Cool and Covered

Hong Kong Project Center 2024

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Abstract

Figure 1: Image of Kwun Tong Skyline and Quarry Bay taken from the Quarry Bay waterfront.

Hong Kong is a city uniquely located on a small yet mountainous island with a rich cultural background. The creation of Hong Kong's public waterfront promenades has been a recent one fueled by the desire for more natural green-blue public spaces for personal and community use.

In this project our group has observed and analysed seven specific public waterfront spaces ranging from Hong Kong Island to the New Territories. The goal of the project is to understand if structures that provide cover at Hong Kong waterfronts affect waterfront usage during the winter season.

Introduction

HONG KONG IS A CITY FACING DISTINCT CHALLENGES DUE TO ITS HIGH POPULATION DENSITY...

With a population density of 7,134 people per square kilometre, it is the fourth densest city in the world,[1] and like many cities it is experiencing urban growth.[2] This problem is further exacerbated by its limited area. Despite towering residential buildings dominating the landscape, Hong Kong still has insufficient space to live. Over 220,000 Hong Kongers live in tiny apartments only large enough for one bunk bed surrounded by a metal cage, categorised as “cage homes.”[3] Due to this extreme density in the city’s living spaces, the people of Hong Kong resort to public spaces such as malls, markets, parks, and waterfronts for community interaction and more space. As residential spaces become increasingly limited in Hong Kong, the importance of accessible public spaces also becomes essential.

Over the past decade, Designing Hong Kong (DHK), a non-profit organisation, has concerted efforts towards increasing public awareness and improving Hong Kong’s collective ability to plan and deliver a ‘beautiful’ city. One of DHK’s campaigns concerns revitalising and connecting Hong Kong’s many waterfronts. These waterfronts are some of Hong Kong’s most accessible public spaces and create natural and semi-natural areas within the larger urban area of Hong Kong. Last year, an Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute researched how the waterfronts promote social engagement.[4] The group observed and documented visitors’ static and moving behaviours across several waterfronts in Hong Kong. One observation the group made was that visitors spent more time in shaded areas on the waterfront, which highlighted the importance of cover structures. The previous project's findings have inspired the conception of the current project.

Visiting waterfront promenades is a popular activity during the summer months, but this is often met with challenges in high UV indexes and heat. These challenges are often mitigated with covering structures; however, the year-round effectiveness of these structures had not yet been observed. Our project analysed visitors' static activities on the waterfront, providing a perspective on how covered and non-covered areas impact waterfront patrons' activities in the winter season. Furthermore, our group investigated waterfront visitors' preferences on covering structures. The group compared preferences on green infrastructure like trees to grey infrastructure such as pavilions and overpasses. This year’s study focused on the same seven waterfronts as last year: Sheung Wan, Quarry Bay, Kwun Tong, Sha Tin, Lam Tsuen River Promenade, Ma On Shan, and Tai Po Waterfront Park.

During this project, we observed the current cover configurations of the seven waterfronts and collected data on patrons' static activities. The conclusions of this study provide perspective on how covered features affect communities on the Hong Kong waterfronts. We suggest improvements for these various waterfronts of Hong Kong, with the goal of heightened visitor attendance and increased community interactions.

Background

The waterfronts of Hong Kong are a treasured jewel of the city that positively impact both the well-being of communities and the health of the environment. Situated just outside the dense urban areas, the waterfronts provide a harmonious relationship between nature and the various human activities along the promenades. These waterfronts are often gathering points, particularly in the summer season welcoming relief from the extremes of the region's subtropical climate, as they are often cooler than the inner city. Cover structures on these waterfronts further mitigate effects of the summer climate and make the waterfronts more enjoyable to visit. This study therefore asks the question of how effective these structures are year-round, particularly in the winter season.

IMPACTS OF CLIMATE CHANGE

Hong Kong is confronting mounting challenges to its outdoor public spaces because of the projected increase in severity of weather patterns due to climate change. When cities experience higher temperatures than surrounding rural areas, this is known as the Urban Heat Island (UHI) effect and is a major consequence of climate change in urban areas. Addressing challenges caused by UHI and promoting community engagement with public spaces requires proactive measures such as bioclimatic design (design based on the local climate) and the incorporation of green-blue spaces, which are natural spaces in urban settings involving both vegetation and a water source. The impacts of the UHI can be credited to the extensive use of materials like concrete and asphalt. These materials have higher thermal conductivity and lower heat capacity compared to natural surfaces. Heat cannot pass through concrete and asphalt easily, causing the affected areas to have a higher sensible heat.[5] The dominance of high-rise buildings in Hong Kong's skyline, especially in central business districts, amplifies the UHI effect by exacerbating heat retention and limiting ventilation. The UHI effect can be minimised, however, through preventative measures such as bioclimatic architecture. Bioclimatic architecture refers to the design of structures that capitalise on natural resources and the environment's climatic conditions to improve energy efficiency and overall benefit the health of the environment.

Figure 2: Quarry Bay Promenade

Background

Green-blue spaces are an example of bioclimatic architecture and play a pivotal role in decreasing the effects of UHI effect, by supplying a cooling effect in a city. Green-blue spaces are natural and semi-natural areas within a city or urban area; a harmonious blend between "green" spaces such as parks and gardens, and "blue" spaces such as rivers, seas, and ponds. The addition of greenery to waterfronts enhances the local environment, promoting them from a blue space to a green-blue space. An example of an integrated climate response can be seen in Kunshan City, near Shanghai. The local government implemented green configurations on the waterfronts that were highly effective in cooling the environment around them. The results illustrated in Figure 3 show various green-blue spatial factors playing a crucial role in generating a cooling impact within waterfront communities situated in Kunshan City.[6] Therefore, climate-responsive design strategies are essential in new town developments to create cooler and livable urban environments.[7]

Trees, a common addition to waterfronts, are proven to block solar radiation and provide cooling. Proper design considerations such as providing adequate planting space, selection of quality plant stocks and planting suitable species, are imperative for the health and Useful Life Expansion (ULE) for trees.[9] ULE is an estimate of how long the tree is likely to beneficially contribute and remain in the landscape. Planting trees with a longer ULE can provide benefits to the community for an extended period at less cost. Moreover, studies indicate that leafy trees can effectively obstruct approximately 70–95% of solar radiation, and even leafless trees contribute significantly to reducing solar exposure. Analysis from these studies also indicates that shade provided by trees contributes to a substantial drop in temperature beneath their canopies during daylight hours.[10] Beyond providing shade, trees also decrease the amount of carbon dioxide (CO_2) in the air, creating a healthier ecosystem and environment for city residents. Thus, incorporating green elements is a feasible option to enhance the cooling capacity and mitigating the urban heat island effect in urban locations.[11]

Figure 3 : The Miaojing River Corridor, Kunshan City, China.[8]

Background

Another bioclimatic consideration is wind. Wind has a significant effect on the thermal comfort of areas, as it effects both latent and sensible heat change. Sensible heat refers to the temperature that can be "sensed" through temperature change, while latent heat refers to the heat that impacts the state of matter. It should also be acknowledged that there is a balancing act between wind and how it impacts the human body's thermal comfort[12] as seen in Figure 4. Wind can enhance the heat transfer between the human body and surrounding environment, causing a pleasant feeling. However, it can also increase a draught sensation, which, depending on the perception of air movement, can be perceived negatively.

This project was conducted in Hong Kong's winter season. Winter lasts about 3 months, from December to March in Hong Kong, with an average low between 14-19 degrees Celsius.[14] Therefore, there is a higher likelihood of people perceiving the wind movement as unenjoyable, even at low velocities.[15] Human perception of air does depend on environmental conditions, therefore, in the context of Hong Kong summers, the waterfronts can become a suitable place to visit because they are often cooler than the urban centres. Wind is important to consider, as investing in bioclimatic design strategies for the Hong Kong waterfront should align with long-term goals of creating resilient and comfortable public spaces the entire year-round.

BENEFITS OF IMPLEMENTING GREEN BLUE SPACES

Green-blue spaces provide both environmental benefits to a city and improve the overall well-being of the community. These spaces mitigate pollution and reduce the impact of the Urban Heat Island effect and are an example of Green Urban Infrastructure (GUI). Implementation of GUI can cool an area between 3.5 to 6 degrees Celsius depending on its geographic location.[16]

This is a significant amount, especially when findings from studies confirm that a 1 °C increase in temperature on a 30°C day is associated with a 4% drop in park attendance.[17] These findings underscore the direct correlation of temperature with attendance at parks and public spaces.

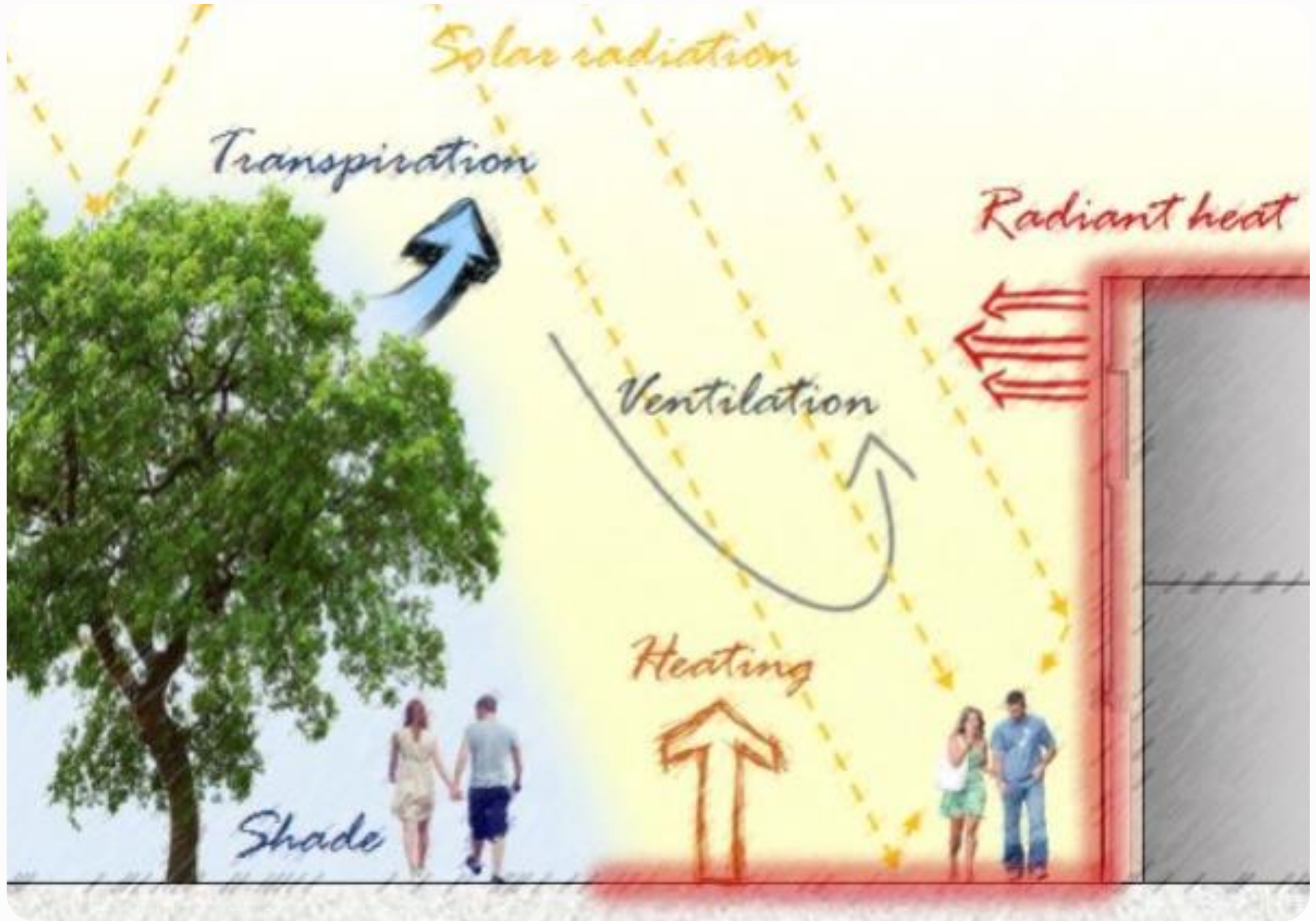

Figure 4: Key environmental components that influence thermal comfort during the day.[13]

Background

As Hong Kong expands with developments in the New Territories, town planners, and policymakers need to integrate climate-responsive design strategies within these new neighbourhoods to ensure the creation of urban spaces that effectively reduce heat and enhance livability.[7] The need to adapt to climate change has prompted those living in urban environments to strategically redefine their urban landscapes. An example of GUI can be seen in New York City at the Hunter's Point South Waterfront Park on Staten Island, Figure 5. Situated on 30 acres (12 hectares) of post-industrial land, the park was specifically designed with climate adaptation in mind. By combining wetland areas and central green park space, the waterfront park acts as a basin for floodwaters, helping mitigate current and future weather patterns.[18] This park helps to protect this community from future climate issues, as well as providing a new open space where local community members can gather and connect with their natural surroundings.

Green-blue spaces significantly enhance the well-being of communities by providing benefits to visitors' well-being. The frequency of recreational visits to green or blue spaces is correlated with positive well-being and negatively associated with mental distress.[20] In addition to mental health benefits, it should be noted that exposure to green and blue spaces has also been linked to improvements in physical health, including a reduction in cortisol levels (the stress hormone), blood pressure, and cholesterol.[21] Park and waterfronts provide recreational spaces for residents and visitors, encourage social interactions, and promote healthier lifestyles. Therefore, combining the two into green-blue spaces can only heighten physical and mental health benefits.

Figure 5: Hunter's Point South Waterfront Park on Staten Island in New York City, USA.[19]

Background

CURRENT CONFIGURATIONS OF PUBLIC SPACE

The transformation of public spaces using careful design considerations can positively affect the local community. Hong Kong is one of the world's most densely populated places; residents have only 2.7 square metres (29 square feet) of public space per person.[22] To put this into perspective, that is about the size of a bathroom cubical. Thus, the investment in public spaces helps improve quality of life by providing accessible recreation space such as parks. Urban residents use park areas for activities such as running, walking, and practising Tai Chi Chuan, while more remote park areas provide space for kite flying, picnicking, hiking, and more. Additionally, Hong Kong has a diverse culture, celebrating festivals and holidays. Many cultural celebrations are hosted in public spaces. For example, the West Kowloon Cultural District hosts open-air music, with dance and theatre performances, in the park and waterfront area.[23] Without public open spaces there would be no place to gather with the community.

Urban parks in Hong Kong are not always user-friendly or foster a community building environment. Environmental factors and designed elements can hinder the enjoyability of these areas, ultimately deterring visitors and imposing obstacles for the community to engage within their public spaces. UHI disrupts the use of outdoor public spaces with climate change making extreme weather patterns, such as high heat, high UV index and heavy rain, more frequent. These weather patterns highlight the importance of the relationship between cover configurations and park visitor interactions. Poor design considerations aggravate these issues: some park configurations are designed in a way to deter people from spending extended time there, such as a slanted wall or a partitioned bench (Figure 6). These design choices indicate that waterfronts are being designed to cater to more individual activities, rather than communal ones.

SUMMARY

Keeping in mind the important benefits these waterfronts provide as green-blue spaces, our group observed the behaviours and activities of the waterfront visitors. The group took specific note of the kind of infrastructure waterfront patrons preferred. The main goal of this study is to see where people perform activities during the winter months and if those are specific to certain infrastructure and if there is a preference for cover or a specific type of cover. Therefore, our group employed observation as the main method for research.

Figure 6: A partitioned bench, example of hostile architecture in Sha Tin Waterfront Hong Kong.

Methodology

We observed current cover configurations looking to understand the impact cover has on visitors and their interactions with each other. With the current configurations in mind, we collected data along the seven waterfronts of visitors' static activities, specifically looking to see if those activities occurred under cover or in the open. The group analysed each waterfront to see if there was correlation between cover structures and user interactions.

WATERFRONTS OF INTEREST

The University of Hong Kong and Designing Hong Kong outlined seven waterfronts of interest for this study: Sheung Wan, Quarry Bay, Kwun Tong, Sha Tin, Lam Tsuen River Promenade, Ma On Shan, and Tai Po Waterfront Park, as shown in Figure 7. These waterfronts are of particular interest due to the observations from last year's IQP and previous studies conducted by the University of Hong Kong.

SCOPE OF WORK

We observed cover as a factor of how visitors use waterfronts and conducted preliminary waterfront observations to determine the areas' current states. Observation sections on the waterfronts were determined based on noticeable infrastructure identifiers such as shades, buildings, bridges, and trees. Upon the completion of the preliminary observations, we concluded that each location had at least four different sections characterised by changes in infrastructure present, as demonstrated in Figure 8. Thus, we split each waterfront up into sections based on these defined characteristics for our further data collection.

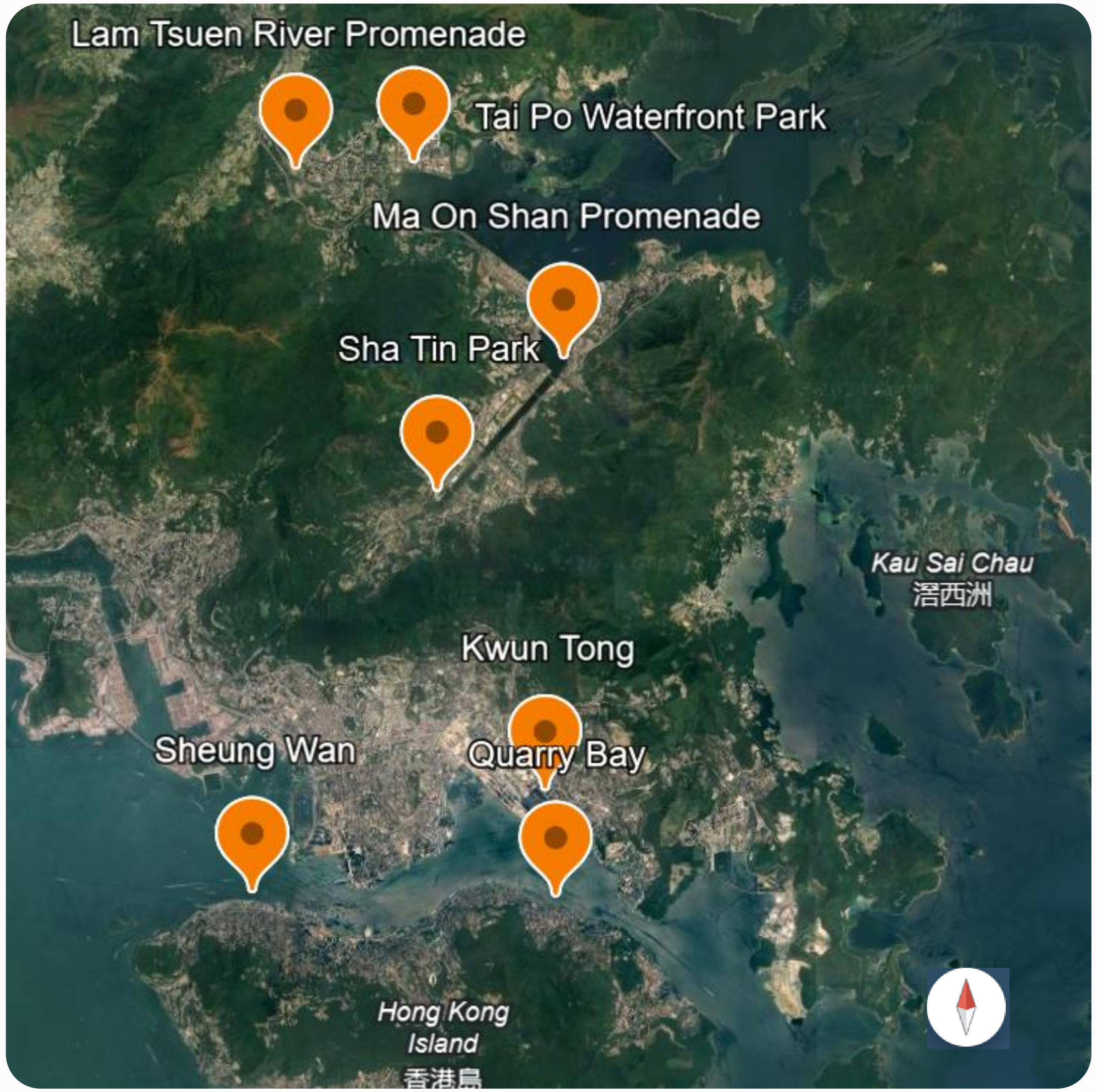

Figure 7: Map of Hong Kong with points indicating the waterfronts of concern in this study.[24]

Methodology

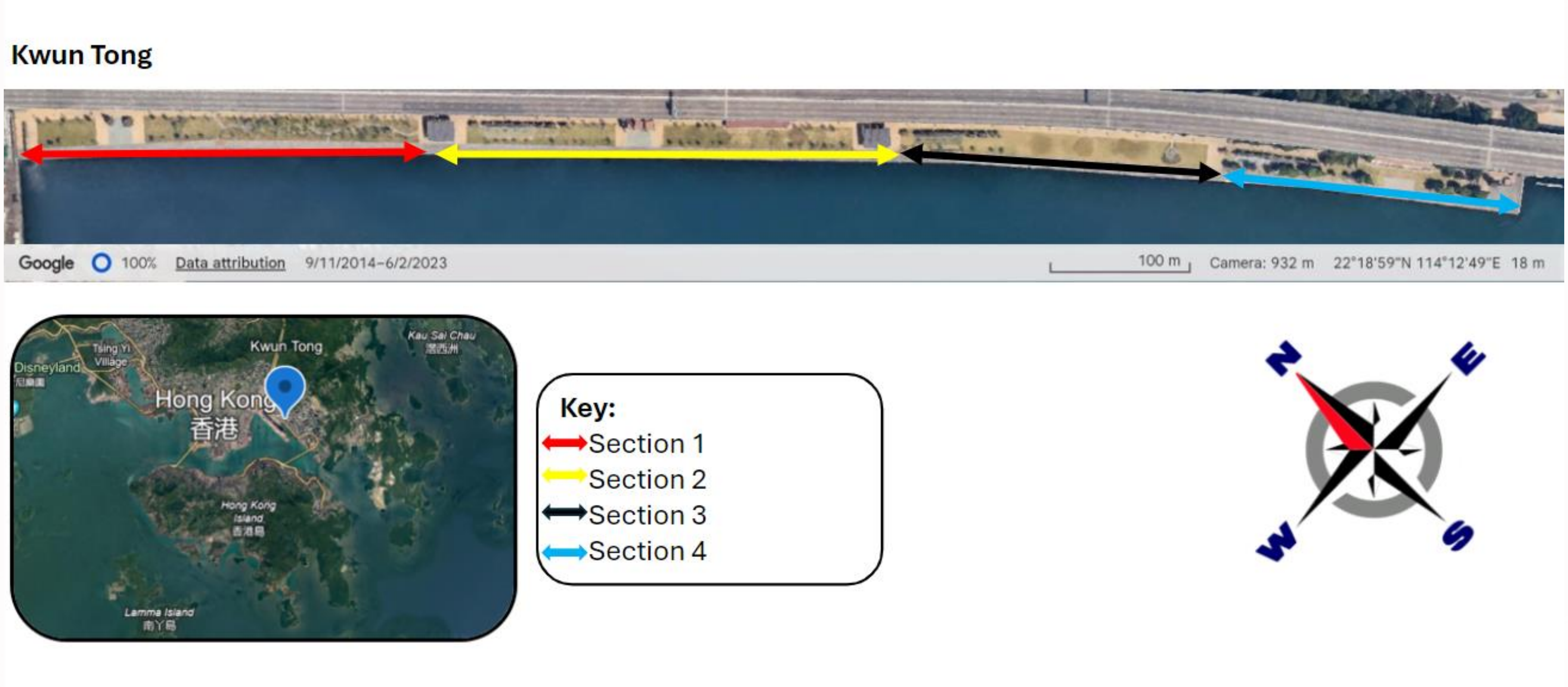

Figure 8: Map of Kwun Tong waterfront with designated observation sections.[24]

Methodology

DOCUMENT VISITOR' STATIC LOCATIONS ON THE WATERFRONTS

We extracted maps for all seven waterfronts from Geo Info Map (Figure 9), a geospatial information service provided by the Hong Kong Special Administrative Region Government to the public. The group recorded locations in which people were static on top of the Geo Info Map. An example of a static map is shown in Figure 10. The maps were zoomed to a scale that allowed for the inclusion of small-scale features such as park benches and kiosks. These maps were important in helping us determine where park visitors spend their time.

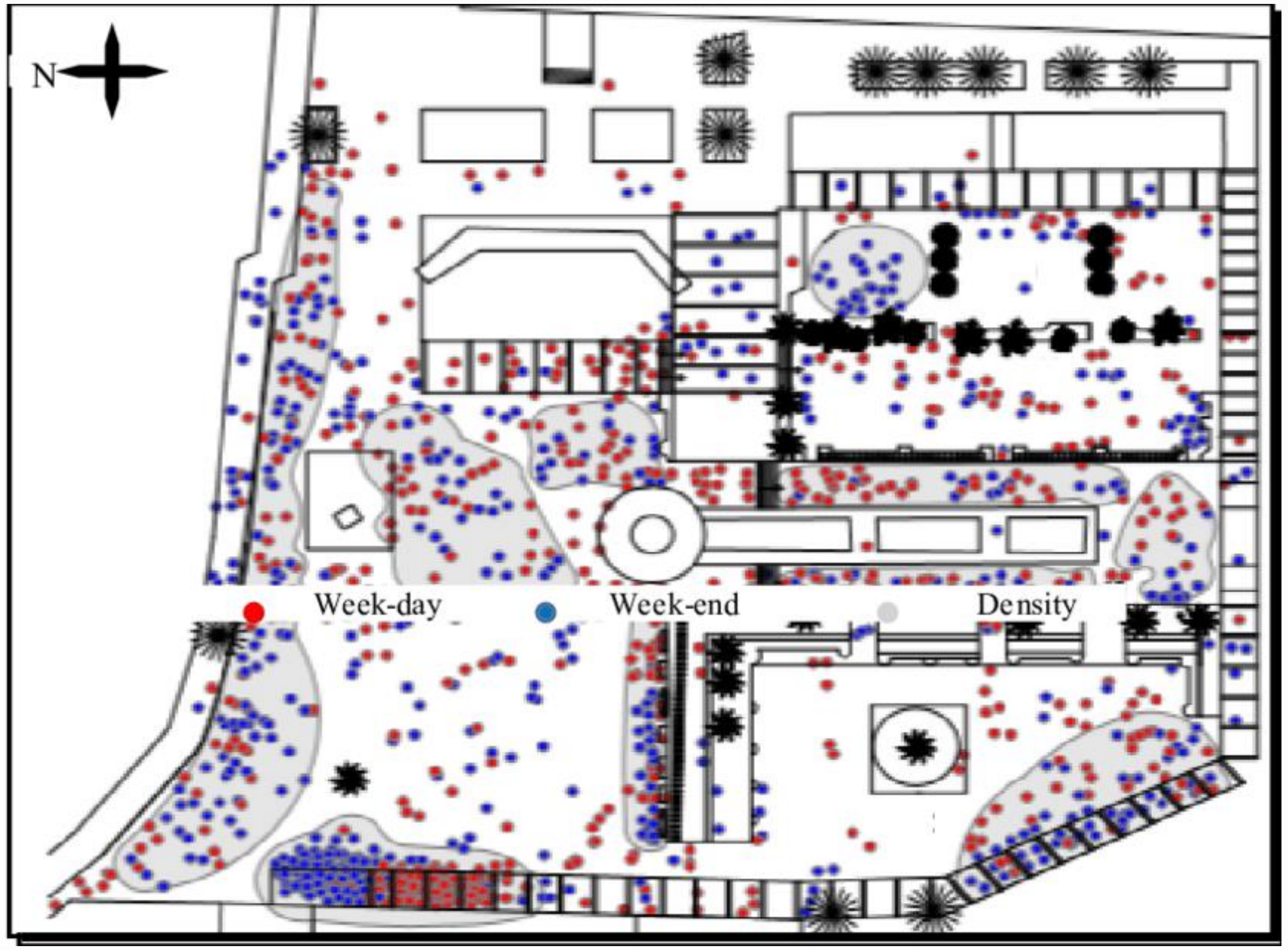

Figure 9: GEOINFOMAP zoomed in on Quarry Bay.[26]

Figure 10: User Patterns: outdoor space and outdoor activities.[25]

Methodology

RECORD THE CIRCUMSTANCES OF VISITORS' ACTIVITIES ON THE WATERFRONTS AND THEIR RELATIONS TO SHADING.

The group collected data of the structures involved in visitors' static activities along with other key factors such as weather, temperature, and wind. We also considered the type of infrastructure people interact with - green or grey; green infrastructure being trees and grey being any physical man-made structure. This distinction's purpose was to observe what type of cover people gravitate towards. The factors listed on the Static Activity Chart in Table 1, enabled the team to determine if green or grey infrastructure is preferred among visitors. Recognising the unique needs of each waterfront, shaped by diverse current uses and configurations, the team employed a mixed-method approach, combining the mapping with the observation of people's behaviours and activities. This activity tracking helped us identify correlations between cover created by the infrastructure on the waterfront and the activities of visitors.

Static Activity Chart

Date: **Time:** **Day of Week:** **Location:** **Weather:** **Wind (speed and direction):**

Structure Characteristics ↓	**Type of Structure** →	**Bench/ Table**	**Ampitheater/ Pavillion**	**Kiosk/ Bathrooms**	**Bridge/ Overpass**	**Natural Structure** (Tree, bush etc.)	**Decoration** (Display, Art)	**Other:**
Structure (A,B,C,D – include description of object) (ex. Bench {A}, Bench {B}, etc.)								
Number of People (#)		A: B: C: D:	A: B: C: D:	A: B: C: D:	A: B: C: D:	A: B: C: D:	A: B: C: D:	A: B: C: D:
Not Covered (# of people)								
Covered (# of people in the area) Green Or Gray?		Green: Gray:	Green: Gray:	Green: Gray:	Green: Gray:	Green: Gray:	Green: Gray:	Green: Gray:

Table 1: Static Activity chart used to collect data regarding the current state of the waterfronts.

Findings and Discussion

The following claims are based on data the group collected on the waterfronts from January 26th through February 17th, 2024. During the collection process we made observations on two weekdays and one weekend day, with recordings made for each waterfront at three time points; 9-10 am, 1-2 pm, and 5-6 pm. Variables such as type of weather present (sunny, partly cloudy, and cloudy), wind speed, and temperature were also recorded using data from the Hong Kong Observatory. We sought to answer three research questions that stemmed from our project goal; when and where do people choose to spend time on the waterfront when static, how do specific weather patterns impact the utilisation of cover, and whether observed activity patterns were consistent throughout all waterfronts. The charts, included in the supplementary writing, use the percentage of people for each specified factor in the graphs, comparing the amount of people who prefer cover vs non-cover or taking the amount of people that prefer cover and comparing between those that prefer green or grey cover. Finally, we determined the overall pattern for each factor at each waterfront using pivot tables. We emphasise that our observations have been made during the winter months in Hong Kong.

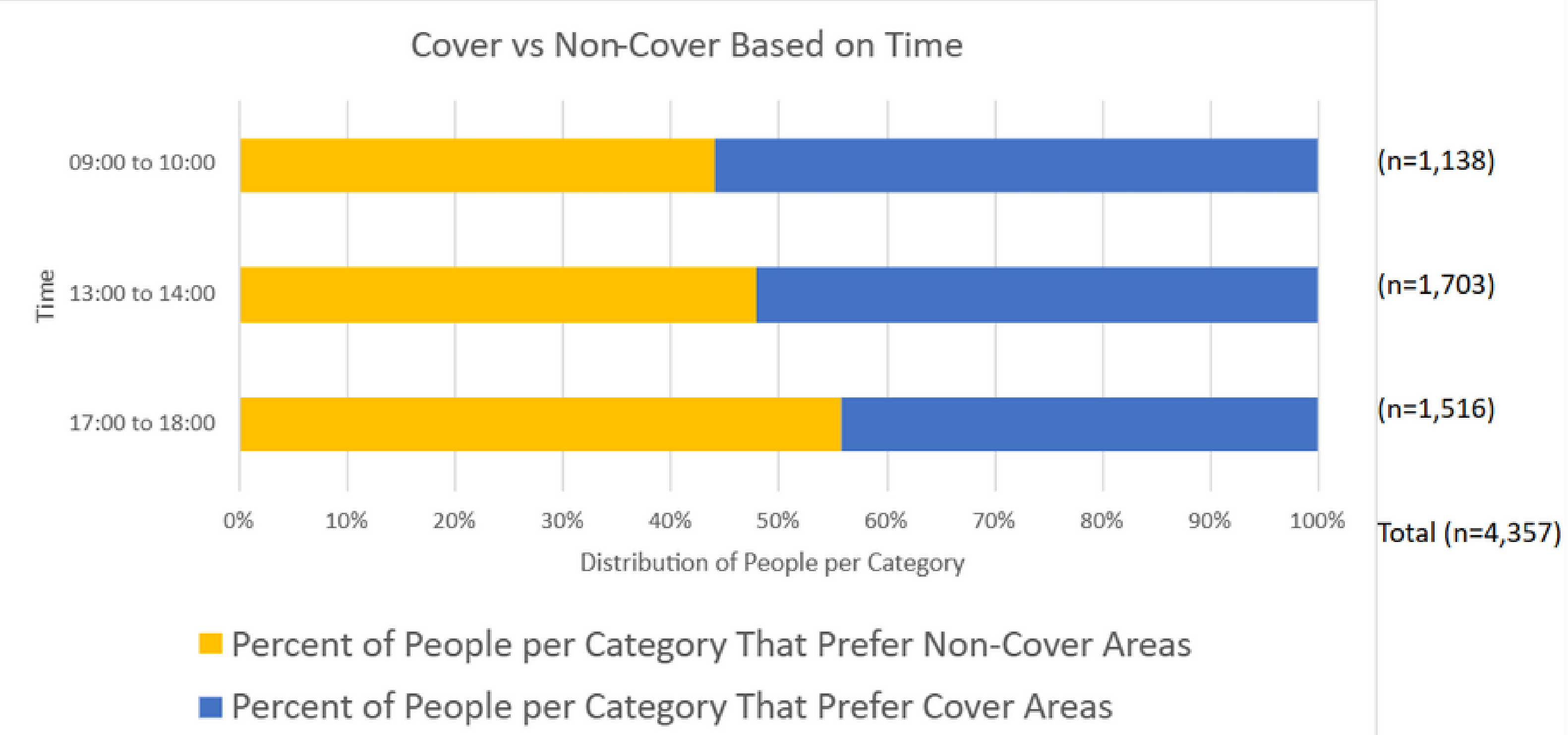

Figure 11: More people prefer to be in non-cover areas later in the day.

BEHAVIOURAL PATTERNS

In terms of understanding how people choose to spend time on the waterfront, we observed that later in the day most people prefer to spend time in uncovered areas. The percentage of people in non-covered areas increased as the time became later in the day (Figure 11). Ultimately, in the last hour of observation (5-6pm) approximately 55% of static people were in non-covered areas. Most individuals utilised covered areas in the earliest observed hour of 9-10am. This period had the largest percentage of people in covered areas (about 55%). Another pattern we recorded was in the relationship between temperature and cover structure usage (Figure 12).

Temperatures greater than 24 degrees Celsius produced the largest percentage of people in non-covered areas (67%), the second greatest percentage coming from a range of temperatures between 18-21 degrees Celsius. In contrast, temperatures between 12-15 degrees Celsius had the largest percentage of people in covered areas. We recorded a similar pattern in temperature and its effects on green versus grey cover usage (Figure 13). Temperatures between 18-21 degrees Celsius and temperatures greater than 24 degrees Celsius averaged the largest percentage of people in green covered space (38% and 58% respectively).

Findings and Discussion

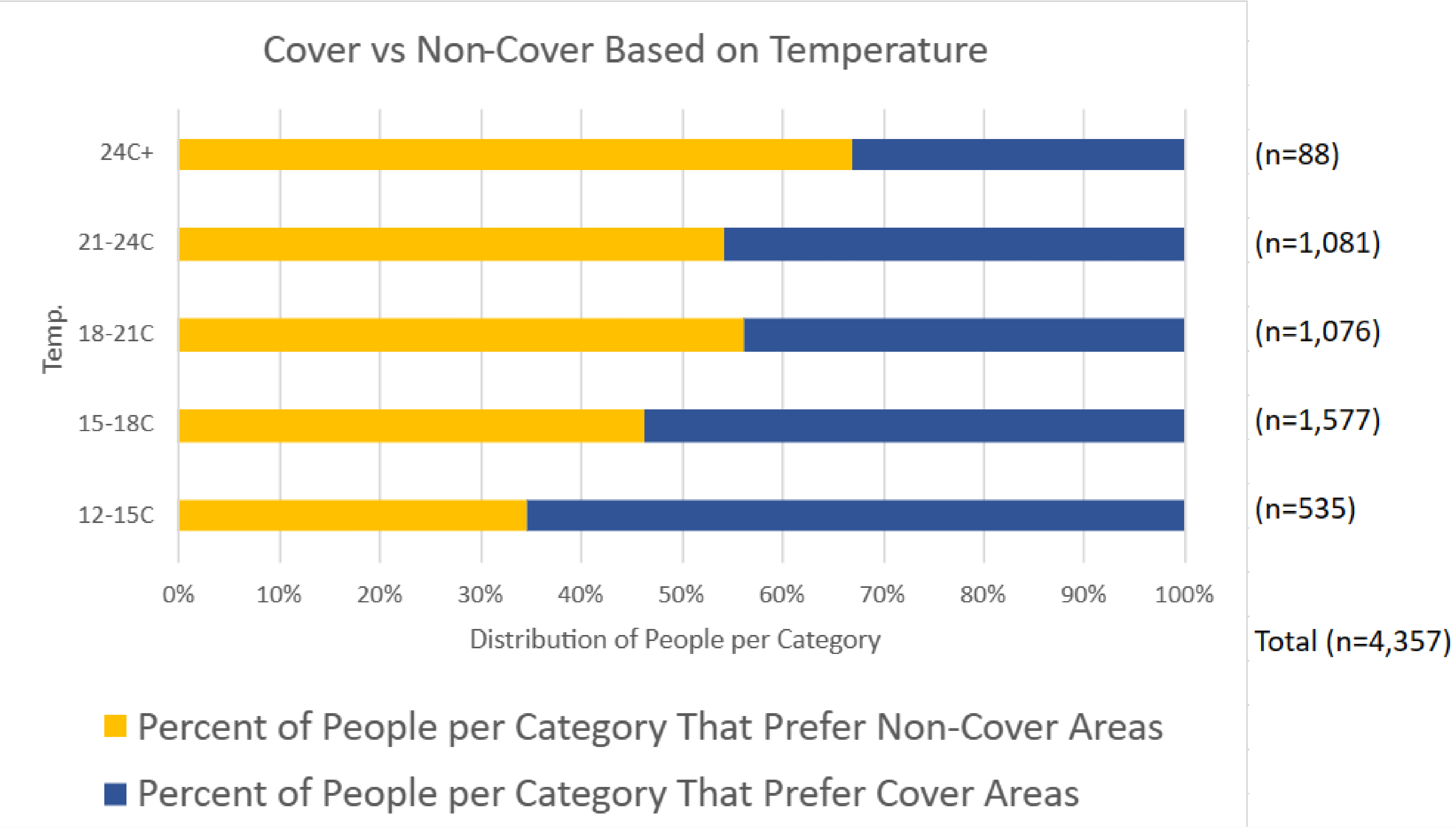

Figure 12: An increase in temperature also shows an increase in preference for non-covered areas

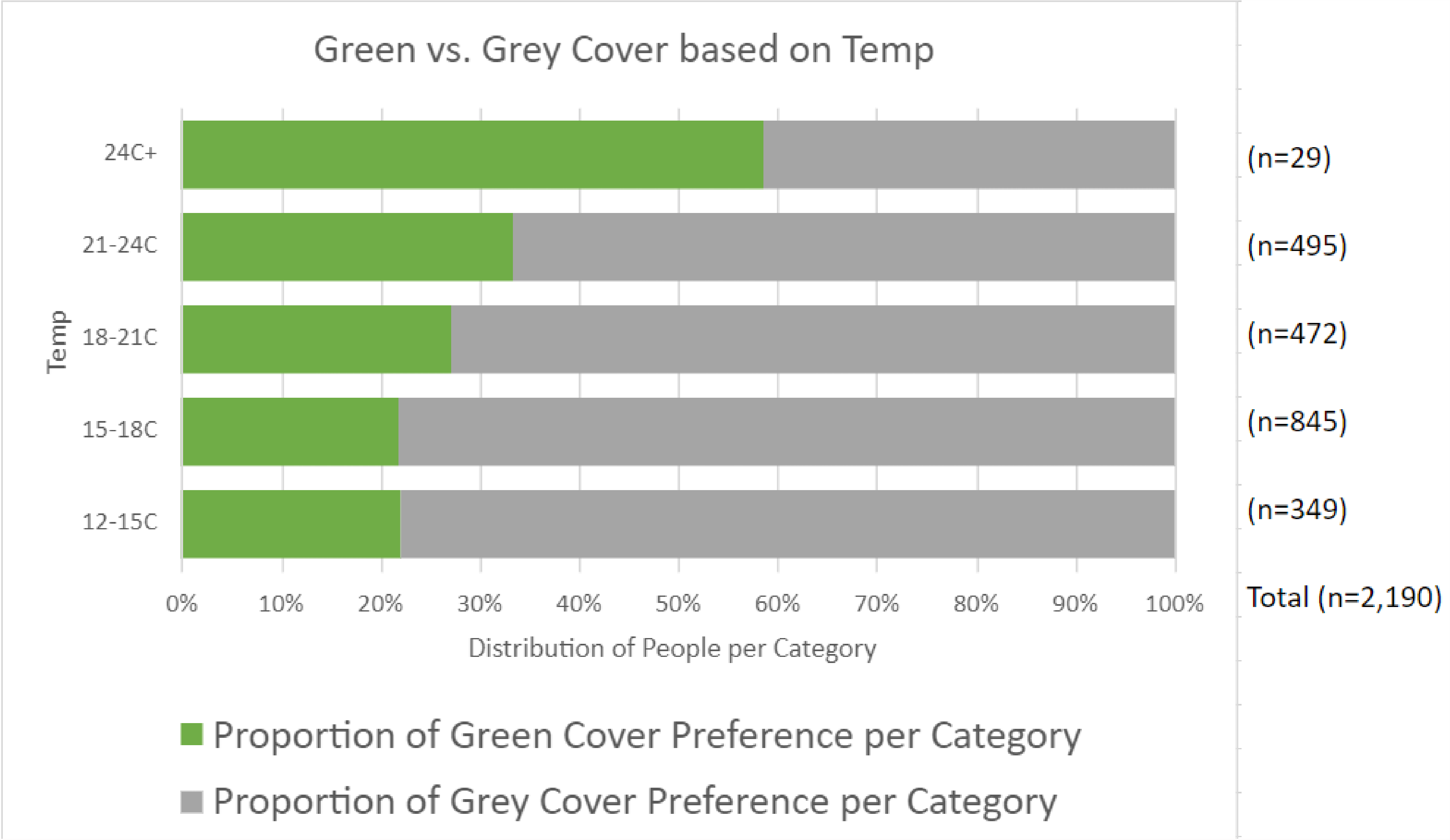

Figure 13: For those who choose to be in cover, the preference for green cover increases as temperature rises.

Findings and Discussion

SEATING CONFIGURATIONS

When analysing the static maps we observed three key areas where visitors tended to congregate: waterfront fences, benches that face the water, and group benches. The group observed that groups were often found in areas that can be defined as “shared” public spaces where many people can congregate at once, as opposed to “personal” public spaces such as an isolated bench. We observed many users naturally formed a circular orientation whether it was standing or sitting. As shown in Figure 14, multiple groups had set themselves up in the circular formation without any aid from waterfront structures.

Figure 14: Image from Tai Po Waterfront Park.

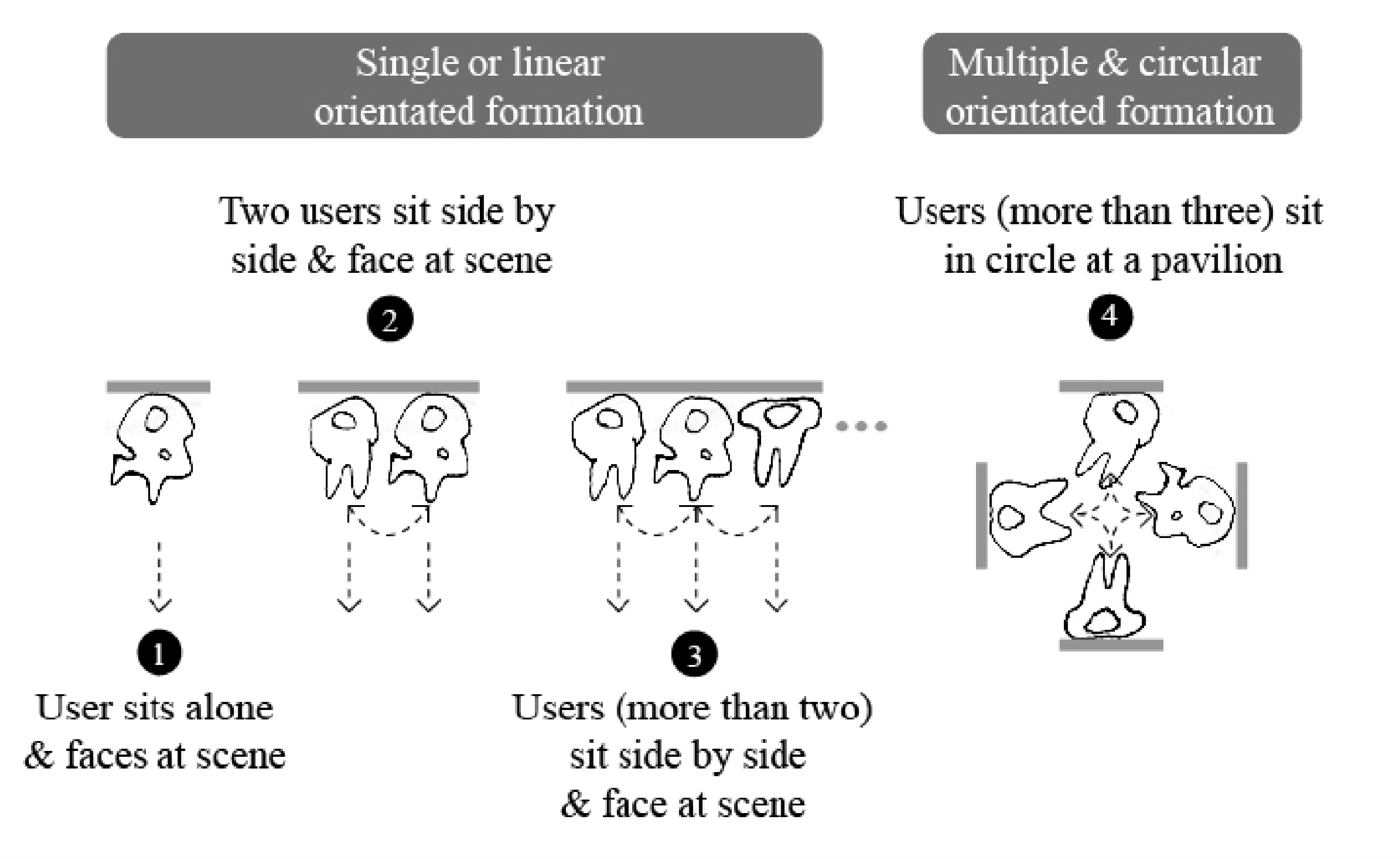

Figure 15: A diagram of the difference between a liner and circular seating arrangements.[27]

Circular seating formations allow users to face each other and, therefore, heighten community interactions. Figure 15 demonstrates the difference between linear and circular seating arrangements. Park benches are linear formation seating arrangements and allow for one to two users to sit and face a view. Picnic benches are circular and are a more comfortable sitting arrangement for multiple users.

Findings and Discussion

Linear formations do not support the ability for multiple users to face each other comfortably. As depicted in Figure 16, the three men on the left were in conversation, orienting their bodies to try face each other despite the linear seating arrangement. Arrangements like benches allow one or two users to face forward, but as the image shows the group was not interested in facing the waterfront. A circular seating formation would have enabled this group to face each other and converse more easily.

Figure 16: Image from Sheung Wan waterfront.

Figure 17: Image of two people on Sheung Wan waterfront.

Activities such as eating together are important for promoting social interactions. Linear formations do not support the ability to eat a meal together as seen in Figure 17. A circular formation, such as a picnic table, would significantly improve this experience and could potentially heighten visitor retention. Infrastructure such as a picnic table would not only provide a comfortable space to place one’s food, but it would allow for face-to-face interactions.

Findings and Discussion

The static activity maps of waterfronts showed that certain areas consistently attracted people. Those areas were mostly benches, pavilions, and along the railings of the waterfronts. Therefore, a balance of covered and non-covered areas is needed to support these common movements as pavilions are usually covered and benches can be both covered and non-covered. Noting the elements that respectively label these waterfronts can be seen as a standardisation of understanding what factors impact this balance.

KWUN TONG WATERFRONT PROMENADE

Kwun Tong serves as a prime example of a waterfront promenade that demonstrates this balance of cover vs non-cover. This waterfront was deemed to be balanced as it provided seating areas that were both covered and non-covered as well as had a variation of tree cover and grey man-made cover structures. The static activity map as seen in Figure 18 shows an even distribution of people throughout the waterfront, highlighting its effectiveness in providing a blend of coverage options.

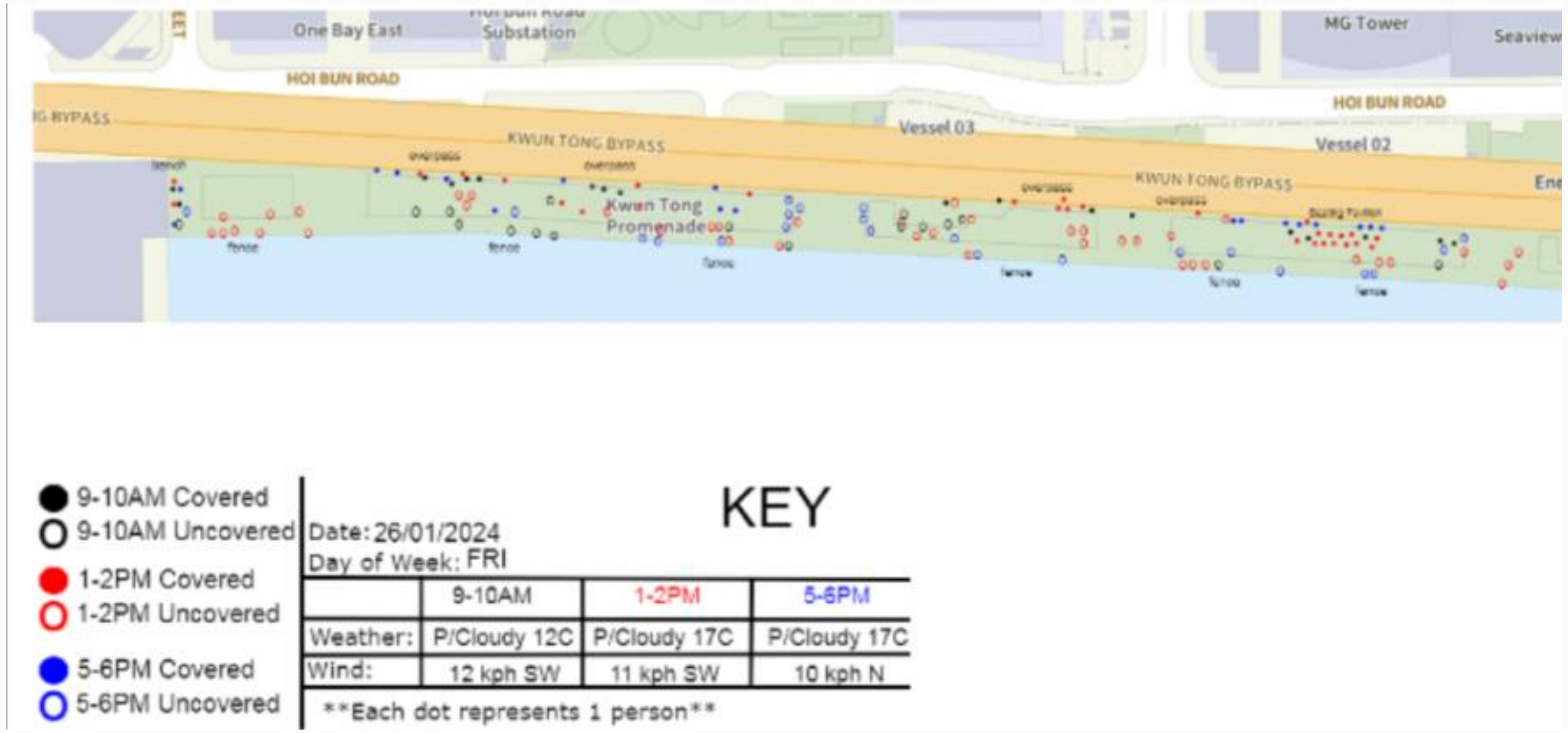

Figure 18: Kwun Tong Waterfront Section 1 Map from January 26th 2024.

Findings and Discussion

LAM TSUEN RIVER PROMENADE

On the contrary, the Lam Tsuen River waterfront lacked this balance, with most of its seating options being uncovered. As a result, waterfront visitors often resorted to sitting in unconventional areas not designed for seating such as a railing (Figure 19) or on a concrete block leftover from construction (Figure 20). The waterfront only features covered benches on a select portion of the promenade. In most cases, uncovered benches were available but were often not used, as seen in Figure 21, the uncovered benches often had bird droppings on them making them an undesirable place to sit.

Figure 19: People sitting under an overpass in Lam Tsuen River Promenade.

Figure 20: A man sitting under an overpass under construction in Lam Tsuen River Promenade.

Figure 21: Benches on Lam Tsuen River Waterfront covered in bird droppings.

Recommendations

ADDITION OF CIRCULAR SEATING ARRANGEMENTS

Circular seating formations create a gathering point for community members enabling activities beyond a simple walk along a waterfront. Groups can play games together, sing karaoke, or share meals, all of which promote social connections and enhance community wellbeing. When circular seating arrangements on waterfronts were provided, they were utilised, with Figure 22 showing a group of men sitting playing Xiangqi (Chinese chess) on the Sha Tin waterfront. We suggest for Designing Hong Kong to request for the Harborfront Commision Board to incorporate more circular seating to promote greater user satisfaction as well as increase social engagement.

Figure 22: Group on Sha Tin waterfront.

FURTHER CONSIDERATION INTO THE SPECIES OF TREES PLANTED

Throughout the study, we observed that certain trees provide a better amount of shade below them than others. For instance, in Figure 23 the Chinese Banyan tree is seen to provide a larger amount of shade than the Royal Palm tree pictured in Figure 24.

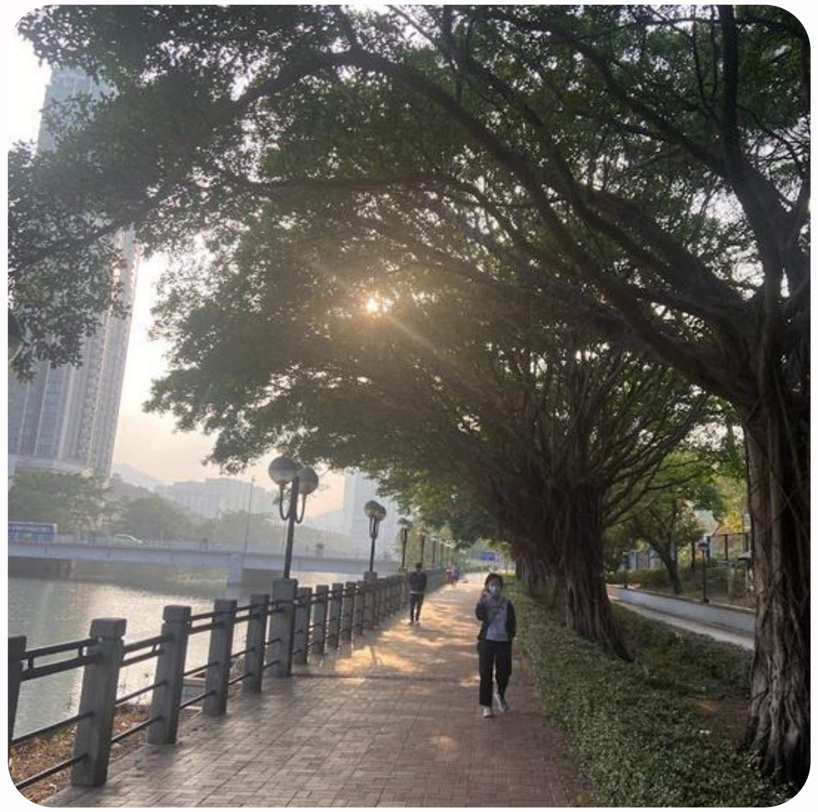

Figure 23: A Chinese Bayan tree on the Sha Tin waterfront.

Figure 24: A Royal Palm tree on the Tai Po waterfront.

Recommendations

As discussed, the preference for green cover over grey increases with the temperature. Given Hong Kong's subtropical climate, where warm weather conditions are prevalent for most of the year, the choice of tree used as green cover, specifically the amount of shade that a species provides, is critical. Trees absorb and reflect solar radiation and are environmentally friendly ways of cooling surfaces below. As opposed to the grey infrastructure, trees do not heat up during the day and emit heat. This ultimately benefits human thermal comfort and can be in the long term more impactful when the most effective species are planted. To determine which types of trees would be most effective, the useful life expectancy (ULE) should be considered. The Chinese Banyan Tree is very effective in providing cover and cooling throughout the waterfronts. These trees also have a high ULE in Hong Kong and can last between 200-500 years. These trees are known as a natural "air conditioner" being able to reach 100 meteres in diameter and significantly cool down its shaded areas.[28] The Chinese Banyan Tree is one example of a type of tree that would significantly improve usability and comfort of Hong Kong waterfronts.

An analysis by the Hong Kong Observatory concluded that the annual mean temperatures have increased by 0.30 degrees Celsius per decade (1994-2023).[29] This is significant because in our study as shown in Figure 13, the preference for green cover increased as temperatures increased. The incorporation of more trees that effectively provide cover would not only benefit the environment but align with behavioural patterns that we observed on the waterfronts as temperatures increase.

CONTINUE THE RESEARCH INTO THE SUMMER MONTHS

This project was conducted during the winter months which only represent about two months of the weather conditions in a year in Hong Kong. As seen in observation, even the cooler months house activities, as seen in Figures 25 and 26.

Because of the region's subtropical climate, the usual temperature and weather patterns differ significantly from those conducted during this study. Therefore, our team recommends a follow-up study during July or August, six months from when this study was conducted, to evaluate changes in the desire from patrons for both green and grey structures. With summer temperatures in Hong Kong well over 30 degrees Celsius, we consider collecting data on the static activity patterns of waterfront visitors during this period highly valuable.

Figure 25: Visitors using Tai Po Waterfront Park Promenade.

Figure 26: Tai Po Waterfront Park Promenade.

Conclusion

The most local and accessible outdoor spaces in Hong Kong are the waterfronts; they can be characterised as green-blue spaces, natural and semi-natural areas within an urban area. Due to this extreme density of the city, the people of Hong Kong resort to public spaces such as malls, markets, parks, and waterfronts for community interaction and more space. As residential spaces are limited in Hong Kong the importance of accessible public ones become crucial. With the recognition of the unique features of each waterfront, shaped by diverse current uses and configurations, the team employed a mixed-method approach, combining the tracking of people's behaviour and activities with observation. This activity tracking helped us identify correlations between cover created from the infrastructure on the waterfront and the choices of activities of visitors. The group conducted a thorough observation of people's behaviours at the waterfront, emphasising their stationary activities, and examining and comparing where these occur.

Our study concluded with three major takeaways. It was found that waterfront fences, benches that face the water, and grouped benches are areas where people choose to spend time when static. Additionally, temperature has the greatest impact on peoples' behavior, with more people choosing non-covered areas at higher temperatures, at least in the winter season. There are three recommendations that we propose: DHK should advocate to the waterfront commission board to incorporate more centralised seating and a better balance of cover vs non-cover seating areas, as well as considering the species of trees planted along the waterfronts. Additionally, we recommend for that Hong Kong University completes a follow-up study in the summer months. These recommendations aim to enhance the waterfront experience, accommodating the varying preferences and environmental conditions.

Figure 27: Ma On Shan Promenade

References

1. World Population Review. (2023). *Hong Kong Population 2020 (Demographics, Maps, Graphs)*. World Population Review. https://worldpopulationreview.com/countries/hong-kong-population
2. *Hong Kong Urban Population 1960-2022*. (n.d.). Macrotrends. https://www.macrotrends.net/countries/HKG/hong-kong/urban-population
3. Wong, B. (2022, June 30). *"Cage Homes" in Hong Kong a Stark Reminder of Its Inequities*. Time. https://time.com/6191786/hong-kong-china-handover-cage-homes/
4. Espinosa, G., Letourneau, M., Onffroy, M., & Valle, S. (2023). WPI (Worcester Polytechnic Institute) Hong Kong Project Center 2023 IQP. E-project-030323-004225
5. Shunlin Liang, Li, X., & Jindi Wang. (2012). *Advanced remote sensing*. Academic Press.
6. Wang, M., Song, H., Zhang, W., & Wang, Y. (2023). The Cooling Effects of Landscape Configurations of Green−Blue Spaces in Urban Waterfront Community. Atmosphere, 14(5), 833−833. https://doi.org/10.3390/atmos14050833
7. Ho, J. Y., Shi, Y., Lau, K. K. L., Ng, E. Y. Y., Ren, C., & Goggins, W. B. (2023). Urban heat island effect-related mortality under extreme heat and non-extreme heat scenarios: A 2010–2019 case study in Hong Kong. *Science of the Total Environment*, *858*, 159791. https://doi.org/10.1016/j.scitotenv.2022.159791
8. Landscape Architecture Aotearoa. (2023). An ecological spine in China. *Landscape Architecture*. https://www.landscapearchitecture.nz/landscapearchitecture-aotearoa/2023/3/2/an-ecological-spine-in-china
9. Greening, Landscape & Tree Management Section Development Bureau. (2018). Street Tree Selection Guide 8.1 Introduction. https://www.greening.gov.hk/en/greening-landscape/right-plant-right-place/street-tree-selection-guide/index.html
10. Knight, T., Price, S., Bowler, D., Hookway, A., King, S., Konno, K., & Richter, R. L. (2021). How effective is "greening" of urban areas in reducing human exposure to ground-level ozone concentrations, UV exposure and the "urban heat island effect"? An updated systematic review. *Environmental Evidence*, 10(1). https://doi.org/10.1186/s13750-021-00226-y
11. Lan, H., Lau, K. K.-L., Shi, Y., & Ren, C. (2021). Improved urban heat island mitigation using bioclimatic redevelopment along an urban waterfront at Victoria Dockside, Hong Kong. *Sustainable Cities and Society*, 74, 103172. https://doi.org/10.1016/j.scs.2021.103172
12. Szűcs, Á. (2013). Wind comfort in a public urban space—Case study within Dublin Docklands. *Frontiers of Architectural Research*, 2(1), 50–66. https://doi.org/10.1016/j.foar.2012.12.002
13. Coutts, A and Tapper. N. (2017). Trees for a Cool City: Guidelines for optimised tree placement. Melbourne Australia: Cooperative Research Centre for Water Sensitive Cities. Key environmental components influencing human thermal comfort during the day. Paper retrieved March 1, 2024 from, https://www.researchgate.net/publication/343993985_Trees_for_a_Cool_City_Guidelines_for_optimised_tree_placement.
14. Weather Spark. (2024). *Average Weather in Hong Kong, Hong Kong SAR China, Year Round*. Weather Spark. https://weatherspark.com/y/127942/Average-Weather-in-Hong-Kong-Hong-Kong-SAR-China-Year-Round
15. Toftum, J. (2004). Air movement--good or bad? *Indoor Air*, 14(s7), 40–45. https://doi.org/10.1111/j.1600-0668.2004.00271.x
16. Zardo, L., Geneletti, D., Pérez-Soba, M., & Van Eupen, M. (2017). Estimating the cooling capacity of green infrastructures to support urban planning. *Ecosystem Services*, *63*(4), 225–235. https://doi.org/10.1016/j.ecoser.2017.06.016
17. Hao, T., Chang, H., Liang, S., Jones, P., Chan, P. W., Li, L., & Huang, J. (2023). Heat and park attendance: Evidence from "small data" and "big data" in Hong Kong. *Building and Environment*, *234*, 110123. https://doi.org/10.1016/j.buildenv.2023.110123

References

18. *Hunter's Point South Waterfront Park - Projects - Weiss/Manfredi*. (n.d.). www.weissmanfredi.com. https://www.weissmanfredi.com/projects/15-hunter-s-point-south-waterfront-park
19. Vecerka, A. (2021). Hunter's Point South Park in Queens, by Weiss/Manfredi in collaboration with Arup and SWA/Balsley. [Online Image]. In *Architectural Digest*. https://www.architecturaldigest.com/story/these-innovators-are-transforming-nycs-waterfront-green-spaces
20. White, M. P., Elliott, L. R., Grellier, J., Economou, T., Bell, S., Bratman, G. N., Cirach, M., Gascon, M., Lima, M. L., Lõhmus, M., Nieuwenhuijsen, M., Ojala, A., Roiko, A., Schultz, S. P., Van den Bosch, & Fleming, L. E. (2021). Associations between green/blue spaces and mental health across 18 countries. *Scientific Reports*, *11*, 8903. https://doi.org/10.1038/s41598-021-87675-0
21. McCartan, C. J. (2020, July 28). *Green and blue spaces - mental health benefits of being outdoors*. Health Research Authority. https://www.hra.nhs.uk/planning-and-improving-research/application-summaries/research-summaries/green-and-blue-spaces-mental-health-benefits-of-being-outdoors/#:~:text=Exposure%20to%20green%20and%20blue
22. Lee, C. (2020, September 2). *Hong Kong's public space problem*. BBC. https://www.bbc.com/worklife/article/20200831-hong-kong-public-space-problem-social-distance
23. First Initiative Foundation, Hong Kong. (2021, May 6). *Interactive public spaces in buzzing city of Hong Kong*. First Initiative Foundation. https://www.fif.org.hk/interactive-public-spaces-in-buzzing-city-of-hong-kong#:~:text=West%20Kowloon%20Cultural%20District%20is
24. Google Earth. (2024). Google Earth. Google.com. https://earth.google.com/web/@22.45075984
25. Sakhri, H., Bada, Y., Emmanuel, R., & Zahariade, A. (2020). USER PATTERNS: OUTDOOR SPACE AND OUTDOOR ACTIVITIES. Present Environment and Sustainable Development Volume 14. Paper retrived March 1, 2024 from, https://doi.org/10.15551/pesd2020141009
26. Hong Kong Special Administrative Region (HKSAR) Government. (2010). [Geographical information map. Hong Kong map provided by the Government of the Hong Kong Special Administrative Region]. GeoInfo Map. https://www.map.gov.hk/gm/
27. Lee, B. & Y.H., Chan, D., & Tang, M. X. (2013). Park Furniture Design in Hong Kong: A Case Study of Inclusive Design and its Relation to User Interaction. Paper presented at Include Asia 2013, 2-3 July 2013, Hong Kong. Retrieved March 1, 2024 from, https://www.researchgate.net/publication/267042345_Park_Furniture_Design_in_Hong_Kong_A_Case_Study_of_Inclusive_Design_and_its_Relation_to_User_Interaction
28. Nursery, K. (2023, January 24). *All You Need to Know About Banyan Trees: A Comprehensive Guide*. Kadiyam Nursery. https://kadiyamnursery.com/blogs/plant-guide/all-you-need-to-know-about-banyan-trees-a-comprehensive-guide
29. Hong Kong Observatory. (2024, January 31). *Climate Change in Hong Kong - Temperature*. Hong Kong Observatory. https://www.hko.gov.hk/en/climate_change/obs_hk_temp.htm#:~:text=Analysis%20of%20the%20annual%20mean