How does the quality of the physical environment vary as one move away from the centre of Ginza?

Word count: 2412
Date of submission: October 2018

Fieldwork and Geographic Context

Fieldwork Question: How does the quality of the physical environment vary as one move away from the centre of Ginza?

Hypotheses

Temperature: As the distance from central Ginza to Hibiya Park decreases, the temperature will decrease.
Albedo: The higher the albedo, the less difference between temperature at ground level and eye level.
Green space: As the distance from central Ginza increases, the area allocated for green space will increase.

Geographical Context

Ginza is a central business district located in Tokyo near the Imperial Palace. It has been prosperous since Meiji government's civilization project and currently stands as an iconic commercial zone. As of 2018, it has the highest land value in Tokyo[1], and is famous for having a variety of high-class shops and department stores. From its character, it has long been a tourist attraction not only from overseas but also from other regions in Japan. Because of its context of being planned as a commercial zone, limited considerations have been made toward sufficient green environments, compared to Marunouchi area which has been under redevelopment from 1998 to 2007. [2]

Given that Ginza has the highest land value in Tokyo, [3]the priority of land allocation is substantially for commerce, not scenery. As a consequence of urbanisation, urban heat island effect is more apparent. For this reason, Ginza area suitable for this investigation to collect a variety of data regarding albedo, air temperature, and green space allocation in the main area of a city, which bridges to a geographic inquiry of urban stress.

Site E in this investigation takes place at Hibiya Park.

The data for this investigation was collected on Thursday, 26th April 2018 from site A to site E, each with 200m interval in between 13:00 to 15:00.

[1] Tokyo Ginza Official, 2017
[2] Mitsubishi Estate, 2018

Methods of investigation

Temperature measurement

Temperature of two different heights are measured using a digital thermometer. This is because it was estimated that the surface will absorb heat and will show different results according to the surface type. For both heights, the thermometer was for 1 minute to record the average temperature. At each location, 3 trials were recorded for each height.

Temperature difference would additionally be found by subtracting higher value from lower value. This would be used to answer the relationship between albedo and energy absorbed in ground.

Albedo measurement

Raw data for albedo levels were measured using a lux meter (Dr.Meter:LX1010B). Ambient light source was measured by placing the meter on the ground, (Figure 1) sensor facing upwards towards the sky for about 5 seconds and recorded the stabilised value. The reflectivity value of a surface was recorded by pointing the sensor towards the sample, with a controlled distance of 15cm above ground using a ruler. At each location, 5 trials were conducted in 3-minute interval.

Albedo is to be calculated by the following formula: $\frac{Reflectivity\ of\ a\ surface}{Ambient\ light\ source}$

While site E is a single location, since it is a park it has variety of surfaces. In this investigation, it will narrow it down to 1. natural surface (with fallen leaves and soil), 2. artificial surface (concrete).

Figure 1

A sample image of using lux meter towards the sky.

Green space measurement

Both qualitative and quantitative data could be gained from series of photographs taken at each location. To obtain the quantitative data, photograph will be loaded to analysis software 'ImageJ'. By specifying a specific hue, saturation, and brightness range, the software is able to extract an area with certain colours. This would support in finding out the relative area allocation for green spaces for different locations.

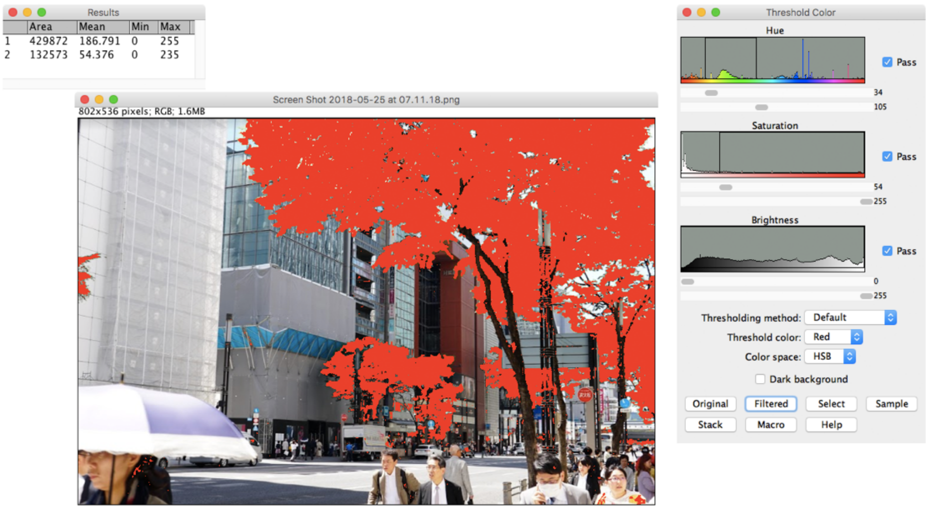


Figure 2: the measuring procedure using ImageJ.

The second method that is used to determine greenspaces through the satellite view of 'Bing maps'. First, we would adjust the scale of a map in image J, and then creating a circle of 25m radius from each site(A-E). After areas with trees being measured by 'select' function, the proportion would be calculated by dividing it with the area of 25m radius.

Area of trees were specifically chosen, as trees have the most impacts in environment, as not only it can absorb carbon dioxide gas but also decease the surrounding temperature, while smaller plants such as flowers do not contribute much to the outcome. Additionally, trees can provide shade for people, in which makes it ‘feel’ cooler for people, making it more comfortable during the hot days, thus yielding a better quality of physical environment.

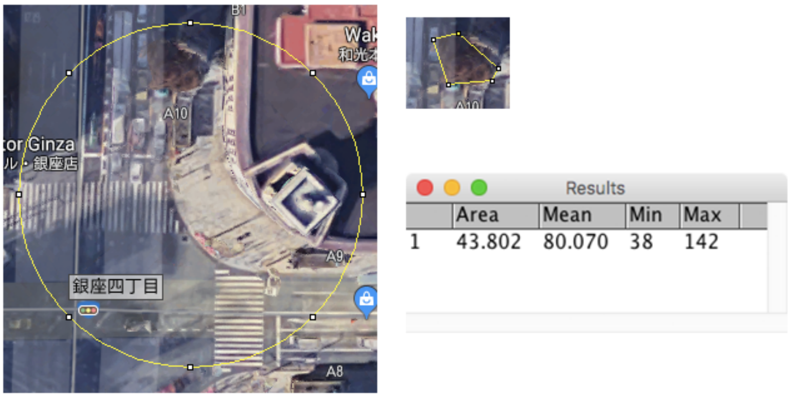


Figure 3. Measuring a tree within 25m radius of site A.

Analysis

Surrounding Temperature

Figure 4

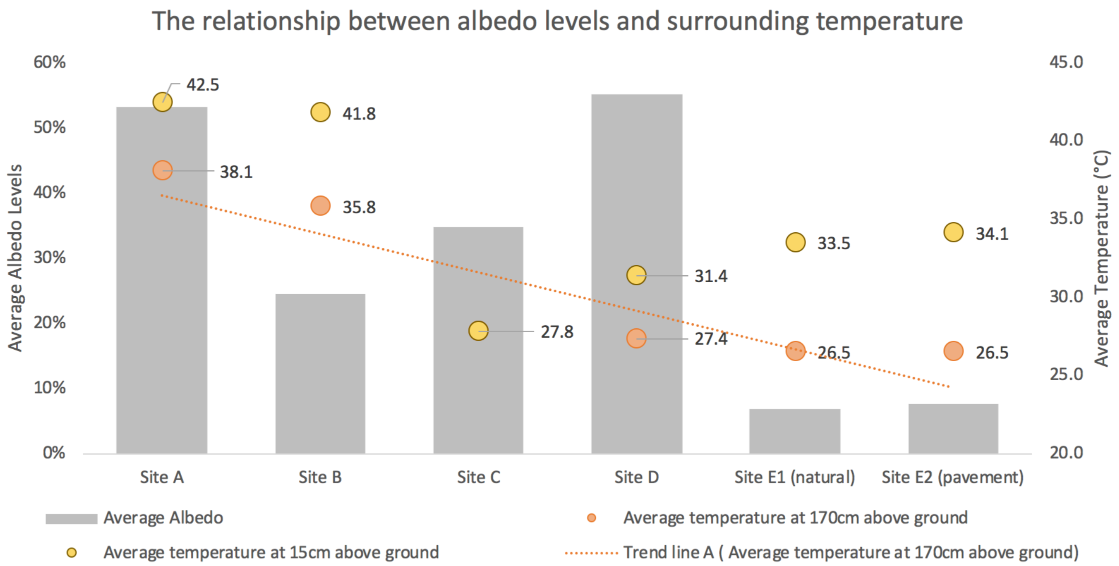


	
Figure 5.1 – Site A (view towards site B park)	Figure 5.2 – Site A (view towards the opposite side)

As seen in figure 4, the highest temperature observed was at site A, the city centre and marked 38.1°C for 170cm above ground, which is what average height people would experience. It is then followed by B with 35.8°C, C with 27.8°C, D with 27.8°C, and E with 26.5°C. Through the visual representation of trend line A, we are able to see that the surrounding temperature decreases as the distance from site A increases. Additionally, starting from site C, the temperature values are below 30°C.

One of the possible reasons for site A scoring the highest temperature would be the amount of congestion. As seen in Figure 5.1/5.2, we could see 2a significant amount of people crowding in one area, disrupting the flow of air, as well as people releasing energy, which adds on more heat to the environment, causing the overall temperature to rise. On the other hand, site E was surrounded by trees, so that consequently would remove heat energy from the air (Evans, n.d.).

For the temperature at 15cm above ground datasets, the values were consistently greater than datasets of 170cm at same site, with an exception of site C. Site C gave an anomalous result of temperature at different heights being the same as other. A factor that made this change would be because the data measured in site C was under a bridge, it was covered from sunlight the whole day. For this reason, the surface at site C did not absorb energy unlike other surfaces and remains steady throughout the day. Therefore, since sunlight was not reflected, the temperature at different heights did not differ.

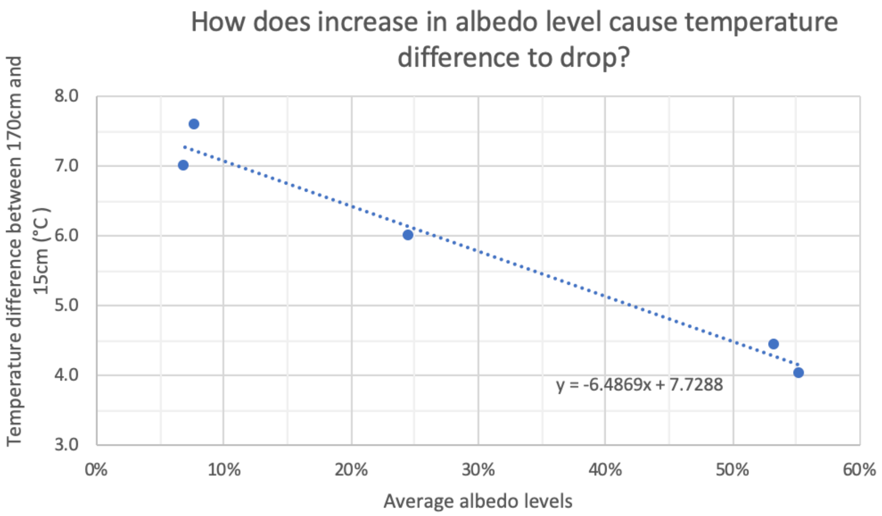
Overall, we could accept the hypothesis I proposed and say that the temperature decreases as the distance from CBD (site A) increases.

Albedo

Figure 4 also displays the average albedo for different sites. Site D marked the highest with 55%, followed by A with 33%, C with 35%, D with 25%, E with 7%, and E2 with 8%. Site E/E2 had the lowest value due to the black pavement and natural soil, which from its nature are more absorbent than grey, white-ish pavements used in site A-D. Overall, the urban stress has been reduced due to low albedo compared to black concrete surface, and its effect on temperature difference.

Figure 6 – Pavement sample from site A-D.

Figure 7



Correlation Coefficient = 0.985929751

y = 0.97x + 2.9033

In order to determine if there is an actual relationship between the temperature difference and albedo levels, Pearson's correlation coefficient would be used. This coefficient is used to measure the association between two different variables and is expressed from the scale of -1 to 1. the closer it is to 1 or -1, the stronger the correlation is. Figure 7 omits site C, as there was no difference between temperatures at two heights, as the location was under shade and ground did not absorb heat.

The result, 0.986 gives that there is a strong correlation between the decrease in albedo levels and temperature difference increasing. Since temperature difference would essentially be a measure of temperature that is retained/absorbed inside the ground, thus the bigger this value is, more heat would be released overnight, which would keep the area warmer than the area that has less temperature difference, thus is suggested to be a cause for urban heat island effect.

Also using figure 6, we were able to figure out a statistical relationship between two variables two determine the validity of the hypothesis. From the data, it is deducted that every 15% of albedo increase will decrease the temperature difference —energy stored— by 1°C and vice versa. This relationship allows us to lead to an answer for my hypothesis, that the hypothesis was correct, and higher the albedo the lower.

Green spaces

Figure 8

The area of green spaces allocated did not increase as the distance from site A increased.

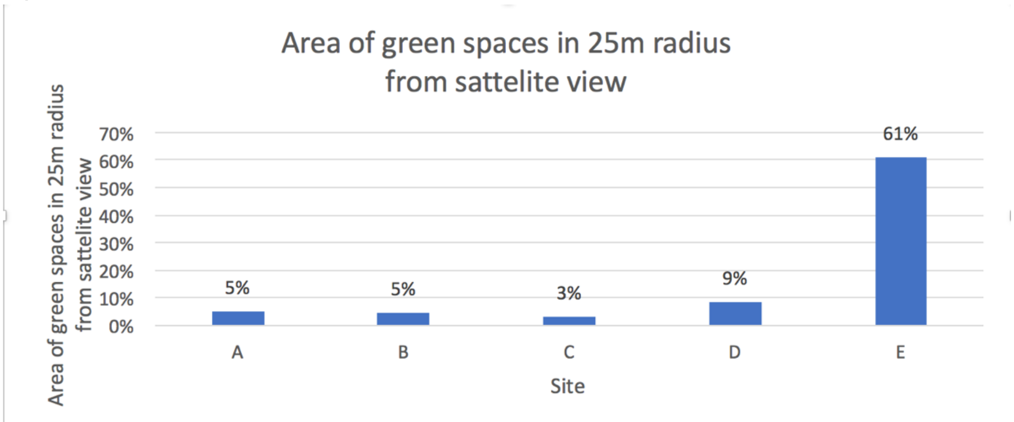
The highest value recorded was site E with 53%, followed by A with 31%, D with 24%, C with 22%, and B with 17%. The CBD area (siteA-D) had a consistent result with the average of 24%, and a range of ±7%, indicating that these areas are likely to be planned to qualify certain regulations for trees. [4]According to Ginza Machidukuri council, the trees must not exceed 4m width, and should be planted 8-10m apart.

Site E could be considered as an anomaly, as the general environment is different from other locations. While the majority of the objects we can observe are artificial in the CBD area, site E emulates the nature to provide a relaxing location, an oasis to the cluttered business area. As a matter of fact, it was observed that female office workers were having lunch sitting outside, which would be an indication of how it is contributing to reducing urban stress.

Additionally, since Ginza was traditionally a shopping district even before cars began running, they had to sacrifice the sidewalk for a road. Even so, the width of the road itself is not wide enough compared to today's standards. For this reason, it is fair to assume that the government had allocated more sidewalk area than for trees in order to cope with increasing number of tourists.

According to the "Ministry of Land, Infrastructure, Transport and Tourism", Ginza has allocated 6.25m of the sidewalk, compared to 8.1m at Omotesando. Additionally, while Ginza area would have to reduce this 6.25m to add planting space if they would have to, Omotesando area – which is already known as a street with trees planted – already has 2.65m of trees allocated within 8.1m. [5]Thus, the sidewalk width could be a possible obstacle for Ginza to have improved green space allocation.

Figure 9



[4] National Institute for Land and Infrastructure Management:

[5] National Institute for Land and Infrastructure Management: Research Center for Infrastructure Management Landscape and Ecology Division, 2004

Figure 9 also displays a similar pattern as photo analysis. Sites A-D remained low, having an average of 5.5%, while site E exceeded 50%, and as it was explained above, site E is aimed to have a different function, therefore this result is as expected. Overall, the area of green spaces did not increase as the distance increased from site A, which makes my hypothesis invalid, along with the analysis on Figure 8. As stated above, this could be because the same green construction planning would apply to the same street.

Conclusion

This investigation provided significant statistical information to answer the field work question exploring the impacts of distance to the quality of physical environment. Three relevant sub-hypotheses were derived to explore this in detail.

The first sub-hypothesis aimed to find a relationship of distance from siteA (center) and temperature. The result has displayed a statistical relationship of temperature decreasing as distance increasing, hence accepting the hypothesis. Overall, we have observed a 30% decrease in temperature from site A to site E.

The second sub-hypothesis stated that higher the albedo, there is less difference between temperature at two heights. The results have shown that the hypothesis is valid as well, giving a strong negative correlation, supported by the mathematical calculations of correlation coefficient.

The third sub-hypothesis stated that as you move further from site A, the area allocated for green spaces would increase. This hypothesis was concluded as being invalid, as there was no difference across the street throughout site A to D, except for site E in which it was inside a park. This result was further supported from government document source.

Overall, the data obtained from this investigation revealed that a quality of physical environment changed significantly by two levels (temperature and albedo) as the distance increased from the city centre, but does not apply for green space allocation.

Evaluation

One of the critical, an unexpected issue that I came across was the quality of the lux meter. The light intensity the meter could measure were 30000lx, and occasionally the measurement reached this value, which means that anything higher is not recorded. As a workaround, I waited until the sun moves under the clouds so that the light is less intense. This would still give an appropriate albedo value, as it is a relative value for $\frac{Reflectivity\ of\ a\ surface}{Ambient\ light\ source}$. For future investigations, the use of higher quality lux meter must be used to avoid such issues and for more efficiencies.

Time constraints were one of the challenges we faced. Since we were in location for merely 2.5 hours, only three indicators were studied to explore urban stress and physical environment. Additionally, it was only conducted on a single day in May, making it difficult to suggest if the same trend we concluded can apply on other days.

Despite the time constraints, I have managed to maintain 5 trials per data, which gives more reliability than only three trials. By having this, it gives more consistency in data representation, especially for the temperature that changes accordingly to the environment.

Other indicators could have been examined to understand urban stress in addition. For example, indicator 'traffic congestion' could have been added to investigate the relationship between temperature, because more cars would mean more CO2 gasses are emitted at the area, which traps heat thus increasing the overall temperature.

Overall, the conclusion that was drawn from only three indicators may not be an accurate representation of urban stress.

Further investigations, such as changing the location may be considered for a better study on urban stress. Locations such as Shinjuku and Omotesando, just like Ginza has a huge park located nearby and thus makes it appropriate to compare with the same fieldwork question.

References

Evans, E. (2002). *Benefits of Trees*. Retrieved from https://projects.ncsu.edu/project/treesofstrength/benefits.htm

東京銀座オフィシャル(2017). ヒストリー. Retrieved from http://www.ginza.jp/history/2

国土交通省　関東地方整備局. (2004).入札公告. Retrieved from: http://www.ktr.mlit.go.jp/yokohama/06data/plan/keikan/pdf/dourokeikan06.pdf

国土交通省. (2018). 銀座通り景観整備検討委員会. Retrieved from 一般社団法人銀座通連合会東京国道事務所 Council website: http://www.ktr.mlit.go.jp/toukoku/kankyo/ginza/20170216iinkai.pdf

国土交通省　国土技術政策総合研究所　社会資本マネジメント研究センター　緑化整体研究室(2007). *Trees in city planning*. Retrieved from http://www.nilim.go.jp/lab/ddg/seika/ks/ks043312.pdf

三菱地所. (n.d.). *Making Marunouchi area resillient and eco friednly*. Retrieved from http://office.mec.co.jp/info/pdf/marunouchi_area.pdf

PCE. (n.d.). *Люксметр PCE-174* [A sample of how to use lux meter]. Retrieved from https://www.pce-instruments.com/russia/slot/13/artimg/large/pce-instruments-%D0%BB%D1%8E%D0%BA%D1%81%D0%BC%D0%B5%D1%82%D1%80-pce-174-5857141_1132370.jpg

Appendix A – Raw Data

Temperature

		temp at 170cm	Average	temp at 15 cm	Average
Site A	Trial 1	38.4	38.1	42.9	42.5
	Trial 2	37.5		42.6	
	Trial 3	38.3		41.9	
Site B	Trial 1	37	35.8	41.5	41.8
	Trial 2	34.5		41.6	
	Trial 3	35.9		42.2	
Site C	Trial 1	27.8	27.8	27.8	27.8
	Trial 2	27.8		27.7	
	Trial 3	27.9		27.8	
Site D	Trial 1	27.2	27.4	31.4	31.4
	Trial 2	27.5		31.5	
	Trial 3	27.4		31.3	
Site E1	Trial 1	26.6	26.5	33.3	33.5
	Trial 2	26.5		33.6	
	Trial 3	26.4		33.5	
Site E2	Trial 1	26.6	26.5	34.5	34.1
	Trial 2	26.5		34.2	
	Trial 3	26.4		33.7	

Difference

	Average temperature at 170cm above ground	Average temperature at 15cm above ground	difference
Site A	38.1	42.5	4.4
Site B	35.8	41.8	6.0
Site C	27.8	27.8	0.0
Site D	27.4	31.4	4.0
Site E	26.5	33.5	7.0
Site E2 (pavement)	26.5	34.1	7.6

Albedo Calculation

	Trial	Lx (x10) Ambient	Reflected	Albedo	Average Albedo
Site A	1	2298	1270	55%	53%
	2	2231	1170	52%	
	3	2219	1187	53%	
	4	2234	1200	54%	
	5	2321	1196	52%	
Site B	1	503	141	28%	25%
	2	492	113	23%	
	3	487	102	21%	
	4	506	103	20%	
	5	450	137	30%	
Site C	1	104	35	34%	35%
	2	107	37	35%	
	3	111	38	34%	
	4	109	39	36%	
	5	111	40	36%	
Site D	1	2784	1431	51%	55%
	2	2749	1526	56%	
	3	2731	1530	56%	
	4	2786	1623	58%	
	5	2783	1534	55%	
Site E1 (Natural)	1	784	57	7%	7%
	2	960	59	6%	
	3	1020	68	7%	
	4	1040	75	7%	
	5	1032	74		
Site E2 (Concrete)	1	700	56	8%	8%
	2	758	60	8%	
	3	780	62	8%	
	4	827	67	8%	
	5	795	50	6%	

Area of Green spaces

Photo Analysis

	Area of Green spaces	Area of Image	proportion
Site A	132573	429872	31%
Site B	3985523	24000000	17%
Site C	5289574	24000000	22%
Site D	2985908	12192768	24%
Site E	6506430	12192768	53%

Map Analysis

	Area of Greenery	Area of Circle	percent age
Site A	98.78	1975.726	5%
Site B	92.34		5%
Site C	63.048		3%
Site D	168.338		9%
Site E	1,204.75		61%