IDENTIFYING VISITOR PREFERENCES FOR LOCATIONS AND FEATURES IN BOGOR BOTANICAL GARDEN, INDONESIA, USING GPS TRACKING AND GEOTAGGED PHOTOS

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ABSTRACT

Research on visitors' landscape preferences in a botanical garden is useful for understanding what visitors see while they visit the site. Analyzing visitors' preference by using GPS tracking data and Visitors'-Employed Photography (VEP) is one of approach that successfully implemented in some studies. GPS loggers and visitors' photos were used in this study to identify and locate features considered impressive by visitors. This research involved 35 normal visitors of Bogor Botanical Garden (BBG) as respondents, who were asked to capture impressive landscape features while visiting the BBG. Each respondent used their own smartphone or camera to take photographs and recorded their actual positions using a GPS logger. The data of GPS tracking and geo-tagged photos were exported into ArcGIS. The 20 by 20 meters square cell were joined with points' data to calculate density of tracking points and photos points. A cell was categorized as hotspots if the number of points more than 2.5 times of standard deviation. The results show that respondents were concentrated on several geographic locations within the BBG; the most-photographed features were water, structures, and plants. Interestingly, the most-photographed plants were those arranged for recreational (rather than botanical or educational) purposes, suggesting new considerations for managers of botanical gardens.
Keywords: *landscape, botanical garden, GPS, photo*

INTRODUCTION

Botanical gardens, originally founded as botanical conservation sites, have nowadays become popular as tourist destinations. A common problem facing modern botanical gardens is that people's motivation for visiting them is shifting from education about conservation issues to a more complex tourism context (Ballantyne, Packer, and Hughes, 2008). In the case of Bogor Botanical Garden (BBG), Indonesia, visitors' motivations include not only the acquisition of botanical knowledge, but also the opportunity to escape from their daily activities, gather with relatives, and enjoy nature (Hermansyah and Waluya, 2012). A better understanding of visitors' perceptions and preferences regarding the BBG is essential to managing for the sustainability of recreation and tourism at the site.

The outdoor recreation is related with landscape quality and visitors' preferences. The aesthetic of landscape features such as objects and sceneries is important for BBG's manager because it is related with visitors' satisfaction during recreation in BBG. Therefore the study about landscape preference is important for evaluation, planning and management of BBG. There are some method to implement landscape preference research, such as by interview, questionnaire and on-site observation. However, sometimes there are differences between people's statement about preferred landscape they think and their response on the site after having on-site experience (Aminzadeh & Ghorashi, 2007).

In this research, we investigate respondents' preference based on their on-site experience to get better result about impressive features while exploring the BBG. To achieve this, we collected evidence of which features visitors found impressive and where they were observed using photographs and Global Positioning System (GPS) data taken by willing participants in the study. These photographs were used as evidence of respondents' sighting of impressive features and the GPS data as evidence of respondents' location when they took the pictures. This type of study, which is less common than botany- and natural-science-related studies, contributes to visitor-related studies on Indonesia's botanical gardens, which are mostly open to the public.

THEORY AND METHOD

Theory

Photo-based research

This research is related to the recognition of visitors as spectators and BBG's landscape elements as objects to see. Therefore, photo-based research can help ascertain visitors' perceptions of the BBG landscape based on their experiences (Jacobsen, 2007). A photo-based research approach highlights that site visitors actively select preferred views and record them in photos during a tourism activities (Markwell, 1997), which serve as evidence of their perception of places they visited. One of photo-based research method in landscape research is visitors'-employed photography method (VEP), that the researcher lent cameras to number of respondents and asked them to take photos of particular subjects, specific themes or

personal view of experience of landscape they visited (Garrod, 2008; Heyman, 2012). This research method was introduced for the first time by GJ Cherem in 1970's (Heyman, 2012). Hence, this study utilizes visitor-employed photography as a suitable method to analyze people's perceptions of Bogor Botanical Garden. In Indonesia, this method is rarely used in landscape perception research, although it has been proven as an effective method for analyzing visitor perceptions of heritage tourism sites (Ernawati and Moore 2014) and rural tourism sites (Cahyanto, *et al*. 2013). Studies on people's perceptions of particular landscapes or places in Indonesia are typically conducted using a questionnaire with selected photos attached to illustrate the investigated objects (Adiwibowo, *et al*. 2015). In the VEP method, visitors become the subject and might have a spontaneous response to important landscape features that they perceived (Jacobsen, 2007; MacKay and Couldwell 2004). This method also encourages respondents to provide more information compared with other types of data collection methods (Garrod, 2008).

GPS tracking-based research

The GPS is a tools to record and calculate spatial location data (Oliver, *et al*. 2013). Research on using GPS tools for visitor tracking in various case studies has increased since around 2005 (Shoval and Ahas, 2016). This approach has also been implemented in park and protected areas research (Beeco and Brown, 2013). Van der Spek, *et al*. (2009) see opportunities to use GPS for various research such as defining destinations, route and track types for urban planning, and design purposes. It is very useful to identify people's experiences in time and space (Pettersson and Zillinger, 2011); this is especially important for measuring carrying capacity in tourism management (Beeco and Brown, 2013).

The use of GIS technology is also important for analyzing data from GPS loggers in tracking visitors. GIS allows the visual display of data on a map, but also deeper analysis such as the density analysis of subjects' tracking points (Hallo, *et al*., 2012; Kienast, *et al*., 2012). Beeco, *et al*. (2014) suggested combining the use of GPS visitor tracking and maps in order to obtain actual recreational patterns in recreational management.

The integration of GPS visitor tracking and tourism photos creates a set of geographically referenced images that are very useful for identifying visitors' experiences and interests at destinations (Shoval and Ahas, 2016). This approach can assist managers in identifying areas for specific types of use (Beeco and Brown, 2013). The GPS and VEP methods have been successfully combined to investigate people's preferences within a visited landscape based on visitors' geotagged photos (Mizuuchi, *et al*, 2015; Sugimoto, 2011).

Data Analysis

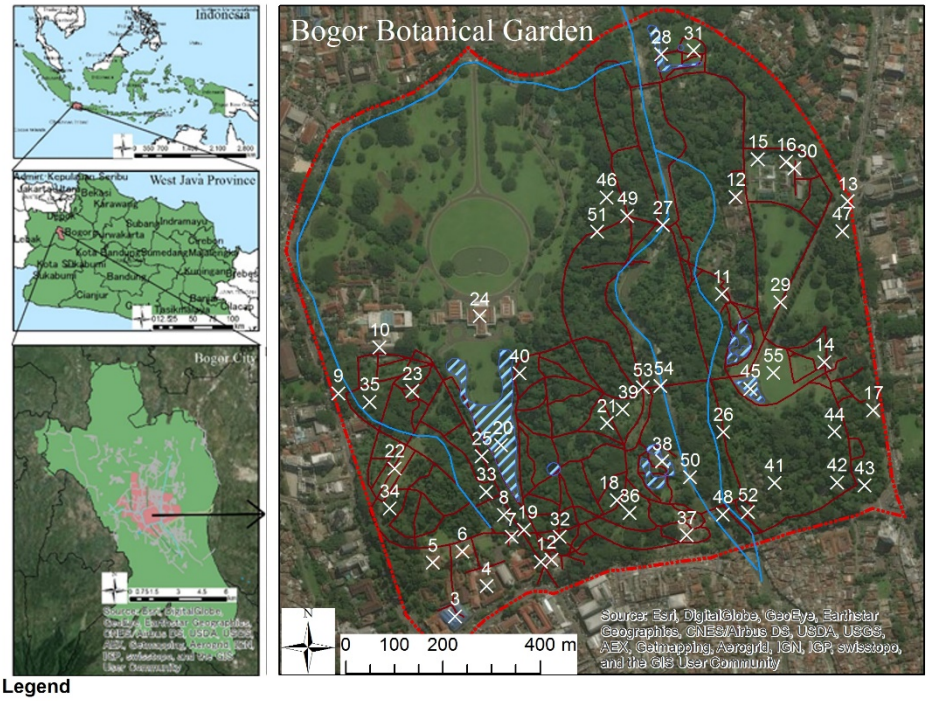
We used VEP combined with GPS tracking to obtain images and locations of impressive features at BBG based on respondents' behavior and to track walking routes and positions recorded by the GPS device every second. The GPS data were also used to track the amount of time respondents spent in particular places.

All data obtained were analyzed in ArcGIS software in order to identify the positions of respondents' photos-captured points and GPS tracking points. The

densest collections of photo points were classified as photo hotspots, revealing the most common observation locations in which visitors perceived impressive landscapes. The densest collections of GPS tracking points were called tracking hotspots, revealing the high number of respondents passing these places and longer stops in a particular places. The locations identified as both photo and tracking hotspots were assumed to be the best observation positions and the places where respondents stopped the longest to see and enjoy features. We assumed that, the more impressive or attractive features exist in a particular place, where the longer respondents stay to enjoy it.

Study Area

We conducted this research at BBG, located in Bogor City in the West Java Province of Indonesia (Figure 1) from April 19 to 25, 2016. The BBG has an area of



Legend

river
waterbody
Boundary
Trails

Existing Places names

01. Main Entrance Gate
02. Information Center
03. Zoology Museum
04. Conservation Building
05. Guest house Nusa Indah
06. Treub laboratory
07. Plants & Flowers Shop
08. Nursery
09. Gate II
10. Main Office
11. Mosque
12. Herbarium
13. Gate III
14. Restaurant
15. Orchid House
16. Tissue Culture Laboratory
17. Gate IV
18. JJ Smith monument
19. Lady rafless Monument
20. Srigunting pond
21. Bat Animal Habitat tree
22. Teijsmann garden
23. Dutch tomb
24. Palace
25. Canary Road I
26. Canary Road II
27. Red Bridge II
28. Surya Lembayung Bridge
29. Astrid Avenue
30. Orchid indoor Garden
31. Sudjana Kassan Garden
32. Koompasia excelsa Tree
33. Amorphophallus titanium
34. Rattan plants Collections
35. Bamboo Collections
36. Pandanus Plants Collections
37. Mexican Garden
38. Water Plants Collections
39. Palm Trees Collections
40. Fruit trees Collections
41. Climber Plants Collections
42. Ferns Collections
43. Forest corner
44. Cinnamon Trees Collection
45. Victoria amazonica Pond
46. Woody Plants Collections
47. Guest House
48. Red bridge I
49. Sacret Tomb
50. Ciliwung river
51. Bung Karno Monument
52. Gd Sembilan Mess
53. Palm Oil monument
54. White bridge
55. Lawn

Figure 1. Location of the study Area

87 hectares with various destinations and facilities. According to the BBG's website (http://www.krbogor.lipi.go.id/id/Jumlah-Koleksi-Kebun-Raya-Bogor.html, date of access: April 17th, 2017), the garden boasts flora from 218 families with 3,301 species and 13,061 specimens. These are grouped into five main collections: palm trees, medical plants, water plants, fruit plants, and climbing plants. Along with the plant collections, the BBG has thematic gardens that highlight specific types of plant collections, such as the Mexican Garden, Teijsman Garden, Medical Plants Garden, Water Garden, Soedjana Kassan Garden, and Araceae Garden. Other buildings and structures are destinations on their own, such as the Orchid House, Zoological Museum, Lady Raffles Monument, Reinwardt Monument, Teijsman Monument, Red Bridge, and Dutch Tomb. The Presidential Palace is not a part of the BBG, although its back side and yard can be seen near Srigunting Pond. This pond, as well as the Lotus Pond and the Ciliwung River, are themselves destination places within the BBG.

Respondents and Tools

The respondents for this study were 35 visitors to the BBG without formal landscape or forestry educational backgrounds. The respondents were recruited on-site without appointment before. We recruited people entering the main gate of the BBG by posting an announcement calling for respondents to a study on landscapes. Interested people were listed as visitor respondents and were required to meet the following criteria: carrying a camera or camera-equipped smartphone with a full battery, eagerness to share their photos with the researchers, and willingness to be interviewed via online chat if there were questions related to survey on the next days. In this case, the eligible respondents were selected from visitors of BBG who qualify the criteria. There were 35 respondents who were eligible according to criteria. They were composed of 22 females and 13 males with ages ranging from 10 to 38 years. One was a housewife, 28 were professionals in various fields, and 6 were high school students. The respondents' frequency of visiting the BBG ranged from 1 to 30 times. All visitors who agreed to participate were given an explanation on the research procedure before entering the BBG gate and starting the survey.

Each respondent used their own camera or phone to capture images of landscapes or other features, but was provided with a GPS logger to record actual geographic positions while inside the BBG. The GPS logger device used was the IgotU GT 120 unit with an error range of 10 to 20 m. These GPS loggers were hung on the respondents' bag or clothes and were not covered, in order to properly receive the GPS signal.

Procedure

The respondents were asked to "capture any impressive or attractive landscape features (surrounding views, sceneries or objects)". The number of photos allowed was unlimited, based on Sugimoto (2011, 2013), to obtain a natural response from respondents to the landscape they saw. No routes were predefined, so respondents were free to decide which part of the BBG they wanted to visit and what direction they wanted to travel.

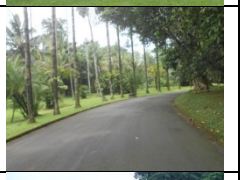
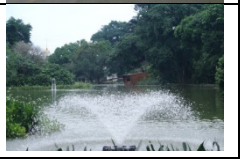
Analysis method and materials

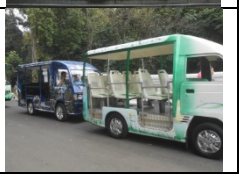
We checked all photos obtained from respondents, deleting duplicate photos or photos that captured the same features twice, along with any accidentally captured or blurred photos. The photos were matched with the time data from the GPS logger to match the position of each respondents and time of photos taken. We downloaded the GPS logger data and imported them into ArcGIS as point features and also checked the GPS tracking points for each respondent; all points located outside the BBG's boundaries were deleted.

The photos points and tracking points were analyzed in ArcGIS. We made a 20 by 20 m cell and counted the number of photos and tracking points in each cell. The geo-tagged photo points were joined with the cell and the number of photo points in each cell was counted. Any cell that did not contain tracking points was classified as not visited by respondents, and these were excluded from hotspot analysis. Cells with a number of points greater than or equal to 1 were analyzed. A cell was categorized as hotspots and important if standard deviation of points' number within cell more than 2.50 times of standard deviation.

Each Photos were analyzed its content by researchers. The photos' content were categorized according to character of landscape of photos, including: plants, opening lawn, corridor, water, buildings & structures and others. The categorization of landscape character of each photos were based on the main focused objects or dominant elements of the photos (Table 1).

Table 1. Criteria of Characteristics of each Photo

No.	Criteria	Photos' Focused Object	Example Photos*
1	Plants	Plants or part of a plant (i.e. leaves, flowers, trunks, etc).	
2	Opening lawn	Wide lawn or photo was captured in situation of lawn area	
3	Corridors	Space of road or trails with surrounding landscape on right or left sides.	
4	Water	Waterbody such as pond and river or water attractions such as fountain.	

5	Structures & Buildings	Man-made structures (i.e. bench, pond's banks, signage, sculptures, etc) or structures that can be entered and settled by people (buildings).	
6	Others	Landscape elements that were not included in criteria above, include: dropped leaves, animals, displayed specimens, well, vehicles, etc	

* Photo Source: Respondents' Photos

RESULTS & DISCUSSION

Tracking Points

There were 1,267 cells containing the tracking points of 35 respondents. Each cell consisted of 1 to 23,140 tracking points with average of 240.70 points. Because the route was not predetermined, areas with fewer tracking points could reflect either places where respondents were walking and not stopping, or unpopular places where fewer respondents passed at all. In the same way, areas with more tracking points could represent either areas where respondents stayed longer or where more respondents passed by.

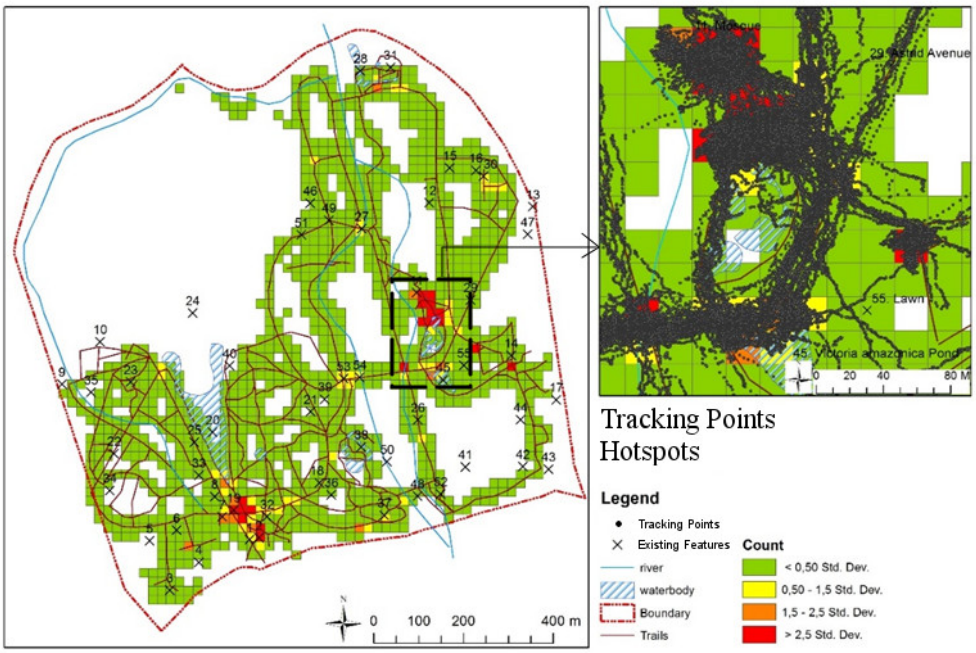


Figure 2. Hotspots defined by Tracking Points

The hotspots categorization of cells is shown in Figure 2. The cell became a tracking hotspot if points were more than 2.5 times of standard deviation for the overall distribution of tracking points. There were 19 hotspot cells and mean of tracking points of these cells were 5,024.42. Because 1 tracking point represents 1 second of a respondent's actual position, in hotspots cells, the respondents spent 5,024.42 seconds in these cells.

Such hotspot cells were found in two places: between the main gate and the Lady Raffles Monument and in an area near the Lawn, Lotus Pond, and Mosque. The first area was passed by all respondents, while the second was passed by 88.89% of respondents. The first area is likely a hotspot because it is close to the main gate, the start of any walking route, and the second area is a popular place to rest where most respondents spent some period of time under trees.

Photo Points

1,710 geo-tagged photos were captured by respondents. The mean number of photos captured in each cell was 1.35, ranging from 0 to 30. The photo hotspots is shown in Figure 3.

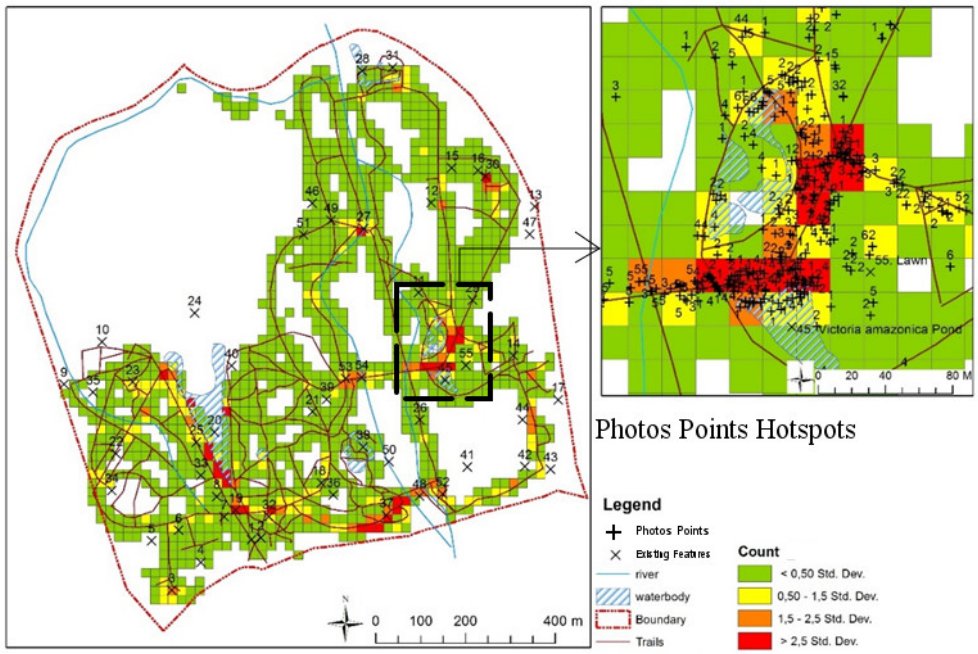


Figure 3. Hotspots defined by Photo Points

Eight locations were identified as photo hotspots: the north and south sides of Srigunting Pond, the Lady Raffles Monument, the Mexican garden, the Cinnamon Trees Collection, the Lawn & Lotus Pond Area, Red Bridge 2, and the Orchid Interior Garden. In photos hotspots cell, the mean of photos captured in each cell was 17.03 photos per cell.

Table 2. Number of Photos points in each Hotspots Cell

No	Cell Hotspots	Plants	Opening lawn	Corridor	Water	buildings & structures	others	total
1	> 2.5 std dev	195	45	38	96	109	10	493
2	1.5-2.5 std dev	142	15	32	19	71	13	292
3	0.5-1.5 std dev	249	55	56	38	100	37	535
4	< 0.5 std dev	199	31	44	36	69	11	390
	total	785	146	170	189	349	71	1710
	percentage	45.91%	8.54%	9.94%	11.05%	20.41%	4.15%	100.00%

Each photo was categorized into 6 groups: plants, opening lawn, corridor, water, buildings, and others. The contents of photos in each category is shown in Table 2. From total 1710 photos, there were 45.91% photos consist of plants as focused objects. As a botanical garden, it is common result that the "plants" captured in hotspots are interesting because respondents took more photos of plants than in other cell or places. There were 3 places hotspots, including Astrid Avenue, Mexican Garden and Orchid Interior Garden (Figure 4). The plants that mostly captured on those places are: 1) Orchid flowers in Orchid Interior garden, 2) Canna flowers as median of Astrid Avenue, and 3) Cactus, Agave, Yucca, Bromelia, Euphorbia and drought resistant plants in Mexican garden and. These plants were

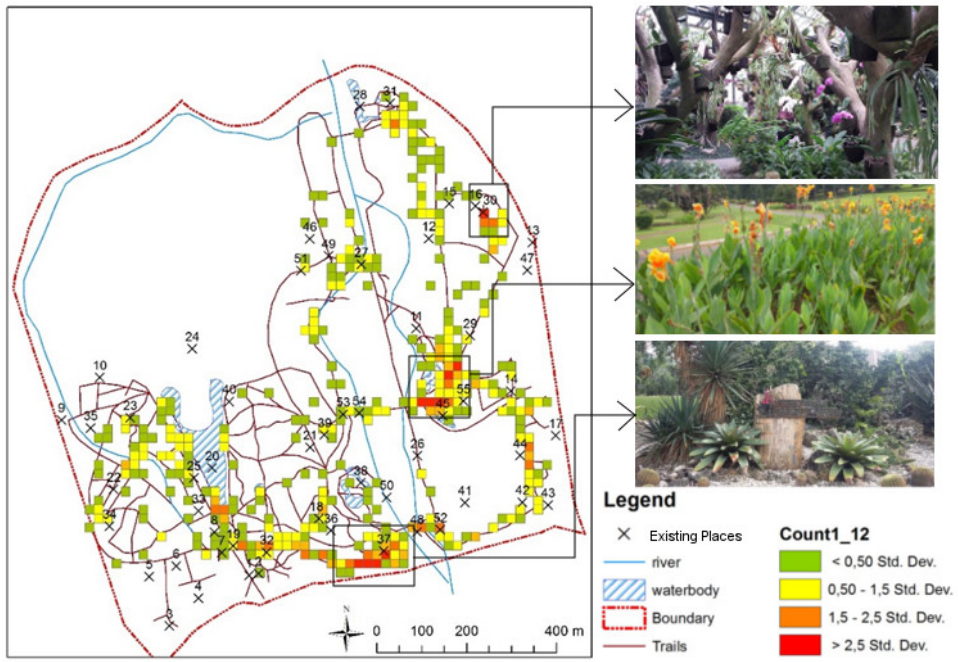


Figure 4. Hotspots of Plants as Photos' Focused Objects defined by Photos Points
Photos source: Respondents' Photos

arranged well with other materials and landscape elements in a good design.

The most-photographed plants, whether in significant hotspots or not, were plants arranged in attractive garden designs and composed well with other landscape elements such as gravel, structures, ponds, etc (Figure 4). On the other hand, plants displayed in an ordinary manner such as plants with labeled names were less photographed. This means that plant collections displayed in an ordinary style were not impressive for respondents and so were less-photographed. Therefore, displaying plants in attractive designs is effective for attracting respondents' attention. This result supports Villagra-Islas (2011) that in botanical garden today, it is important to consider the design of plant displays in order to increase people's awareness of the environment.

Buildings and structures were also frequently captured by respondents. (20.41% of total photos), include: Lady Raffles Monument, Presidential palace, sculptures of Mexican Garden's name, frame structures on promenade of Srigunting pond, red bridge 1, red bridge 2 and restaurant building in lawn area. Of the most-photographed buildings and structures, most have a colonial heritage value, including the Lady Raffles Monument, Presidential Palace, Red Bridge 1, and Red Bridge 2, which were established in the colonial era and preserved until today. This shows that the historical aspect of buildings makes them more impressive objects for respondents.

The "water" is the third numbers of focused objects that captured by respondents (11.05% of total photos). Photos of "water" mostly captured surround Srigunting Pond and Lotus Pond. In these locations, objects including ponds and fountains were the most impressive features for respondents. This result is similar to (Sugimoto, 2011) who conducted preference research with VEP and GPS tracking and observed that a pond in a park is an impressive element that attracts people, who take photos of the water and nearby elements. Water is an important aesthetic element for landscape attraction and supports recreation activities (Burmil, *et al*. 1999).

Trend of Photo Points and Tracking Points

To identify the trend of photo points and tracking points, we defined Photo points and Tracking points Number (PTN_i) as follows:

$$PTN_i = \frac{n_{ph_i}}{\sigma_{ph}} \times \frac{n_{tr_i}}{\sigma_{tr}}$$

where n_{phi} is number of photos and n_{trj} is number of tracking points of cell i. σ_{ph} is the standard deviation of photos points (3.13) and σ_{tr} is the standard deviation of tracking points (921.79).

The higher PTN shows the cells that respondents took photos more and stop more. The result shows locations of high PTN cell were spread along Srigunting pond promenade, Lady Raffless monument to Koompasia tree, Mexican garden to Red Bridge I, White Bridge, Lotus Pond to Astrid Avenue, Red Bridge II, Sudjana Kassan Garden and Orchid Interior Garden (Figure 5).

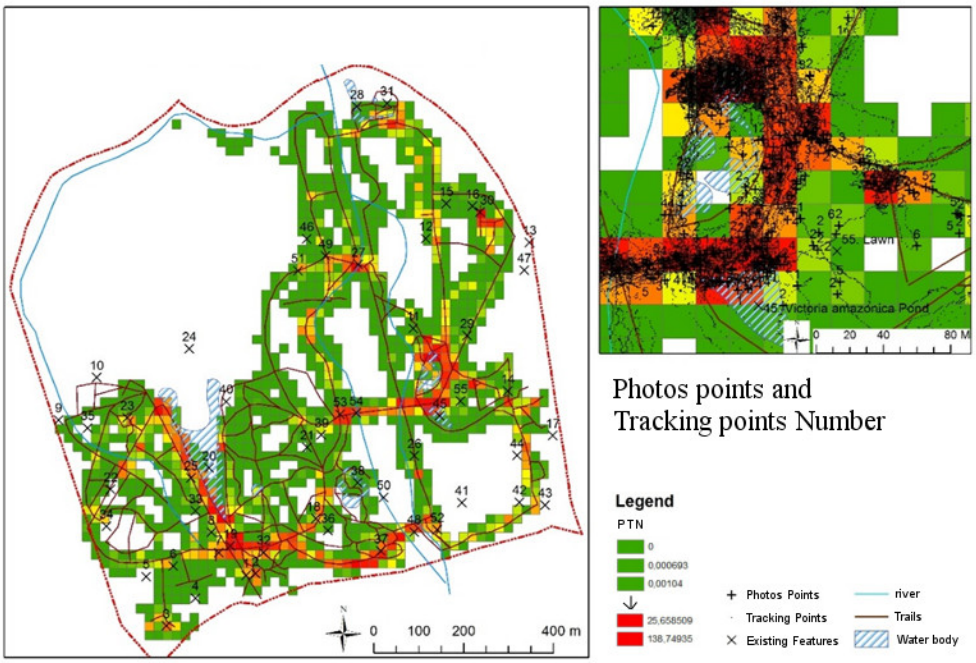


Figure 5. Photo Points and Tracking Points Numbers of Cell

CONCLUSION

In this research, respondents who were normal visitors and without educational background in landscape architecture were succeeded to do self-identification of impressive landscape objects in Bogor Botanical Garden (BBG). During on-site observation, respondents tended to seek out places with impressive objects that encouraged them to enjoy the scenery of outdoor environment. It overcome trend of photo points number and GPS tracking number in each cell where respondents passed by. Based on resulting Photo points' number and GPS Tracking number (PTN_i), we found that in BBG, respondents preferred to visit recreational places than botanical-displayed places. The important places that performed by PTN_i were places that should be considered by landscape manager of BBG to provide appropriate accommodation for recreation and to conserve the existence of impressive landscape elements.

The use of GPS tracking and VEP in this research was successful in detecting respondents' movements, popular visiting places and impressive landscape elements and the results were represented on hotspots maps. The information from the GPS tracking maps and VEP maps can be used by BBG as reference for landscape maintenance of botanical garden. Those maps also can be used as data for creating landscape planning of BBG in displaying attraction, developing facilities and preserving good view for visitors. According to those benefits, the method of identifying visitors' preferences and behavior through GPS tracking and VEP is recommended to be implemented in other botanical garden in Indonesia.

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