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The Effectiveness of Green Infrastructure Concept Design at City Parks, Bandung City, Indonesia

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ABSTRACT

In the past, the role of green infrastructure concept design has been almost ignored by civil engineers. The main purpose of the study is to examine the features at several public city parks in study area in order to support green infrastructure concept design. These studies also assessed public perspectives through satisfaction survey regarding the existing green infrastructure features and collect their opinion about how to improve the design in the study area. Green infrastructure investments in study area boost the economy, enhance community health and safety, and provide recreation, and other benefits that can increase public satisfaction level.

KEY WORDS: Aesthetic value; City parks; Public perspectives; green infrastructure; landscape attributes

INTRODUCTION

Unplanned land cover changes due to population explosion become more increased especially in developing countries. Green infrastructure concept design is an offered approach concerning sustainable land and water resources management. This concept design covered the benefits and values of natural environmental in certain area such as in aesthetic, economic, community and ecosystem. Even not entirely implemented, the green infrastructure concept design has been applied in some open areas in Bandung City, West Java Province, Indonesia. Some restoration projects for city parks have been accomplished to achieve some important ecological, environmental and aesthetics values. The main purpose of the study is to examine the features at several public city parks in study area in order to support green infrastructure concept design. This study also assessed public perspectives through satisfaction survey regarding the existing green infrastructure features and collects their opinion about how to improve the design in the study area.

PRINCIPLES OF GREEN INFRASTRUCTURE

Natural environments are living and dynamic system. Therefore, it is necessary to preserve and improve the existing condition. Green infrastructure concept design is an approach to maintain, restores, or mimics the natural environment by design. Green infrastructure also incorporates both the natural environment and engineered systems to provide water, conserve ecosystem values and functions, and provide some of benefits to public and wildlife. It highlights the importance of the natural environment in decisions about land-use planning. In the beginning, this idea came up with concepts of urban farming and garden allotments, but now it already extend in the applications. Many case studies related green infrastructure projects are applied worldwide with some extensions and modifications.

MATERIALS AND METHODS

Targeted Study Area

The study was conducted in four city parks at Bandung City, Indonesia. Bandung City is counted as the capital of West Java province in Indonesia (Fig. 1). It became Indonesia's third largest city by population, with over 2.4 million persons from 30 districts. Geographically, Bandung City has an area of about 16.729,65 ha. In 2014, the average temperature ranged between 22.5 °C and 23.7 °C. The average annual rainfall precipitation in 2014 is 198.8 mm. Meanwhile, Bandung City is reported to have around 600 parks, with the city government targeting the adoption of thematic concept in 30 parks. The major purpose of the city parks in Bandung City is recreation intended for improving ecological environment with harmoniously formed landscapes and waterscapes of natural features. We selected four city parks in study area: Lansia Park, Maluku Park, Pet Park, and Balai Kota Park, to examine the features at several public city parks in order to support green infrastructure concept design. This study also assessed public perspectives through satisfaction survey regarding the existing green infrastructure features and collects their opinion about how to improve the design in the study area.

Surveys and Sampling Method

A simple and short presentation was prepared to introduce the purpose of this questionnaire. In the questionnaire, the respondents were asked to rank their satisfactions about the features at city parks related with green infrastructure concept design. Perspectives and selected connotative perceptual constructs were rated on a 5-point modified likert scale. Surveys were taken on-site in four city parks directly and off-site in randomly area in Bandung City (Fig. 2). Respondents were asked to rate each statement combined with figure by marking one of five boxes that most closely matched their perspectives. The responses were later coded on a five point numerical scale for analysis where 1= Dissatisfied, 2= Somehow dissatisfied, 3= Neither satisfied nor

dissatisfied, 4= Somehow satisfied, and 5= Satisfied. Then, the respondents were asked to respond to written items based on their suggestions if they have any.

RESULTS AND DISCUSSIONS

Many environmental assessment and evaluation projects use the perspective of people (Daniel 2001; Yao et al. 2012). Most studies used the opinions from visitors as respondents to get more in-depth information (von Essen et al. 2013; Meitner 2004; D'Antonio et al. 2013; Pettebone et al. 2011; Iojă et al. 2011; Yamashita 2002). The current study used public perspectives through satisfaction survey both visitors and non-visitors as common people who knew the targeted parks. The respondents above 10 years and below 65 of age were selected. The quick sampling has been completed with statistical analysis that can be seen at Table 1 and Table 2.

Table 1 Respondent's characteristics of targeted study area

City Parks	Respondents			
	Visitors	%	Non-visitors	Total
Lansia	35	28	50	78
Maluku	27	23		73
Pet	26	22		72
Balai Kota	32	27		77
Total	120	100	50	-

Table 2 Descriptive Analysis (N=163)

Parameters	Bioretention	Strips	Pavement	Canopy	Others
Mean	4.13	4.61	4.63	4.69	4.47
Median	4.00	5.00	5.00	5.00	5.00
Std. Deviation	0.946	0.593	0.557	0.550	0.811
Variance	0.895	0.351	0.310	0.303	0.658

The data obtained from the questionnaires was processed using the SPSS 17.0 program for statistical analysis. Specifically, Multivariate Analysis of Variance (MANOVA) was used, and this was a way to test hypotheses in which one or more independent variables, or factors, were proposed to have an effect on a set of two or more dependent variables (Mathew 1989). It can be seen as a form of ANOVA with several dependent variables. While ANOVA tests for the difference in means between two or more groups, MANOVA tests for the difference in two or more vectors of means (Abbas Alkarkhi et al. 2008). MANOVA was used in this work to test whether different types of respondents and locations of city parks affect the perceptions of the respondents with regard of a measure of aesthetic value based on various perceived green infrastructure attributes (bioretention, buffer strips, permeable pavements, canopy trees and others). In SPSS, there are four multivariate measures: Wilks' lambda, Pillai's trace, Hotelling's trace and Roy's largest root. The difference between the four measures is the way in which they combine the dependent variables in order to examine the amount of variance in the data. The results of the multivariate analysis cannot be shown in this paper due to the limitation. However, in Wilks' lambda criteria, the intercept showed Wilks' $\lambda = 0.003$, $F(5, 155) = 9008.768$, $p < 0.001$, and the parks showed Wilks' $\lambda = 0.444$, $F(21, 1316) = 57$, $p < 0.001$.

We used Pearson correlation analysis to explore the relationships among the perceived waterscape attributes. According to the results of the correlation analysis, there was a statistically significant correlation between all of the perceived green infrastructure features (Table 2). Bioretention was more significantly correlated with pavement ($r = 0.296$) compared to the other features. There was also a strong relationship between Pavement and other features, which showed strong relationship ($r = 0.230$), while canopy and other features showed the weakest relationship ($r = 0.015$).

Table 3 Results of Pearson Correlations

		A	B	C	D	E
A	Pearson Correlation	1	0.084	0.296**	0.046	0.222**
	Sig. (2-tailed)		0.286	0	0.559	0.004
	N	163	163	163	163	163
B	Pearson Correlation	0.084	1	0.095	0.037	0.119
	Sig. (2-tailed)	0.286		0.230	0.635	0.132
	N	163	163	163	163	163
C	Pearson Correlation	0.296**	0.095	1	0.079	0.230**
	Sig. (2-tailed)	0	0.230		0.317	0.003
	N	163	163	163	163	163
D	Pearson Correlation	0.046	0.037	0.079	1	0.015
	Sig. (2-tailed)	0.559	0.635	0.317		0.848
	N	163	163	163	163	163
E	Pearson Correlation	0.222**	0.119	0.230**	0.015	1
	Sig. (2-tailed)	0.004	0.132	0.003	0.848	
	N	163	163	163	163	163

**. Correlation is significant at the 0.01 level (2-tailed).
A = Bioretention; B = Strips; C = Pavements; D = Canopy; E = Others

The results indicated that most visitors satisfied with the available green infrastructure features in targeted city parks (Table 3). Canopy is the most preferable of green infrastructure features according to public perspectives. Meanwhile, bioretention is the least preferable among green infrastructure features. Some comments from respondents mentioned that they agreed and supported green infrastructure concept design to be applied in public city parks. Most of them also stated it is necessary to improve aesthetic value by applying those features in study area.

CONCLUSIONS

The outcomes showed that the public city parks are one of the most effective application areas for green infrastructure concept design. Green infrastructure investments in study area boost the economy, enhance community health and safety, and provide recreation, wildlife, and other benefits that can increase public satisfaction level. This study can guide local planners and decision makers from the other cities to create and develop their public city parks based on green infrastructures concept design. As with other forms of infrastructure, green

infrastructure requires sustainable management and maintenance arrangements to be in place if it is to provide benefits and services in the long term. Arrangements for managing green infrastructure, and for funding its management over the long-term, should be identified as early as possible when planning green infrastructure and factored into the way that it is designed and implemented.

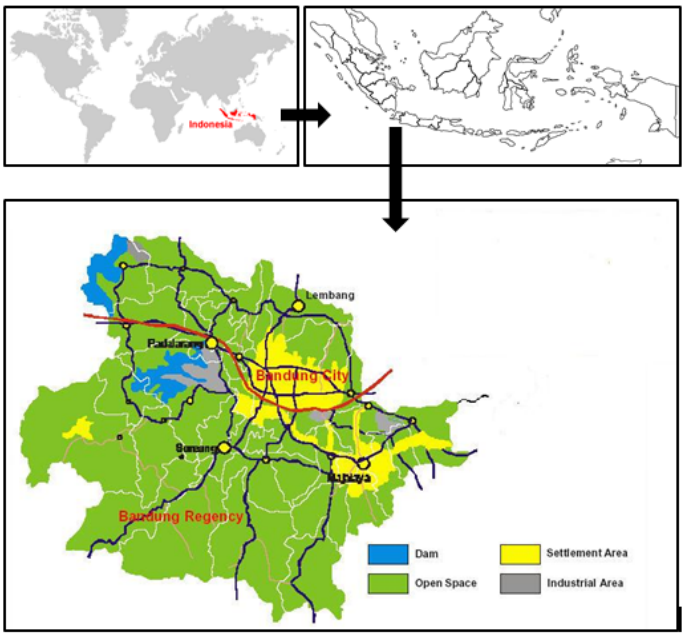

Fig. 1 Location of Bandung City

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REFERENCES

Abbas Alkarkhi FM, Ismail N, Easa AM (2008) Assessment of arsenic and heavy metal contents in cockles (Anadara granosa) using multivariate statistical techniques. J Hazard Mater 150 (3):783-789.

D'Antonio A, Monz C, Newman P, Lawson S, Taff D (2013) Enhancing the utility of visitor impact assessment in parks and protected areas: A combined social-ecological approach. J Environ Manage 124:72-81

Daniel T.C. (2001) Whither scenic beauty? Visual landscape quality assessment in the 21st century. Landscape and Urban Planning 54 (1-4):267-281

Iojă C.I., Rozylowicz L., Pătroescu M., Niță M.R., Vânau G.O. (2011) Dog walkers' vs. other park visitors' perceptions: The importance of planning sustainable urban parks in Bucharest, Romania. Landscape and Urban Planning 103 (1):74-82.

Mathew T. (1989) MANOVA in the multivariate components of variance model. Journal of Multivariate Analysis 29 (1):30-38.

Meitner MJ (2004) Scenic beauty of river views in the Grand Canyon: relating perceptual judgments to locations. Landscape and Urban Planning 68 (1):3-13.

Pettebone D, Newman P, Lawson SR, Hunt L, Monz C, Zwiefka J (2011) Estimating visitors' travel mode choices along the Bear Lake Road in Rocky Mountain National Park. Journal of Transport Geography 19 (6):1210-1221.

von Essen L.M., Ferse S.C.A., Glaser M., Kunzmann A. (2013) Attitudes and perceptions of villagers toward community-based mariculture in Minahasa, North Sulawesi, Indonesia. Ocean & Coastal Management 73:101-112

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.

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. Environ Monit Assess 184 (2):951-967.