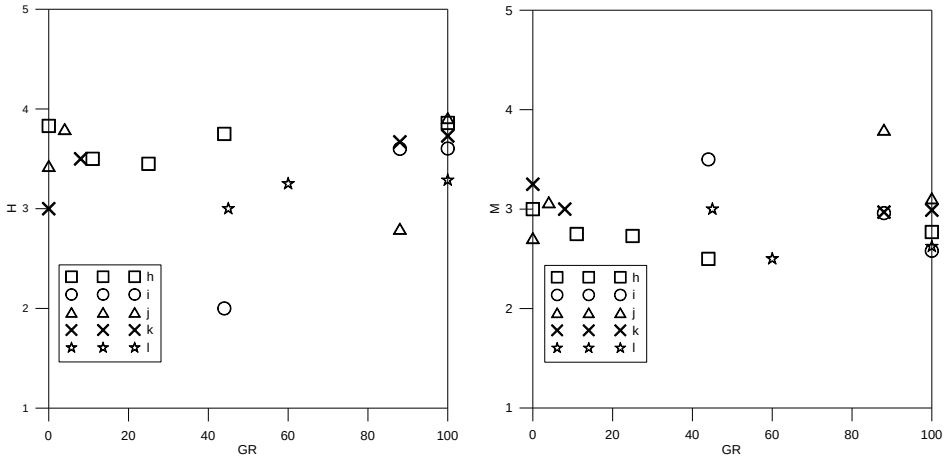
Figure 6. Relationship between the visual preference P and green looking ratio (GR) for riverbed vegetation.



(a) N versus GR (b) CL versus GR

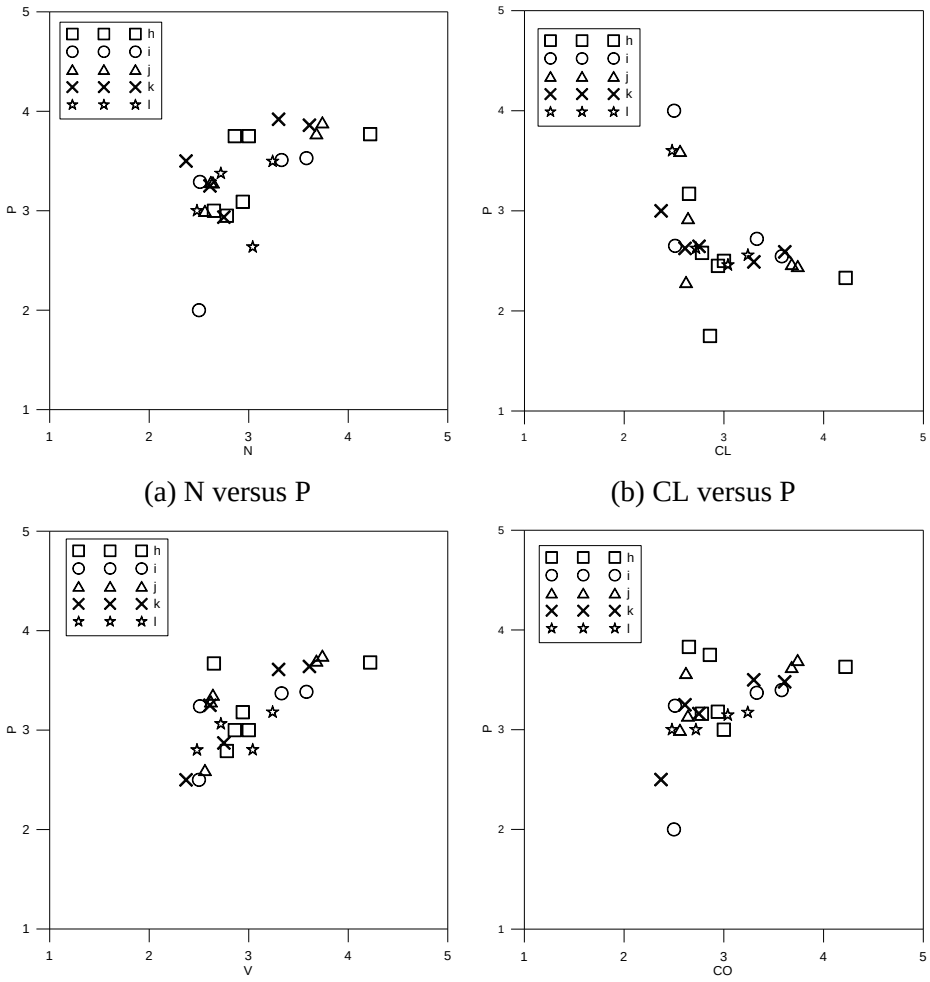


(c) V versus GR (d) CO versus GR



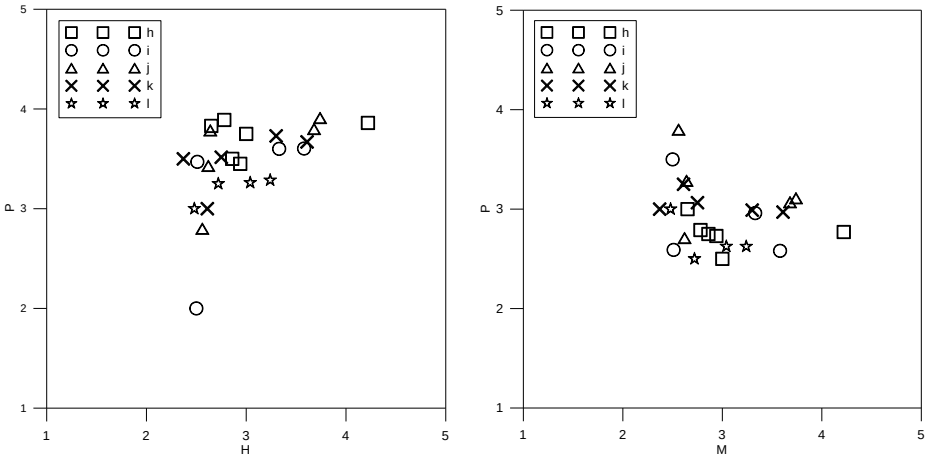
(e) H versus GR (f) M versus GR

Figure 7. Six cognitive factors: naturalness N, vividness V, harmony H, closure CL, continuity CO, and mystery M, associated with green looking ratio (GR) for various vegetation changes on the riverbed.



(a) N versus P (b) CL versus P

(c) V versus P (d) CO versus P



(e) H versus P (f) M versus P

Figure 8. Six cognitive factors: naturalness N, vividness V, harmony H, closure CL, continuity CO, and mystery M, associated with the visual preference P for vegetation variations on riverbed.

5. CONCLUSIONS

This paper studied the visual preference for changes in vegetation on the riverbeds of a artificialized river in Taichung city, central Taiwan. The GR was used to evaluate the vegetation area on the riverbed. The results showed that the visual preference P increases with increasing GR, when GR > 40%. The addition or creation of the green area on the riverbed (with GR > 40%) can help promote naturalness N, vividness V, and continuity CO as well as reduce the closure CL of the river landscape. Increasing N, V, or CO, or decreasing CL can help increase visual preference. The results of this study can be used as reference for river engineering and river landscape design.

REFERENCES

1. Bell, P. A., (1996). Environmental psychology (4th ed.). Harcourt Brace College Publishers: Fort Worth.
2. Chen, J.-C., Ho L.-C., (2013) Changes in the streambank landscape and vegetation recovery on a stone revetment using the image spectrum: Case study of the Nan-Shi-Ken stream, Taiwan, Ecological Engineering,61, p 482 – 485.
3. Chen, J.C., & Jiang, J.G. (2015).Visual Preference Assessments on Stream Engineering in the Yu-Kua-Lin Stream, Journal of Art and Design of Huafan University,10, p31~46. (in Chinese)
4. Ide, H., (1980). Conservation of Greenland Ecology, Tokyo University Press Conference. (in Japanese)
5. Kenwick, R. A., Shammin, M. R., Sullivan, W. C. (2009). Preferences for riparian buffers, Landscape and Urban Planning, 91, p88~96.
6. Lee, M. S. (1979) Assessing Visual Preference for Louisiana River Landscape, General Technical Report (GTR).
7. Shandas, V., (2007). An Empirical Study of Streamside Landowners' Interest in Riparian Conservation, Journal of the American Planning Association, Spring, 73(2), p173~184.
8. Zhao, J., Wang, R., Luo, P., Xing, L., & Sun, T. (2017). Visual Ecology: Exploring the Relationships between Ecological Quality and Aesthetic Preference, Landscape Ecol Eng, 13, p107~118