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Public Health and Well-being in Public Open Spaces through Climate Responsive Urban Planning and Design

The Journal of Public Space
ISSN 2206-9658
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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
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THE JOURNAL OF PUBLIC SPACE

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Guest Editors
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Managing Editor
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Vol. 5 n. 2 | 2020

S P E C I A L I S S U E

The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Cover image: *Ponds Dreaming.* Art work by Jill Chism (Sydney, 2011-2014).

The Journal of Public Space
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EDITORIAL

Public health and well-being in public open spaces through climate responsive urban planning and design

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Scope

The urban fabric enables people to move between climate-controlled environments (such as home and indoors work) and non-controlled ones (such as parks and beaches). The planning and design of urban spaces, on the other hand, largely define the way we live and affect our health as it can, for instance, promote or hinder active lifestyles and social cohesion (Owen, 2009; Speck, 2012). But even when the cities have compact built form and provide key features and infrastructure conducive to healthy lifestyles, local climate can indirectly dictate and restrict the use of public open spaces if the weather is prohibitive (Tavares & Swaffield, 2017). Climate responsive urban planning and design is, therefore, key to secure a healthy urban lifestyle (Barton, Thompson, Burgess, & Grant, 2015; Kent et al., 2017; Mouratidis, 2017) especially in light of frequency and severity of extreme weather events.

The impacts of climate responsive urban planning and design can also be observed through the factor determining the degree of inclusiveness or exclusiveness of social environments in which a broad range of people can spend time in. In addition, all aspects of public health have a relationship with local microclimates (Brown, Vanos, Kenny, & Lenzholzer, 2015; Monteiro & Velho, 2014) which are also set to be impacted by climate change. The extent of the changes of those microclimates is largely unknown and need to be better understood. As many places are experiencing harsher climate conditions and more extreme weather on macro scale, it is fundamental to plan for the current micro conditions in order to build resilience and adapt well to future challenges.

In terms of healthy lifestyles in conducive microclimates, moderate to rigorous level of physical activity is one of the most effective ways to reduce stress as part of everyday life (Ivory et al., 2015). Aspects of urban life such as walkability, connectivity, mixed-use, diversity of uses, architecture and urban design qualities, and increased density (Iravani & Rao, 2019) affect the level of activity people consciously and unconsciously decide to undertake. Urban planning and design that seeks to avoid urban sprawl in order to bring people closer together is a core pillar when designing for healthy lifestyles. These design attributes include e.g. active travel (walking, cycling, access to public transport), transit oriented developments (TOD's), easy access to public open spaces (Carmona, Tiesdell, Heath, & Oc, 2010; Dannenberg, Frumkin, & Jackson, 2011; Speck, 2012, 2018). Easy access to – and the use of – public open space is important for daily physical activity, meaningful experiences in public places, social encounters with strangers and close friends are fundamental aspects for building a healthy community. If people are close, social encounters among each other will naturally happen, and they will see themselves more frequently and build relationships that make them feel included (Gehl, 2010; Gehl, Kaefer, & Reigstad, 2006). Thus, this can contribute to the improvement of their sense of community and belonging, as well as place identity and, consequently, impact their personal mental health.

In recent years the traditional urban planning – focused on urban infrastructure, transportation, land use and housing – has experienced a paradigm shift towards a people-centred approach. The New Urban Agenda (2016) plays a key role and shifted the attention to health and well-being and part of city-making processes and policies (Mews, Muminovic, & Tranter, 2018). This special issue, 'Public health and well-being in public open spaces through climate responsive urban planning and design', of The Journal of Public Space focuses on the nexus and interrogates the relationship between these dimensions of human life. This issue is premised on the belief that for the United Nations New Urban Agenda - adopted in Quito at the Habitat III Conference on Housing and Sustainable Urban Development (UN-Habitat, 2016) - to work locally it is necessary more than overall regulations or importing solutions from elsewhere. Climate can vary within short distances and the way public open spaces are designed must also vary according to the climatic characteristics of each place. The contributions in this issue come from Finland, China, The Netherlands, Italy, Japan, Switzerland and Rwanda.

While there has been a shift to a people-centred approach to urban planning and design, we acknowledge the current situation where public life has come to a standstill in the face of COVID-19. In this context, places of community cohesion have become potential places for disease outbreak. The urban health challenges presented by COVID-19 are unprecedented in modern times and will certainly impact on how cities are planned and designed in the future. In addition, public open spaces are crucial for the return to

normality once COVID-19 is less of a threat. While we acknowledge all the challenges upon and ahead of us, the contributions to this special issue were collected long before the infectious outbreak as this publication was idealised following up a UN-Habitat Urban Thinkers Campus (UTC) organised by Silvia Tavares and David Sellars held at James Cook University in Cairns and Townsville (Queensland, Australia) in June 2018, with the significant contribution of Gregor Mews, Karine Dupré and Simon Towle. The UTC gathered experts from various disciplines to discuss the relationships between Urban Planning, Urban Design and Public Health. The discussions helped frame locally based actions – at the event focused on the local tropical climate – to advance Cairns and Townsville towards achieving the Sustainable Development Goals (SDGs) (see Tavares & Sellars, 2018).

Content

The content of this special issue is organised based on three main themes: space, society and systems. The first two papers are focused on space. In the first paper, Zhen Xu argues that adverse changes of microclimate are more likely a consequence of local developments than a consequence of global climate change. The author uses CFD (Computational Fluid Dynamics) simulations to compare winter and summer airflow patterns. Results provide evidence to put the microclimate issue (and specifically wind studies) firmly on the agenda of public well-being policy, involving various stakeholders in the development and assessment of urban design code.

In the second article, Marco Maretto, Barbara Gherri, Anthea Chiovitti, Greta Pitanti, Francesco Scattino and Nicolò Boggio used Viterbo (Italy) as a case study to analyse the city as a combination of 'fabrics', including the social, economic and cultural ones. The analysis is based on the morphology of the city and its potential to make the city centre an accessible, pedestrian and child-friendly neighbourhood. The authors focus on the interplay between urban morphology and sustainability and take the city design as a way of controlling the environment. In this regard, microclimate becomes a focus and, when analysed from a combined design and climate data perspective, it can enhance social interaction, enable energy saving in buildings and promote healthy and comfortable urban environments.

The next three papers are focused on the society and how the planning and design of public spaces impacts how societies function and are organised. In the third article in this special issue, Essi Oikarinen focuses on expanding the understanding of climatic experiences both on practical and empirical dimensions. Oikarinen argues that despite the recent developments in dealing with weather, seasonality still affects the rhythm of life and willingness to spend time outside, undermining the local population's health and well-being. The author focuses on the 'white space' of the sub-Arctic region to highlight the potential of developing winter-related spaces which – based on the local urban spaces' affordances – have the potential of adding to the local population's healthy habits.

In the following contribution, Satoshi Sano, Ivan Filipović and Darko Radović discuss the advantages of low-rise high-density residential buildings in Tokyo. The authors highlight that, as in many other places, Tokyo has been moving towards a high-rise low-density urban fabric. Their work shows the bioclimatic and cultural advantages of the traditional urban morphology. In conclusion, the study demonstrates how the design requirements

of bioclimatically responsive semi-exterior spaces coincide with desirable public-private human interaction.

In the fifth paper Marlyne Sahakian, Manisha Anantharaman, Antonietta Di Giulio, Czarina Saloma, Dunfu Zhang, Rupali Khanna, Srikanth Narasimalu, Abigail Marie Favis, Cherie Audrey Alfiler, Sumana Narayanan, Xin Gao and Chenxin Li discuss the importance of green public spaces for sustainable well-being. The study is based on case studies of four South and Southeast-Asian mega-cities, which are in various climatic regions – tropical, subtropical and temperate. The study contributes to the understanding of how different activities are carried out in parks by diverse groups of people, and it concludes discussing tensions that may arise due to the various interests and uses involved.

The next two articles are focused on systems. Kaoru Matsuo, Rui Izumiyama, Shihona Arai, Akiko Tanimura and Yusuke Horie developed an analysis of public space use and thermal environmental and wind conditions to support the design of attractive public spaces in Saitama (Japan) New Urban Centre Area. The study was based on the fact that, due to strict regulations in Japan, there are many underused public spaces due to the lack of use flexibility. The authors propose that visualisation is an effective way of generating discussions towards achieving public consensus through stakeholders' discussions. This consensus is fundamental to develop practical and effective 'placemaking'.

In the last contribution, Ilija Gubic and Oana Baloi present Rwanda's response to urban population growth and 2050 strategic vision based on Green Growth and Climate Resilient Strategy. The study is based on six secondary cities identified as economic nodes of growth and which are currently reviewing their masterplans. The article presents the results of public open spaces assessment and participatory design workshops. It also reports policy changes intended at promoting public open spaces as crucial for healthy urban lifestyles.

To conclude this special issue, two viewpoints highlight important matters focusing on the relevance of understanding the local context. The first one is written by Chuck Wolfe, author of *Urbanism Without Effort* (Wolfe, 2019) and *Seeing the Better City* (Wolfe, 2017), the latter carrying important influence in the 2018 UTC. The second viewpoint was written by Jill Chism, a local artist from Cairns (Australia), who produced the piece *Ponds Dreaming* featured on the cover of this special issue. Jill's work is focused on enhancing the awareness of the impact of people on the local environments and ecosystems, and her viewpoint presents different challenges artists may find when commissioning public art works.

Concluding remarks

UN-Habitat's New Urban Agenda provides a new focus and adds momentum to the research and discussions related to the importance of fair urban environments. Under the auspices of the United Nations, it is imperative that the urban environments - of today and of the future – motivate people to be active, provide frequent and meaningful encounters promoting social connections and consequent inclusion for all citizens. This special issue argues for planning and design of healthy cities for all people by taking context, culture and climate into account. Largely based on case studies coming from diverse geographic locations, the articles in this publication provide valuable evidence of the importance of climate responsive design in promoting healthy future cities.

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To cite this article:
Tavares, S. G., Sellars, D., Mews, G., Dupré, K., Cândido, C., Towle, S. (2020). Public health and well-being in public open spaces through climate responsive urban planning and design. *The Journal of Public Space*, 5(2), 1-6, DOI 10.32891/jps.v5i2.1279

The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

What can urban design learn from changing winds?
A case study of public space in Nanjing (1990s-2010s)

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Abstract
Climate is one of the prominent and persistent factors affecting the human habitat. During the recent urbanization, human society has left remarkable environment footprints including the macro- and micro- climates related to human settlement. It's essential for urban planning decision-maker to contextualize people's wellbeing in the public space and micro-climate changes. The adverse changes of micro-climate are usually related more to local developments than to global changes, with the causality relatively feasible to detect.
Characteristic of openness, the open spaces play an important role as outdoor relaxation and wind corridor, which is precious yet vulnerable assets for the citizens' wellbeing. Agglomerated and unintentional developments inevitably change the wind patterns which potentially affect public life. A longitudinal study of such circumstance will provide knowledge and lessons for sustainable and salutary urban design.
Based on CFD simulation, this paper compared the static winter and summer airflows patterns of the Drum Tower area in downtown Nanjing during the period of 1990s-2010s. The results indicated that the wind pattern complexity increased gradually, the outdoor comfortability degraded dramatically in some areas, the environment inequity might be deteriorated too. The researcher suggests putting micro-climate issues firmly on the agenda of public wellbeing policy, involving various stakeholders in the assessment and urban design code with technical and social supports.

Keywords: public space, urban design, CFD simulation

To cite this article:
Xu, Q., Xu, Z. (2020). What can urban design learn from changing winds? A case study of public space in Nanjing (1990s-2010s), *The Journal of Public Space*, 5(2), 7-22, DOI 10.32891/jps.v5i2.1278

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

1. Introduction

Open space is an area where people can enter freely and spontaneously, including parks and public green spaces, idle places, waterfront areas, etc. (Lynch, Banerjee and Southworth, 1990). The design concept of open space is often conducive to the occupation and use of the public, providing residents with recreational places, encouraging outdoor activities and creating a vibrant city. Open spaces also have an important impact on the health of residents. A study in Japan analysed the survival rate of 3,144 elderly people and concluded that urban green space has a positive impact on the elderly (Takano, 2002).

When external conditions, weather and open spaces are attractive, people spontaneously participate in activities including walking, breathing fresh air, stopping to watch interesting things, sun exposure, and so forth (Gehl and Koch, 2011). Recent studies have shown that the wind environment is an important factor in the use of open space (Lin et al., 2012; Zacharias, Stathopoulos and Wu, 2001; Thorsson, Lindqvist and Lindqvist, 2004; Nikolopoulou and Lykoudis, 2007; Eliasson et al., 2007). The wind environment at the pedestrian level is most closely related to human behaviour. Under different outdoor wind speeds at the same temperatures, the human body has different thermal comfort. Neglecting human comfort can lead to a reduction in people's outdoor activities, thereby reducing the city's vitality. The wind environment is also related to heat island effects and air qualities. Oke's observations from a large number of urban heat island effects have found that urban ventilation can promote air circulation, greatly reducing air pollution and even eliminating urban heat islands (Oke, 1973). Liu et al. conducted a study of particulate matters (PM10 and PM2.5) in Beijing for 9 years (2004-2012) and found that the concentration of particulate matter was negatively correlated with wind speed (Liu et al., 2014). Although we cannot change the regional climate, the optimization of build environment can improve the wind comforts of urban outdoor public spaces, thus effectively extending the comfortable time of outdoor climate.

Incorporating climates into the urban design can be traced back to more than 2,000 years ago. In "Ten Books on Architecture", Vitruvius (70BC-15BC) discussed the impact of different climates on the layout of towns and buildings (Vitruvius, 2003). But climate knowledge was rarely applied during urban planning (Eliasson, 2000; Mills, G. 2006), and for the first time in the 1960s and 1970s Germany applied urban climate research to practice (Matzarakis, 2005). Urban planning guidelines, tools like climate maps (Oke, 1984; Bitan, 1988; Golany, 1996), and literature (Balázs, 1989; Evans and Schiller, 1996) have gradually successfully incorporated climate into urban planning. In the current urban planning and design of China, the wind environment of urban outdoor space has not yet received enough attention. Few quantitative winds have been considered in the urban plan or the pre-stage analysis of the urban design.

For urban designers, understanding people's perceptions and assessments of the surrounding environment to urge urban structural reforms is a necessary condition for maintaining the qualities of urban life, such as the reduction of European heatwaves in 2003. The qualities of the public spaces in the city depend on various aspects, and wind comfort has been identified as one of the important factors (Eliasson et al., 2007; Zacharias, Stathopoulos and Wu, 2001). Climate-unaware urban planning exacerbates the already fragile urban microclimate environment, causing public spaces to be

underutilized or idle due to providing an uncomfortable thermal comfort environment and seriously affecting the quality of life of urban populations.
City Centres with dense buildings, overlapping functions, and population agglomeration, face even more prominent problems regarding the wind environment of the city. Since the 1990s, the functions and infrastructures of the old city of Nanjing have been rapidly regenerated, the population has continued to grow, and the urban form has undergone tremendous changes. The high-rise buildings and architectural groups around the open spaces in the urban centre area are increasing, the street canyon effects are enhanced, the space type and spatial form are complex, and the wind environment of the open space faces relatively more complicated factors. Therefore, the wind environment of open space in this high-density urban has become an urgent problem to be solved.
The purpose of this paper is to explore the impact of urban changes on the wind environment in open spaces from a historical perspective. Based on the open space of the Drum Tower area (Nanjing, China) and the surrounding buildings during the period of 1990s-2010s the wind environments on the open space were simulated and it was expected to provide a basis for future urban renewal.

2. Methodology

2.1 Case studies and background

Nanjing is one of the fastest-growing and most densely populated cities in China in the past 20 years. The population of Nanjing has increased by more than 1 million and the city has expanded by 5 to 10 times (Wang et al., 2012). Summer and winter are the representative seasons of Nanjing, and the high humidity exacerbates the summer high heat index and the winter low heat index. Outdoor public spaces in summer and winter have a greater restrictive effect on people's activities, affecting the use of open space.
The annual wind speeds do not change much, and winds will blow in all directions in Nanjing, showing in Figure1. The northeast wind, east wind and southeast wind have a higher frequency, which must be paid attention to in urban planning.

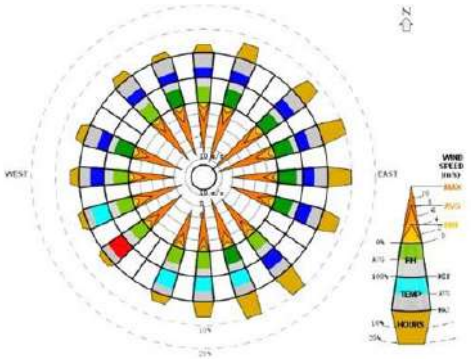


Figure 1. Wind speed and direction in Nanjing.
(Source: Authors)

The Drum Tower area with the important public spaces is an urban centre area with dense buildings, traffic congestion and population agglomeration in Nanjing, China. Since the 1990s, according to the urban planning, this area has begun a large-scale transformation and development in a concentrated manner. The spatial form was large and diversified, and the building height was constantly developing. The most prominent change in the study area was the height of the buildings. In the 1990s, the buildings were dominated by multiple floors, and they were transformed into high-rise buildings in the 2010s. During the same period, 450-metres-high Zifeng Tower was built in this area. Open spaces, especially civic squares and plazas, had been rare until the 1990s. From then on, the local government gradually invested on construct civic squares to provide outdoor public space for the citizens. The form of ventilation corridors in cities such as

roads and open spaces have remained basically the same, roads have been expanded, and buildings have only been relinquished in some areas. The main open spaces in the area were university, plazas, parks, secondary school, roads and intersections. All the buildings and roads data in this area came from the government.

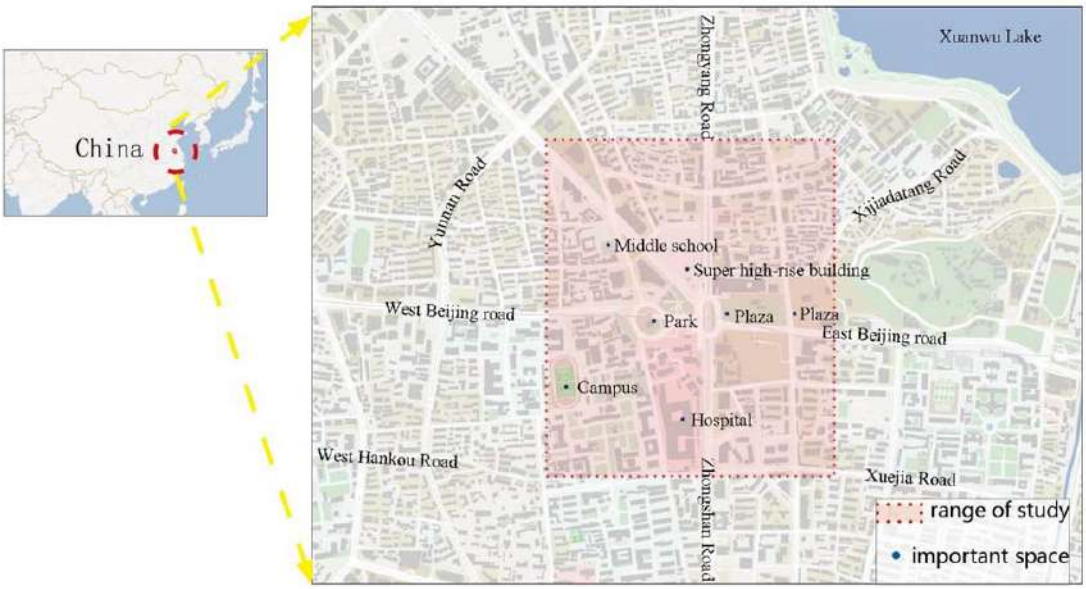


Figure 2. Location of the Drum Tower and Important space
(Source: Authors)

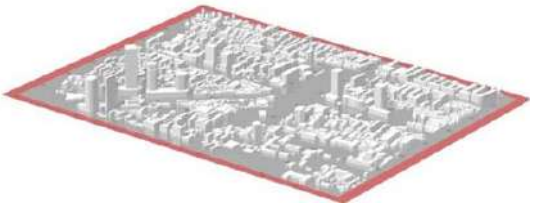


Figure 3. The 3D model of the Drum Tower area, 1990s
(Source: Authors)

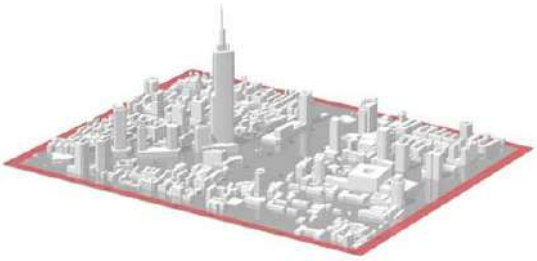


Figure 4. The 3D model of the Drum Tower area, 2010s
(Source: Authors)

2.2 Research methods

In recent years, a specific software of computational fluid dynamics (CFD) has come out, which is low-cost and controllable compared to wind tunnel simulation. Studies have shown that the reliability of CFD for fluid simulation has been widely used in the urban-scale (Murakami et al., 1999). The commercial CFD software XFlow2017 was chosen for this study as it had been used extensively in the automotive industry, aviation, construction, civil engineering, and other industries. XFlow2017 uses the large eddy simulation (LES) model, which has been proven to be more accurate compared to the Reynolds-Averaged Navier–Stokes (RANS) at lower wind speeds (Blocken et al., 2016). Combined CFD software with historical maps of the 1990s and 2010s, the

historical wind environments were deduced, based on the maps of the two periods the buildings modelled in three dimensions by AutoCAD.
To make modelling simpler and manageable, during the modelling process, the outlines of the buildings were simplified. The height of the building was stretched based on the number of layers as building height was indicated this way on the historical maps. Such simplification provides sufficiently accurate buildings for simulation of wind environment particularity on such a large scale. The shrubs and arbours were omitted during the modelling process, and the sloping roofs were also reduced to flat roofs because of the incomplete records of roof forms, shrubs, and arbours in the 1990s. On the other hand, Xu and Han (2018) found that the flat roof or sloping roof and the shrubs and arbours have little effect on the wind environment at large scales.

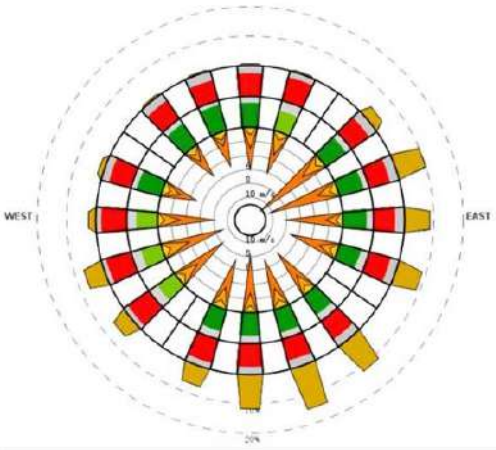


Figure 5. Wind speed, direction, frequency statistics in summer
(Source: Authors)

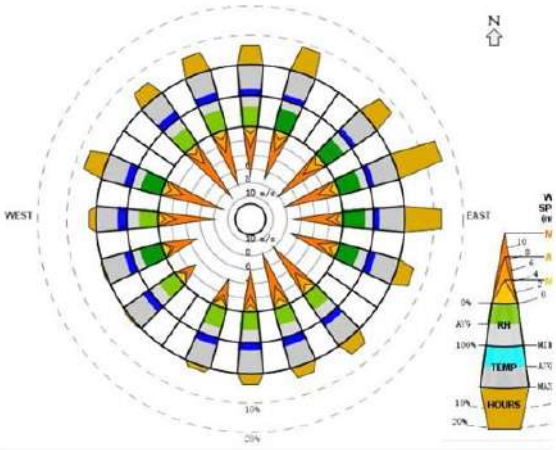


Figure 6. Wind speed, direction, frequency statistics in winter
(Source: Authors)

This paper simulated the wind environment in summer and winter. The meteorological data was the Chinese Standard Weather Data standard provided by the US Department of Energy (gathered and organized jointly by Tsinghua University and the China Meteorological Administration) and the sampling point is 582380. Then wind speed and direction data were analysed in 2016 by the Climate Consultant 6.0 developed by Robin Liggett and Murray Milne at the University of California, Los Angeles Energy Design Tool Research Group. The wind is a process of random fluctuations over time, but average wind speed is an effective and simple parameter for evaluating wind conditions (Melbourne, 1978), so this paper simulated with the average wind speed. In Figure 5 and Figure 6, the wind direction with the highest frequency of summer (June to August) in Nanjing was south-southeast (SSE), and the average wind speed of the dominant wind was about 3m/s. In winter (December to February), the wind direction whose frequency of occurrence was highest was east-northeast (ENE) and the average wind speed of the dominant wind was about 3 m/s. In this paper, the average wind speed of the dominant wind direction was used as the simulation data for the Drum Tower area. Both periods used the same wind speed and direction instead of the average speed for different periods, so we assumed that the wind speed changes were entirely determined by build environment changes.

2.3 Defining Comfort Criteria

Choosing appropriate wind comfort evaluation criteria is the key to the reliable evaluation of pedestrian level wind environment. Regarding the evaluation of the wind environment, there are significant differences in the criteria for the threshold value of wind speed comfort in various countries or studies. In 2006, the Ministry of Construction of China issued the "Green Building Evaluation Standard", which required that the wind speed was less than 5m/s around the pedestrian area in the outdoor, which did not affect the comfort of outdoor activities and building ventilation (Wang and Qin, 2006). In addition to wind speed, the frequency of wind speed is also very important. The American Society of Municipal Engineers proposed wind comfort indicators for various outdoor activities, which specified the average wind speed and gust wind speed threshold and maximum allowable overrun probability for different activities, as shown in Table 1 (American Society of Civil Engineers, 2003). Such standards need to be observed for a period of time, while also ignoring the decline in comfort caused by weak winds in urban centres. Low wind speeds lead to a decline in air quality, pollutants could not be eliminated, and the possibility of epidemics increased (Ng, 2009). The authors of the book Urban Planning and Atmospheric Environment (2004) recommended 1m/s as the standard for urban air pollution diffusion. Furthermore, to enhance the ventilation for pedestrians, in 2015, the Hong Kong Government has developed detailed technical guidelines and plans for high-density, low-speed cities, entitled "Feasibility study for establishment of air ventilation assessment (AVA) system". It was considered that the wind environment with a wind speed exceeding 1.5 m/s pedestrian level was acceptable, but the wind comfort was not specified (Ng, 2009). From the perspective of thermal comfort, Cheng and Ng combed the research on the thermal comfort of the area close to Hong Kong's climate and proposed that 1m/s to 2m/s in the shade is required in summer (Cheng and Ng, 2006). The thermal comfort in cold winter was different from the demand for wind in the hot summer. The wind will worsen the feeling of cold in the outdoors. Yang et al. (2015) believed that the wind speed of 1~2m/s in winter is tolerable. Based on the above various standards and considering the balance of climatic conditions in Nanjing, thermal comfort, mechanical comfort and air quality in Nanjing, we concluded that the acceptable wind speed in summer was 1m/s≤v<5m/s and the acceptable wind speed in winter was 1m/s≤v<2m/s.

Table 1. Comfort Criteria, Based on 5% or 20% probability of Exceedance
Source: American Society of Civil Engineers (2003)

Comfort Level Guideline	Activity	Comfort Ranges for $\underline{U}$ and U_{GEM} 5% probability	Description of Wind Effects	Approximate Corresponding Range for $\underline{U}$ and U_{GEM} at 20% probability
C1+	Exceeds Comfort Criteria	>10m/s	Umbrellas used with difficulty Hair blown straight Difficult to walk straight Wind noise on ears unpleasant	6.8m/s

C1	Walking Purposefully or Business Walking	0-10m/s	Force of wind felt on body Trees in leaf begin to move Limit of agreeable wind on land	0-6.8m/s
C2	Strolling or Window Shopping	0-8m/s	Moderate, raises dust, loose paper Hair disarranged Small branches move	0-5.4m/s
C3	Standing or sitting-short exposure	0-6m/s	Hair is disturbed, clothing flaps Light leaves and twigs in motion Wind extends lightweight flag	0-3.9m/s
C4	Standing or sitting-long exposure	0-4m/s	Light wind felt on face Leaves rustle	0-2.6m/s

3. Research results and analysis

3.1 Analysis of summer wind environment changes

When it was the summer simulated at an average speed of 3 m/s with prevailing wind direction (ESS), the average speed was 0.71 m/s at the pedestrian level wind (h=1.5 m) in the study area at the 1990s, and the maximum wind speed was 11.27 m/s. The maximum wind only appeared in the narrow space between buildings. In the 2010s, the average wind speed at 1.5m height in the area increased slightly to 0.84m/s, and the maximum wind speed at the pedestrian level reached 18.04m/s, which also appeared in the narrow space between buildings. In the 1990s, the wind speed in this area of 74.82% was <1m/s. After 20 years of urban development, the low wind area (v<1m/s) decreased by 8.54%, and the region wind speed in 1~2m/s of the area increased by 7.37%. The specific speed distribution was shown in Figure 7, Figure 8. The wind speed distribution trends were consistent in the two periods that the larger the wind speed, the smaller the coverage area.

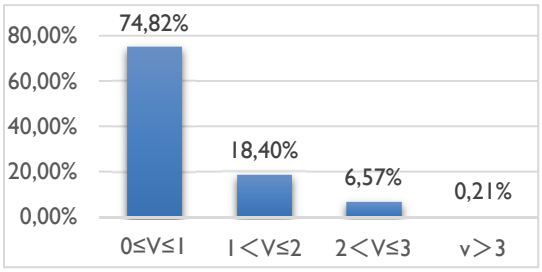


Figure 7. The distribution of wind speed at 1.5m height in the summer, 1990s
(Source: Authors)

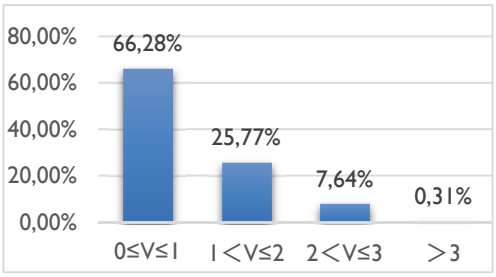
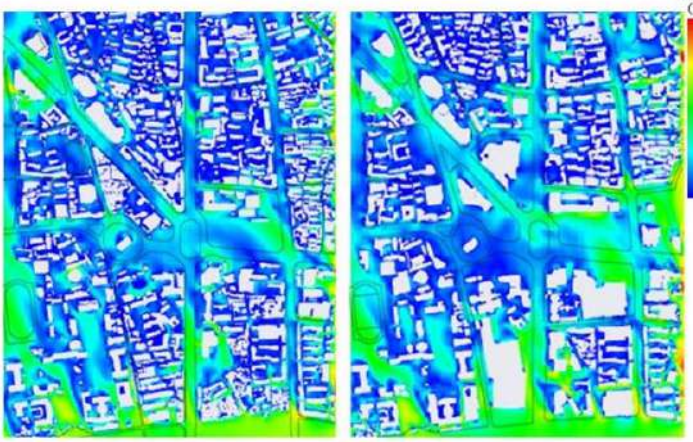


Figure 8. The distribution of wind speed at 1.5m height in the summer, 2010s
(Source: Authors)

In the two periods, wind speeds > 4 m/s appeared only in a very small range, and even difficult to find in the visual representation. Therefore, in the illustrated process, with a maximum threshold of 4 m/s, the wind speeds of outdoor spaces at 1.5m height in the

two periods were as follows Figure 9. The spatial distributions of wind environment on outdoor spaces at pedestrians-level in the two periods were generally similar. Most of the open spaces inside blocks were in low wind speeds, such as the outdoor spaces in the residential area, campus, main roads, intersections, parks, and plazas. The areas with relatively high wind speed were the spaces along the road and the large open spaces. To find the specific wind speed changes in the open space, we overlaid the pedestrian level wind speed of the 1990s and 2010s in ArcGIS, and removed all the architectural areas in the two periods, as Figure 10. We found that the wind speed increase area was larger, and most of the residential areas and roads wind speeds increased, while the large-scale wind speed reduction appeared in campus, middle school, parks, and squares. In the continuous open space in the middle, there are more speed decelerating areas and a large area of low wind speed. Changes in some areas may be overlooked due to the changes in the building or non-building properties over two periods.



1990s 2010s

Figure 9. Wind speed at 1.5m height in the summer (Source: Authors)

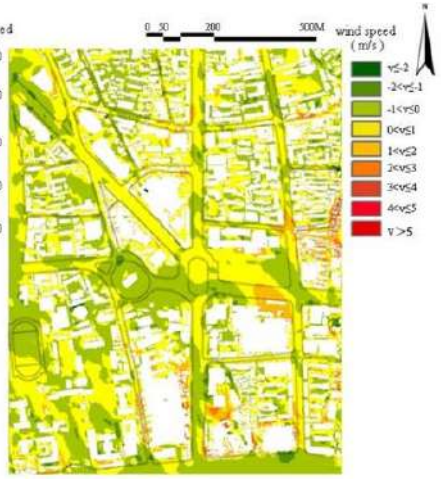
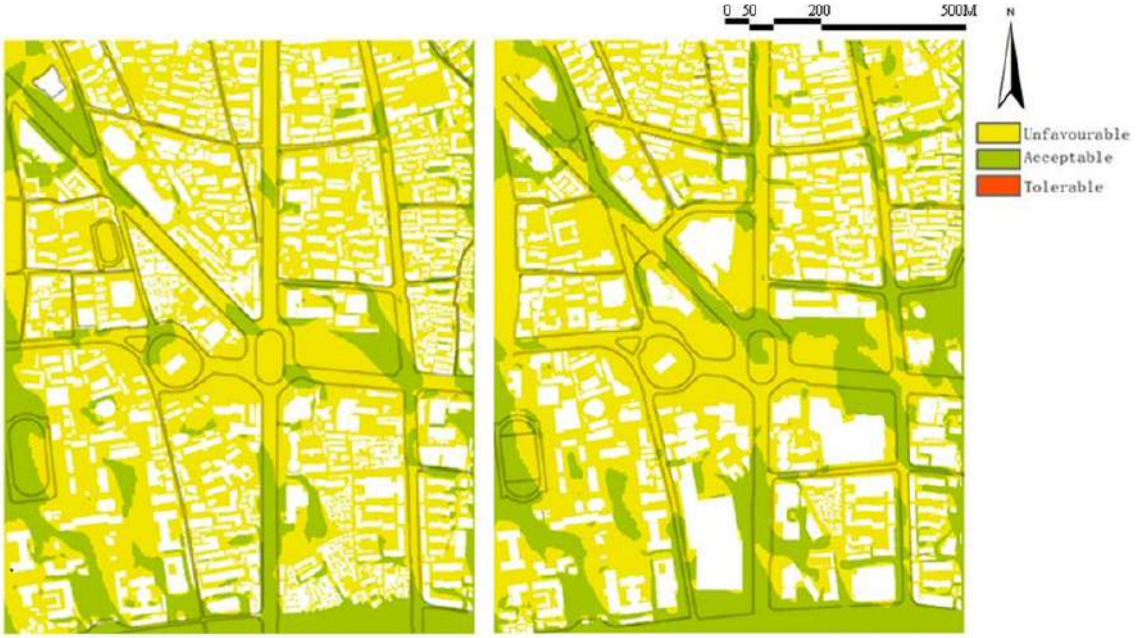


Figure 10. Changes of wind speed at 1.5m height in the summer between the 1990s and 2010s; v>0m/s is the wind speed of the 2010s higher than 1990s, and v<0m/s is the opposite. (Source: Authors)

Combined with the comfort evaluation criteria of pedestrian level wind environment in summer, the 1990s and 2010s outdoor spaces were classified into three categories: unfavourable areas, acceptable areas, tolerable areas, as shown in Figure11. With the average wind speed of the dominant wind direction in summer, 25.17% of the outdoor spaces pedestrian height in the 1990s are acceptable, and the acceptable areas of the 2010s outdoor spaces increased, accounting for 33.72%. The added acceptable area was mainly in the middle of the continuous open space and spaces along with the roads. Unfavourable areas, which may cause problems such as sultry heat and degraded air quality due to low wind speeds, accounted for a large area in both periods. However, with two decades of urban form change, the unfavourable areas have decreased.

Table 2. Assessment results of the wind comfort at 1.5m height for summer
Source: Authors

Comfort zone	1990s		2010s	
	Are(m^2)	Proportion (%)	Are(m^2)	Proportion (%)
Unfavorable areas	612669	74.83	547020	66.28
Acceptable areas	206150	25.17	278314	33.72
Tolerable areas	5	0	5	0



1990s 2010s

Figure 11. Assessment results of wind comfort at 1.5m height for summer
(Source: Authors)

3.2 Analysis of winter wind environment changes

When it was simulated at an average speed of 3 m/s with prevailing wind direction in the winter, the average speed in the study area was 0.70 m/s at 1.5m height in the 1990s, and the maximum wind speed was 3.17 m/s. The average wind speed increased to 0.88 m/s and the maximum wind speed was 17.12 m/s in the 2010s. The 1990s wind speeds were mainly concentrated in 0~2m/s, accounting for 97.38 %. After 20 years of urban development, the outdoor spaces with wind speed <1m/s were reduced by 6.98%, and the range of wind speed 1-2m/s remained unchanged. The specific wind speeds were shown in Figure12 and Fig13.

In the 1990s, the relatively high wind speeds in the study area appeared in the continuous open space. Its long axis had a small angle with the prevailing wind in winter, forming a continuous ventilation corridor. And its wind speed was relatively uniform, between 1~2m/s. The outdoor spaces of the densely built residential area were in a large area with very low wind speeds. In addition to some architectural wind shadow areas, the outdoor spaces of middle school and the university had a wind speed of about 1 m/s in most areas.

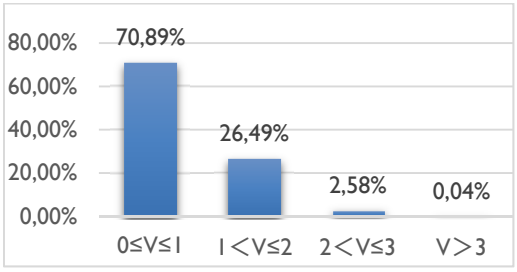


Figure 12. The distribution of wind speed at 1.5m height in the winter, 1990s
(Source: Authors)

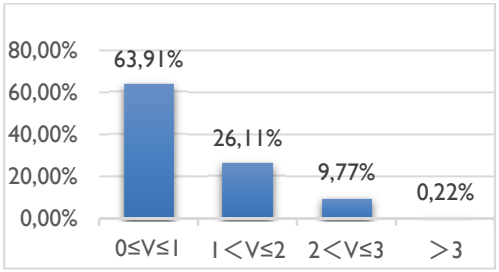
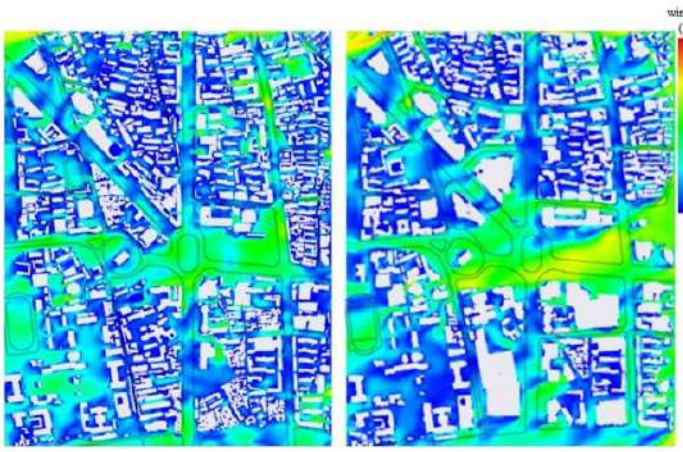


Figure 13. The distribution of wind speed at 1.5m height in the winter, 2010s
(Source: Authors)

In the 2010s, the wind speed in continuous open space was uneven, and some wind speed increased the area with a high wind speed of 2.8m/s, and some wind speeds decreased to cause low wind speeds. Large spaces of residential areas were still at low wind speeds. The wind speeds in the outdoor spaces of the middle school and the university slowed down, and some even experienced a slowdown of 1-2 m/s. The outdoor spaces of the campus were at a low wind speed of about 0.5 m/s. There were no high wind speeds in the new plazas around the high-rise buildings. The wind speeds in the north of the north-south road slowed down and in the south increased.



1990s 2010s
Figure14. Distribution of wind speeds at 1.5m height in the winter
(Source: Authors)

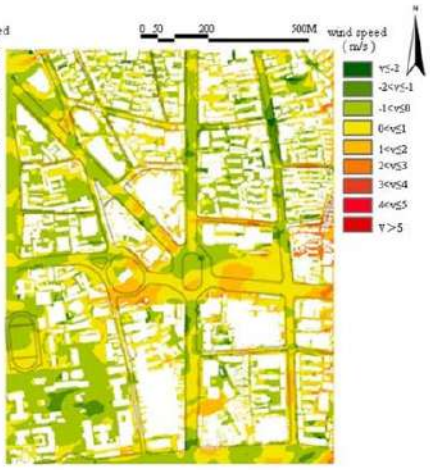


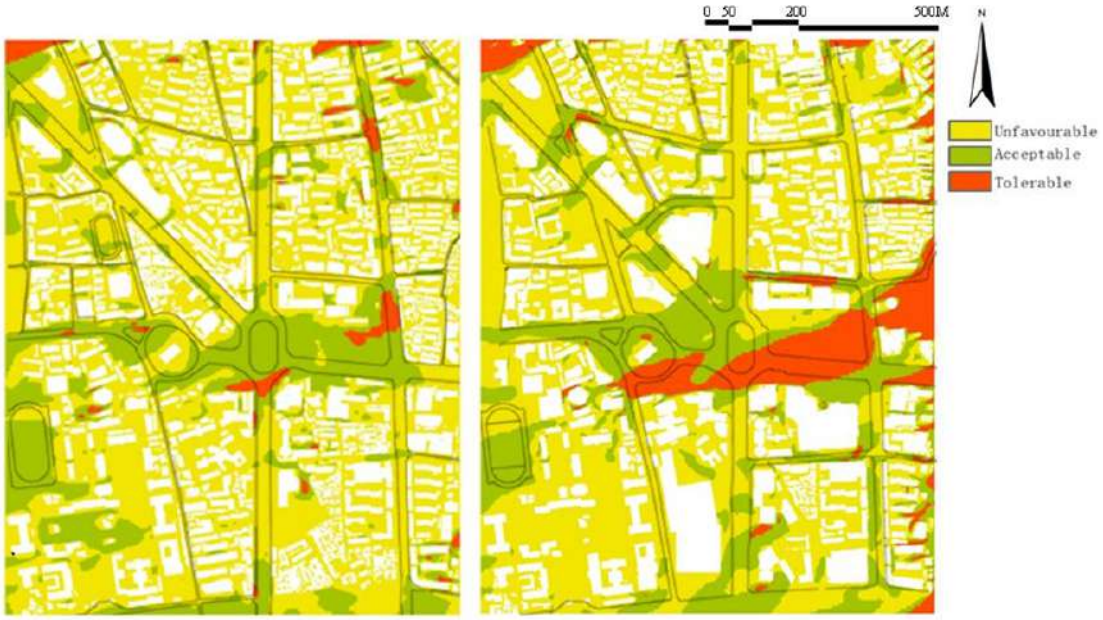
Figure 15. Distribution of wind speed changes at 1.5m height in the winter between the 1990s to 2010s; v>0m/s is the wind speed of the 2010s higher than 1990s, and v<0m/s is the opposite.
(Source: Authors)

Combined with the comfort criteria of the winter wind environment, wind environments of the outdoor spaces were evaluated at 1.5m height in the 1990s and 2010s. We divided the wind environment into three categories the same as summer, as shown in Figure16. 26.11% of the outdoor spaces were relatively comfortable and acceptable at 1.5m height in the 1990s. Its area was close to the 2010s, accounting for

26.49%. In the 1990s, the comfort zone mainly existed in the continuous open space, the campus, and the corners around high-rise buildings. The acceptable areas of the campus and the continuous open space were reduced, the added acceptable areas were the corner spaces around the high-rise buildings. In the two periods, the unfavourable areas of air quality degradation accounted for a large area due to low wind speeds, which was the same as the summer. In the 1990s, the tolerable areas, which affected human activities due to the excessive wind speed, accounted for 2.62%, increased to 9.98% in 2010s. The added tolerable areas were mainly in continuous open space.

Table 3. Assessment results of the wind comfort at 1.5m height for winter
Source: Authors

Comfort zone	1990s		2010s	
	Are(m^2)	Proportion (%)	Are(m^2)	Proportion (%)
Unfavorable area	580281	70.89	527438	63.91
Acceptable area	216813	26.49	215505	26.11
Tolerable area	21477	2.62	82391	9.98



1990s 2010s

Figure 16. Assessment results of the wind comfort at 1.5m height for winter
(Source: Authors)

4. Discussion

4.1 Overall wind environment changes

In the two periods, the average wind speed was between 0m/s and 2m/s at 1.5m height in most of the study area. Therefore, the pedestrian-level wind environment in the Drum Tower area is low-wind in summer and winter, which is similar to the wind environment in most high-density building cities, Such as Hong Kong and Tokyo (Ng, E. 2009). In the two decades, the overall average speed increased in summer and winter at 1.5m height, the unfavorable wind speed area decreased. In summer, outdoor spaces

with relatively comfortable wind speeds increased. Most of the existing research was about the wind weakening phenomenon in the city (Hou et al., 2013; Li et al., 2011). Peng et al. (2018) found that the overall wind weakening in Hong Kong in the past 50 years, but the local weather station showed a slight increase in wind speed from 2010 to 2017 due to the corner effect. For some cities, the reason for the weakening of the wind environment was partly due to the urbanization of the whole city, and some caused by the urbanizations around the wind speed measurement points. In this case, the study area was in central Nanjing with dense buildings in the 1990s and 2010s. In the 2010s, the density of buildings decreased and the building height increased, which is one of the typical models of urban renewal in the central area of big cities. The increase in average wind speed in the study area may be related to the decrease in building density or the corner effect of the high-level buildings. In the 1990s, the residential buildings with small volume and gathering to form a large area of low wind speed areas. In the 2010s, some of these buildings were transformed into giant buildings and the distances between the buildings were increased, so the situation of low wind speed was alleviated. In urban construction, buildings with high density should be avoided as much as possible, or the distance between buildings should be increased. Because the outdoor spaces of this kind of buildings are poorly ventilated at the pedestrian level.

4.2 Wind environment changes in open spaces

In urban planning, the wind environment of urban open spaces should be taken into account when they were used frequently by residents and had a greater impact on their health (Takano, 2002). In the study area, the proportion of acceptable open spaces did not change much, but the spatial organization changed. In the summer, the added open spaces acceptable for comfort were continuous open spaces in the central area (including parks and squares), spaces along the roads, and the reduced acceptable areas were relatively small. In winter, the added acceptable areas were mainly the east-west minor roads, the reduced acceptable open spaces were the campus and continuous open space. In the 2010s, the height of the buildings on both sides of the long axis of the ventilation gallery increased, and its east side changed from the low buildings to open spaces. This caused the wind to directly fill the open spaces, resulting in a faster wind speed into the open spaces. With the influence of the north side high-rise buildings, the wind speeds increased due to the corner effect in some areas. The summer wind environment was more comfortable, but it suffered in the winter. The windward surface of the prevailing wind in summer of open spaces should be open to keep the air flowing, and its windward surface of the prevailing wind in winter should be properly windproof so that it can be more comfortable in both seasons.

The architectural layout of the university had remained largely unchanged, but the changes in the surrounding environment had caused a decline in wind comfort. It gradually became uncomfortable for residents in and around the campus to use open spaces, especially for students at the university. In the design of the buildings, attention should be paid to minimizing the negative impact of the building on the wind environment of the open spaces around it, and some measures can be taken to alleviate the negative impact on the wind in the open spaces. The geometric characteristics of the building can change the airflow pattern at the pedestrian level (Gao et al, 2012). The pedestrian-level wind environment should be simulated during the specific architectures that are designed (Du and Mak, 2018). The architectural design of the overhead floor

was a way to reduce the weakening of the wind environment to the surrounding open space (Du and Mak, 2018).
This study included high-rise buildings and even super high-rise buildings of up to 450m. The wind speed around those buildings increased at pedestrian height (h=1.5m) to form a corner effect, but there was little high-speed turbulence affecting winter wind comfort. It had certain benefits to solve urban air pollution and hot air in summer. The vortex was formed on the back of the building to form a complex wind environment when the downdraft in the windward side of the high-rise buildings formed a reflow. It had a negative effect on the elimination of pollutants in the wind shadow area (Oke, 1988). In our study, we found that the presence of high-rise buildings might be beneficial to human comfort by increasing wind speed, but it may be unfavourable to human health due to the concentration of pollutants caused by the vortex on the back of the building. Previous studies were ideal for wind conditions around the building (Li and Stathopoulos, 1997). The shape, orientation, adjacent buildings or obstacles of the building have a large impact on the wind speeds and directions around the building. These should also be considered when designing or researching. The open spaces in the central area of the city are the main concentrated area for outdoor activities of residents, so the quality of its wind environment is crucial. Especially for the elderly and children, they are often vulnerable and sensitive to the wind environment (Takano, 2002). Uncomfortable open spaces have a certain impact on their outdoor activities and outings and even affect their health.

4.4 Wind changes in a ventilation corridor
Connected open spaces and main roads are the main air ducts in the central area of the city, especially important for cities with quiet or weak winds. The "Chapter 11: Urban Design Guidelines" in the Hong Kong planning standard and guideline defines ventilation corridors as large open spaces, such as main roads, connected open spaces, landscaping, non-construction sites, building line setback zones and low-rise buildings; and urban structures that run through high-rise buildings. In this study, the Square, the road intersection, the park, and connected roads formed a continuous ventilation corridor. The long axis of the corridor was at a small angle with the dominant wind direction in winter, and the angle between the dominant wind in summer was about 77.5°. In the winter, the effect of the ventilation corridor was exerted. The direction of the ventilation corridor is within 30° of the prevailing wind, and the ventilation efficiency was better in the air duct (Oke, 1988).
The road angles in the study area had not changed, some buildings on both sides of the road have retreated a certain distance, and the height of the buildings on both sides has increased. We found that most of the ventilation conditions were improved on roads with an angle of less than 30° with the prevailing wind direction, possibly due to the increase in the height of the buildings on both sides to form a street canyon effect. When the ratio H/W (H: average height of the canyon walls, W: the canyon width) is large, the airflow in the street is accelerated in the street, and vortex will occur in the street (Hunter, Watson and Johnson, 1990). When the ratio H/W was greater than 1/5, the airflow above the street is difficult to enter the space (Moonen, Dorer and Carmeliet, 2011). The main road is often polluted by air pollution, and vortex will accumulate pollutants and affect the air quality of the street (Sini, Anquetin and Mestayer, 1996). The ratio H/W of the ventilation corridor and the angle with the

street wind have a great influence on the wind environment and should be paid attention to in urban planning.

5. Conclusion

Global warming, heat island effects, and high concentrations of particulate matter are threatening public safety and health. Inadequacies of urban built environments are often verified, leading in many cases to these issues. These issues will become more prominent in the coming decades, and there is an urgent need to actively intervene in these issues in combination with microclimate and urban planning. In urban microclimate, because of the direct relationship between sunshine and urban form, it is the most widely used in urban planning and design. The wind rose diagram is one of the important tools for determining the urban wind environment in the early planning and design. It has certain guiding significance for the location selection of urban industrial and residential areas. For the planning and design of the block scale, the wind speed and direction will also have a large change due to the influence of the surrounding complex buildings, so the wind rose diagram has no guiding significance. However, climatology has certain thresholds for urban planners and designers. It is urgent to enhance multidisciplinary work including urban planning, landscape architecture, and climatology, etc. Applying climate knowledge to urban planning and design at the block scale will significantly improve urban microclimate, thereby extending the stay of urban residents in open spaces and slowing global warming and increasing urban resilience to climate change.

This paper provides a brief history of urban spatial attributes in the central area of Nanjing. It emphasizes the problems of open space in the development of urban blocks that ignore the microclimate, especially the wind. Many cities are experiencing the process of external expansion and internal spatial restructuring. In this process, urban design often involves changing urban space properties, thus affecting the wind environment. Although there are great differences in climate and built environments in different regions, the influence of urban form changes on the wind environment in open spaces still has applied lessons.

The process of urban planning is complex, and the local government policies and the economic interests of developers are usually given priority. Residents are often in a passive position. In the process of spatial property reorganization, buildings around the open space lacking wind environment assessment may lead to changes in wind comfort conditions in open spaces. Although it may be unintentional, the interests of the residents will be impaired. At the individual level, the profitability of urban residents is different, which may lead to internal contradictions among residents and create new environmental injustices. The starting point of modern urban planning is the responsibility of public interest to market failures, considering the needs of society and the interests of individual residents. Open space is the medium for maintaining and realizing the public interest. The assessment of the wind environment in an open space and the improvement of the wind environment comfort of pedestrians are just one of the elements of environmental equity. In urban planning and design, it is necessary to coordinate with other equally important factors to plan and design most optimally. However, due to the lack of plants record in the 1990s, plants were not considered in wind simulation. The wind speed to be presented might higher than the actual speed

because plants weaken the wind speed. We also lack actual measurements of wind speed through the placement of the weather station. The accuracy of the simulation will not be verified in this case. Thus, future research can further refine the built environment, including plants, building roofs, etc. By combining measured data with simulated data, our results will be more credible.

Acknowledgement
This work was supported by the Humanity and Social Science Youth Foundation of Ministry of Education [grant number 18YJCZH043].

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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Morphology and sustainability in the project of public spaces. The case of the historic centre of Viterbo (Italy)

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Abstract
The research at the base of the project proposal is based on the idea that a city is, first of all, a body made out of "fabrics": Social, economic, cultural and environmental fabrics that in the physical form of the built environment find their dynamic expression. If the morphological analysis of Viterbo urban fabric has been then the analytical base of the design process, the focus on daily use of urban spaces has been its main analytical goal. But to talk about a shared, efficient, citizen-friendly city, means, at the end of the day, to tell of a sustainable city where Morphology and Sustainability can be part of a unique creative process. That has been our main goal from a methodological point of view. The city is in fact a key resource for the environmental control. The scale of microclimate come into play tighter interactions between design and climate data, improving context environmental conditions, promoting social relations between users and enabling energy-saving-strategies for the creation of a healthy and comfortable urban environment. The joint use of Urban Morphology together with an accurate environmental analysis by GIS Environmental maps and a parametric costs control of design choices for the Economic and Financial sustainability has made possible the design of living spaces, aware and respectful from the identity point of view, efficient from the energetic point of view, but also open and flexible to the changing use conditions of city-life.

Keywords: urban morphology, urban design, outdoor comfort, transdisciplinary, Viterbo

To cite this article:
Maretto, M., Gherri, B., Chiovitti, A., Pitanti, G., Scattino, F., Boggio, N. (2020). Morphology and Sustainability in the project of Public Spaces. The case of the historic centre of Viterbo (Italy), *The Journal of Public Space*, 5(2), 23-44, DOI 10.32891/jps.v5i2.1280

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

Introduction and methodology

The city is, first of all, an organism made of "fabrics". Social, economic and cultural fabrics that find in the physical form of the built city, its streets and its squares, direct and dynamic expression of its vitality over time (Maretto, 2008). The morphological analysis of the urban fabric of Viterbo and its public spaces was therefore the first step of the design action. An analysis that started with the historical-morphological understanding of the walled city (Guidoni et al., 2006) then focused on the daily use of urban spaces and their potential for development and future use to make the centre of Viterbo a sustainable city, suitable for pedestrians and children. It is citizens who ultimately transform the city on a daily basis through their actions and it is always the citizens who guarantee their continuity over time through their ability to "create community" and recognize themselves in a shared identity. Being able to define public spaces capable of generating a diverse use of the city and together, responding to the needs of those who live it was thus one of the main challenges and objectives we set ourselves. One of the tools used for this purpose was the mapping of pedestrian movement flows within the seven squares of the historic centre of Viterbo.

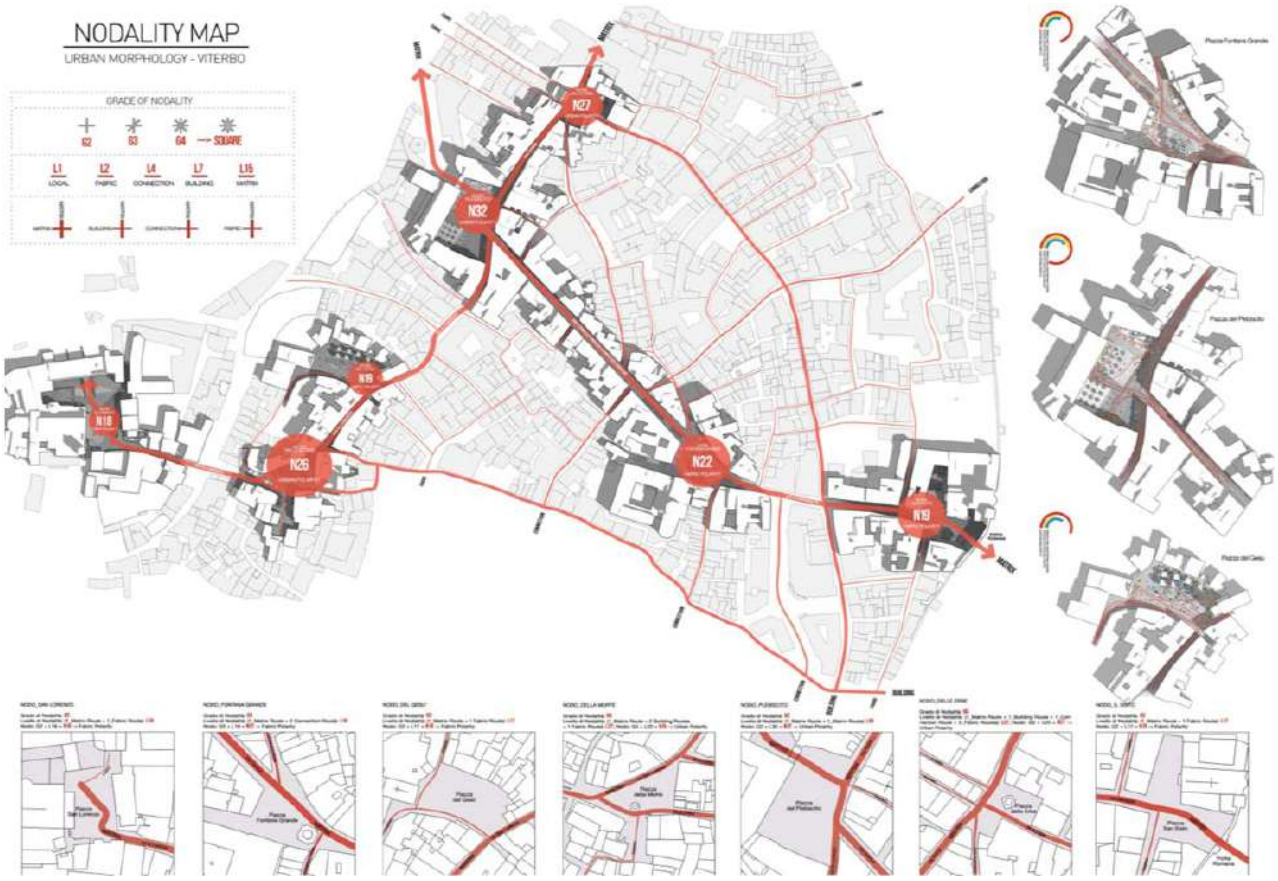

Figure. 1. Nodality Survey and Flows Analysis. On the general map the hierarchies of public spaces is given by their different Value of Nodality (N...). A focus on the seven squares (bottom) evidences the Grade and the Level of Nodality of each one in order to obtain their Value. (Source: M. Maretto).

The observation of pedestrian flows of movement within a public space (Gehl, 1987) is, in fact, of great importance for at least two reasons. From a morphological point of view, it allows us to define hierarchies, between paths, urban spaces, functions and other urban features and solutions. These hierarchies, combined with each other, and systematized with the morphology of the urban fabric contribute to the definition of a scale of Nodality Values (Maretto, 2018) able to give us a dynamic map of the morphology of a place both in its physical and immaterial aspects (Figure 1). On the other hand, the mapping of daily movement flows tells us how citizens-users use a given public space, providing us with valuable information for its transformation (Figure 2).[1]

Figure. 2. Pedestrian Flows Analysis of Piazza del Gesù, Piazza del Plebiscito and Piazza Fontana Grande (Source: M. Maretto).

Moreover, these data, combined with the environmental ones, allow us to define a useful analytical basis for the conscious and sustainable design of public spaces. To talk

[1] For each square the prevailing *movement flows* and the *stopover directions* were considered. These latter were then divided into *diurnal* and *nocturnal*. The new public space is then shown in transparency in order to highlight the relationship between Flows Analysis and the new project. *Piazza del Gesù*: The main flows go along Via San Lorenzo (Matrix route), from here a secondary flow goes towards one of the main ascents from valley to the ridge. The main stopover directions are instead towards the church (diurnal) and towards a building front characterized by shops and clubs (nocturnal). At the center between these two major directions is a beautiful historic fountain, also catalyzing a part, albeit secondary, of the stopover directions. *Piazza del Plebiscito*: The three main flows characterize Via Cavour, Via San Lorenzo and Via Roma (Matrix routes). From this trident that informs the entire urban structure of the historic center of Viterbo a secondary flow heads towards the valley bottom (to the northeast). The main stopover directions instead move towards the Palazzo dei Priori (in the center), the Prefettura (on the left) and the Town Hall (on the right). These are mainly diurnal stops with the exception of the Town Hall side where there are some commercial activities open even at night. *Piazza Fontana Grande*: the mainstream flows along the great axis of Via Cavour (Matrix route), from which two secondary flows go (west and east) along Via delle Fabbriche and Via Aurelio Saffi. The square develops mainly on the left side of Via Cavour, for this reason the main stopover directions are on this side, directed to the church (diurnal) and to a small wall of shops. Here too the presence of a historic fountain catalyzes some of the stops (day and night). Although there are also shops on the right side, the substantial absence of a sidewalk prevents, in fact, the stop.

about a shared, efficient, citizen-friendly city also means talking about a sustainable city, where the concept of sustainability is understood in its widest and most complete meaning. The city is not, in fact, a "zero-emission settlement machine", on the contrary it is a much more complex and vital organism that cannot be reduced to simple performances (Maretto, 2012). In 2016, in order to answer to the Call of the Municipality of Viterbo for the redevelopment of the seven squares of its historic centre, we adopted a methodology combining the themes of urban morphology (Marat-Mendes, 2013) with those of sustainability. (Figure 3). A square is both a social and an architectural space, is "lived and dreamed" (Levi-Strauss, 1955) and requires a transdisciplinary approach capable of dealing organically with its complexities.

Figure. 3. The project of the seven squares within the historical urban fabric (Source: M. Maretto).

The Environmental Project.
Microclimate Modelling for Urban Sustainability in public open spaces

A new paradigm is affirming itself regarding the design of urban open spaces: the climate changes cities, but at the same time it is clear that the city is also responsible for climate change. (Maretto, 2012). In this context, what remains is the disregard of global effects that changes outdoor urban setting and impacts liveability of public open spaces, and in particular the thermal behaviour of dwellers. The climate control of the micro-urban context must be investigated as a lever to enhance energy-efficient and sustainability strategies in case of urban planning and in design for public open spaces. The continuous comparison between the environmental-energetic issue and the morphological-urban topic for urban outdoor space design is a relevant scientific subject, as well as understanding physical-energetical phenomena, on one side, and environmental-social facts on the other, helps in defining a correct approach to the question of how to intervene on public urban open spaces in order to pursue a widespread sustainability model.

In order to achieve the aims of the Paris Agreement, the building and construction sector must decarbonise by 2050 (COP 21 Conference, December 2015) and to meet that target a proper urban analysis should comprise energy efficiency, environmental and social dimensions, in order to reduce greenhouse gas (GHG) emissions. With nations worldwide tackling operational emissions for buildings, a relevant target that now needs to be address is related to urban morphology, called urban Heat Island Effect control, in order to ensure liveability for its citizens to enable a greater level of consciousness regarding environmental sustainability performance.
Recently it has been clearly stated by the UN Environment Programme with the Emissions Gap Report 2019 the embodied carbon reductions can contribute to climate goals in the short term. So far, the attention has been reserved to the total of all greenhouse gas emission results from manufacturing to supply of construction products and materials as well as the construction process itself. But what about the space between buildings, namely the open spaces, the interaction between building envelopes and outdoor environment? Exploring the relationship between climate-based design and city's needs in order to respond dwellers' age, cultural needs, subjective preferences and users' perceptions can be pursued by Microclimatic Sensitive Urban Design - MCSUD- (Erell et al., 2011; Pijpers-van Esch, 2016) to promote sustainable and healthy lifestyles.
Thanks to a MCSUD, designers can intervene in environmental contexts within the densely constructed urban fabric in order to control its main microclimatic attributes (natural and artificial), as a design strategy to address sustainable energy choices for building material selection in this case for the design of public open spaces. Because of parametric simulations, acting on the local microclimate, both in terms of local outdoor air temperature at the street level and in terms of Mean Radiant Temperature (MRT) can be effective in reducing building thermal loads as well as in enhancing users' thermal comfort. In light of these relationships, the contribution of climate-based strategies of the micro-urban space in terms of both indoor and outdoor climate mitigation, energy saving and reduction of GHGs emissions can be assessed by using parametric or dynamic simulation. Thanks to those numerical simulations, the project of Viterbo aims at simulating different configuration of outdoor urban environments and to assess the effects and application of climate sensitive green architecture visions in decision making process in relation to urban public open spaces. Assessing micro-scale urban environments (intended for a typical horizontal resolution from 0.5 to 5 metres and a typical time frame of 24 to 48h) has enabled the analysis of the small-scale interactions between individual buildings, surfaces and materials' property (albedo values).
Since the properties of the materials used within the building envelope play an essential role in defining building performance in terms of thermal comfort and energy savings (Doulos et al., 2004; Aida, 1982; Santamouris, 2004; Taha et al., 1992), establishing new outdoor elements (urban microclimate based approach) can also strongly influence the thermal behaviour and healthy lifestyles for final users. Indeed, as a first effect, for a given outdoor climate the features of buildings' envelope and the selection of urban finishing materials (pavements, asphalts) and vegetation directly affect the heating and cooling load generated to ensure comfort in public outdoor spaces and, conversely, urban local climate has also significant influence on the building envelope and on outdoor liveability, playing an essential role in facing Heat Urban Effect, due to radiant

and convective heat exchange with external building envelope and outdoor finishing materials (Taha, 1997; Akbari et al., 2001; Synnefa et al., 2008; Santamouris et al., 2008; Santamouris et al., 2011; Morini, 2016).

National and international state of the art and open issues

Growth of urban populations is estimated to double the global building stock by 2060 (United Nations, 2019). The growing awareness towards the topic of energy savings and the reduction of the environmental footprint has shifted the focus lately from traditional boundaries of building envelopes towards the arrangement of specific parameters and instruments that can be translated to the scale of the urban block, public spaces and transitional areas. The environmental analysis for the urban project needs a rigorous methodology to evaluate the mutual effect of any design project to address the micro-urban scale design and the related thermal behaviour of building envelopes in relation to human perception. Several academic studies about decarbonisation strategies (Gomez, 2010; Duarte, Shinzato, dos Santos Gusson & Abrahão Alves, 2015) highlight that there are no distinct relationships among urban fabrics, building envelope and outdoor open urban spaces. Despite mutual connections have not been fully investigated yet, however they generate a research gap and, consequently, the need for a suitable design method which is offered here. Outdoor thermal comfort is a complex issue, since microclimate and environmental conditions as well as urban morphology strongly affect the thermal load on building facades (Givoni, 1998). Thus, there are several studies that assess human thermal comfort in outdoor areas (Gaitani, Mihalakakou & Santamouris, 2007; Pizarro 2009). Nevertheless, none of them investigates the repercussion of outdoor design options (i.e. materials choices, green masses disposition and any further bioclimatic devices), on building techniques and design. Furthermore, several tools have been introduced to help designers and practitioners in modelling the outdoor environmental condition such as Rayman and ENVI-met.

The rapid increase of tools to evaluate microclimate conditions in early stages of performance site analysis (Naboni, 2013), however, does not take into account the influence of outdoor design choices on thermal loads for buildings energy demand. Most of the responsibilities are imputable to the proliferation of hyper specialized software that can be supportive during the energy design phase, but often disregard the community engagement to local microclimate as well as the multiplied use of qualitative analysis tools create a significant limitation for urban microclimate based approaches. Along with these premises, the research project for the historical centre of Viterbo aims to define the best practice in order to demonstrate that the use of specific software for microclimatic simulation (such as Autodesk Ecotect, in this specific case design, thanks to its computing and modelling easiness), allows the designer to identify the most suitable technological and architectural choice by considering morphological, technological and environmental knowledge, based on a microclimate based approach. Although Autodesk Ecotect Analysis has been discontinued since 2016, it has been considered in this assessment phase as it seemed very effective and still valid today. It should be noted that key solutions are now available in the Autodesk Revit environment too. Those different software tools have therefore been used in environmental assessments in order to design a climate-based project for each of the seven squares in the Municipality of Viterbo, as illustrated in Figure 4.

Figure. 4. Examples of environmental analysis and evidence of critical issues within the urban fabric. (Source: M. Maretto).

Instruments and methods for urban open spaces climate-based design

When broadening basic pillars of environmental comfort assessment, it is evident that the design of the urban open space should be intended not only for outdoor comfort and liveability for citizens but also for environmental variables associated with wind fluxes, the amount of solar radiation, the albedo values of finishing materials as well as the air temperatures to prevent harmful situations and undesirable thermal loads. Since cities have proven to be efficient and resilient when facing climate change. Each urban environment can adapt to the effects of climate chance, by scaling up different solutions, mainly based on low carbon and bioclimatic tactics. A climate sensitive approach should consider the city itself as a decarbonizing lever. Several parameters demonstrated to be effective means when reducing temperature and GHG emission, by taking into consideration: topography and elevation; ground cover and vegetation; wind distribution among buildings and roads; presence of green mass; presence of water bodies; urban geometry (orientation of the streets and urban form) and Albedo values (Gherri, Maretto, Guzhda, Motti & Zannetti, 2018). The microclimatic environmental analysis used for the case study of Viterbo allowed the authors to control and manipulate the environmental conditions for a given urban environment in

order to define a tailored urban design response with the primary goal of mitigating potential negative effects (i.e. relieving excessive solar irradiation on horizontal surfaces) and to exploit the positive ones (i.e. channelling wind breezes to cool down outdoor areas), to ensure optimal comfort conditions supporting designers with an interactive and comprehensible analysis procedure. Therefore, the aim of the present paper is to prove that urban morphology and sustainability issues can achieve improved outcomes for sustainable urban projects, combining microclimatic-environmental variables and subjective comfort metrics. They shall be applied to the urban blocks, public spaces and transitional areas.

A survey to define an appropriate range of sustainable and comfort indexes has been preliminarily focused on a review of the indices and metrics that are currently used to measure the environmental sustainability of the open spaces as well as subjective comfort indexes for final users. Therefore, the existing indexes were analysed to measure perception of outdoor comfort of human subjects. Among the parameters that contribute to outdoor human comfort, temperature is the most important factor when defining the quality of an outdoor space. Thermal comfort is a condition in which the user prefers neither warmer nor cooler temperatures, i.e., the ideal temperature. Outdoor thermal comfort (Fanger, 1970) is a complex issue to be assessed since microclimatic and environmental conditions as well as urban morphology strongly affect the perception of outdoor thermal comfort.

Currently there are several studies on assessment human thermal comfort in outdoor areas available (Cheng et al., 2007; Ali-Toudert & Mayer, 2006; Nikolopoulou & Lykoudis, 2006; Tseliou et al., 2010). They can be used to assess outdoor thermal comfort for dwellers and include the following: Predicted Mean Vote (PMV) (Humphreys, 2010) and Standard Effective Temperature (SET) (Gagge, Stolwijk & Nishi, 1971) which are originally proposed for indoor assessments, Physiological Equivalent Temperature (PET) (Matzarakis & Amelung, 2008) and Universal Thermal Climate Index (UTCI) (Matzarakis, Mayer & Iziomon, 1999) for outdoor comfort assessments.

Starting from the Predicted Mean Vote (PMV), introduced by Fanger (1982), Predicted Percentage Dissatisfied (PPD) state the percentage of users who are not satisfied with individual PMV values from a thermal point of view. Nonetheless, PMV and PPD were primarily intended to evaluate thermal comfort condition for any indoor environment and, therefore, are not appropriate for outdoor zones assessments (Kinouchi, 2001), mainly due to overestimation of the thermal sensation in the warmer climate and inversely in colder condition. The Predicted Mean Vote PMV assesses the well-being of individuals and considers both the physical-climatic variables and the subjective variables. Therefore, the thermal sensation can vary from one individual to another according to their sensitivity. PMV considers air temperature (Ta), Mean Radiant Temperature (MRT), Relative Humidity (RH), wind speed and the subjective variables that depend on the individual clothing (measured by "clo") and the metabolic activity performed (measured by “met"). On the contrary, it defines the percentage of users dissatisfied by the thermo-hygrometric conditions. According to the ISO 7730 the 10% (ISO 1994) of users is the maximum limit of dissatisfaction that can be acceptable to define a comfortable environment. As for the ASHRAE 55 standard, the limit shifts to 20% (ASHRAE 2004). On-site thermal environments can be assessed by using the Universal Thermal Climate Index (UTCI). The UTCI equivalent temperature for a given combination of wind, radiation, humidity and air temperature is then defined as the air

temperature of the reference environment that produces the same strain index value. Physiological Equivalent Temperature (PET) (Mayer and Höppe, 1987) is the index for the steady-state method in outdoor spaces' evaluation. Since PET can take into account the impacts of short-wave and long-wave radiation fluxes on human energy balance, PET is considered as one of the most reliable indexes especially in semi-enclosed spaces (Mayer and Hӧppe, 1987; Gulyás et al., 2006).

Environmental Analysis of Viterbo historical urban fabric

The authors have initially assessed the outdoor conditions of the project area by choosing some environmental variables with respect to which the numerical analysis has been conducted (Autodesk Ecotect). The main parameters and their associate variables assessed in the Viterbo project had to include some key elements that help in identifying the generalisability of a micro space and its ability to correspond to multiple dimensions in a microclimatic scenario within the urban precinct (Cutler, 2008).

The evaluation has been performed during four thresholds (March 21st, June 21st, September 21st, December 21st) and during three different times (i.e. morning, early afternoon and one hour before sunset).

The environmental parameters that have been considered for the calculation are:

- Air temperature, which is used to investigate the level of comfort, based on the vertical difference of temperature, measured at ankle and head height. Those heights are the most significative ones to depict thermal comfort. Assuming a 3°C temperature difference as the optimal range to fall within the comfort range, the data assessed on three annual thresholds detected some zones with a vertical temperature difference that were higher than the maximum acceptable threshold.
- Relative Humidity has been analysed in relation to the air temperature and calculated at one meter height from the ground surface.
- Wind flux is an essential data point for the identification of potential discomfort areas. In case of detection of turbulent areas, weak mitigation interventions on the open space scale could be applied in order to avoid canyon effects or other related phenomena. Therefore, two different heights, significant for design purpose, have been evaluated: ankle height and head height which are useful to understand the influence of the wind on the user's sensitive areas.
- Solar radiation, global amount of solar radiation calculated by software returns data from direct, diffused and reflected solar radiation. Areas of excessive irradiation can be spotted all year round. Using this data, designers could foresee how to better design finishing materials.

This data has led to further elaborations of maps that are considered to be useful for setting up adequate environmental mitigation strategies from the early stages of the project onwards. A fundamental tool for this purpose was the use of GIS (Geographical Information System) software in order to guide all the design choices in an integrated and efficient manner (Figures 5-6).

Figure. 5. Piazza del Plebiscito: Shadows Overlapping. The analysis shows a moderate winter shading (December 21st threshold) in the lower part of the square and an excessive summer sunshine (threshold of June 21st) in the central part. (Source: M. Maretto).

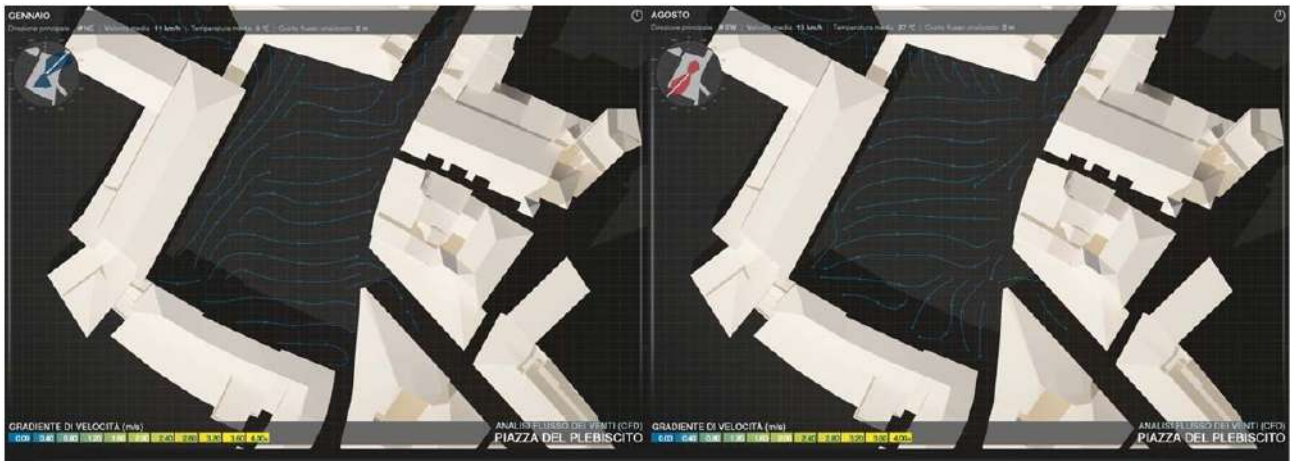

Figure. 6. Piazza del Plebiscito: Wind Flows Analysis. The analysis shows a strong winter ventilation (January threshold) both in SouthWest-NorthEast direction and in West-East direction and a warm summer ventilation (August threshold) in East-West direction. (Source: M. Maretto).

Particular attention was also given to the presence of vegetation and water as important bioclimatic indicators in regulating temperatures, favouring in particular passive cooling in hot weather. Moreover, the presence of deciduous trees has allowed containment of the solar radiation in hot weather and the possibility of obtaining solar gains in the cold season. However, vegetation and water also have the ability to favour the formation of night and morning breezes that contributes to a gain in air quality and increases outdoor comfort. Finally, the evaluation of finishing materials through the choice of their environmental compatibility and their albedo value completes the environmental analysis in support of sustainable urban design. The proportion of solar radiation (direct and diffuse) that is reflected by the ground and surrounding objects (albedo) can, in fact, be increased or reduced through the use of suitable materials, encouraging the use of open spaces that would otherwise be excessively exposed to solar radiation or too dark and cold to accommodate outdoor relational spaces (Figures 7-8).

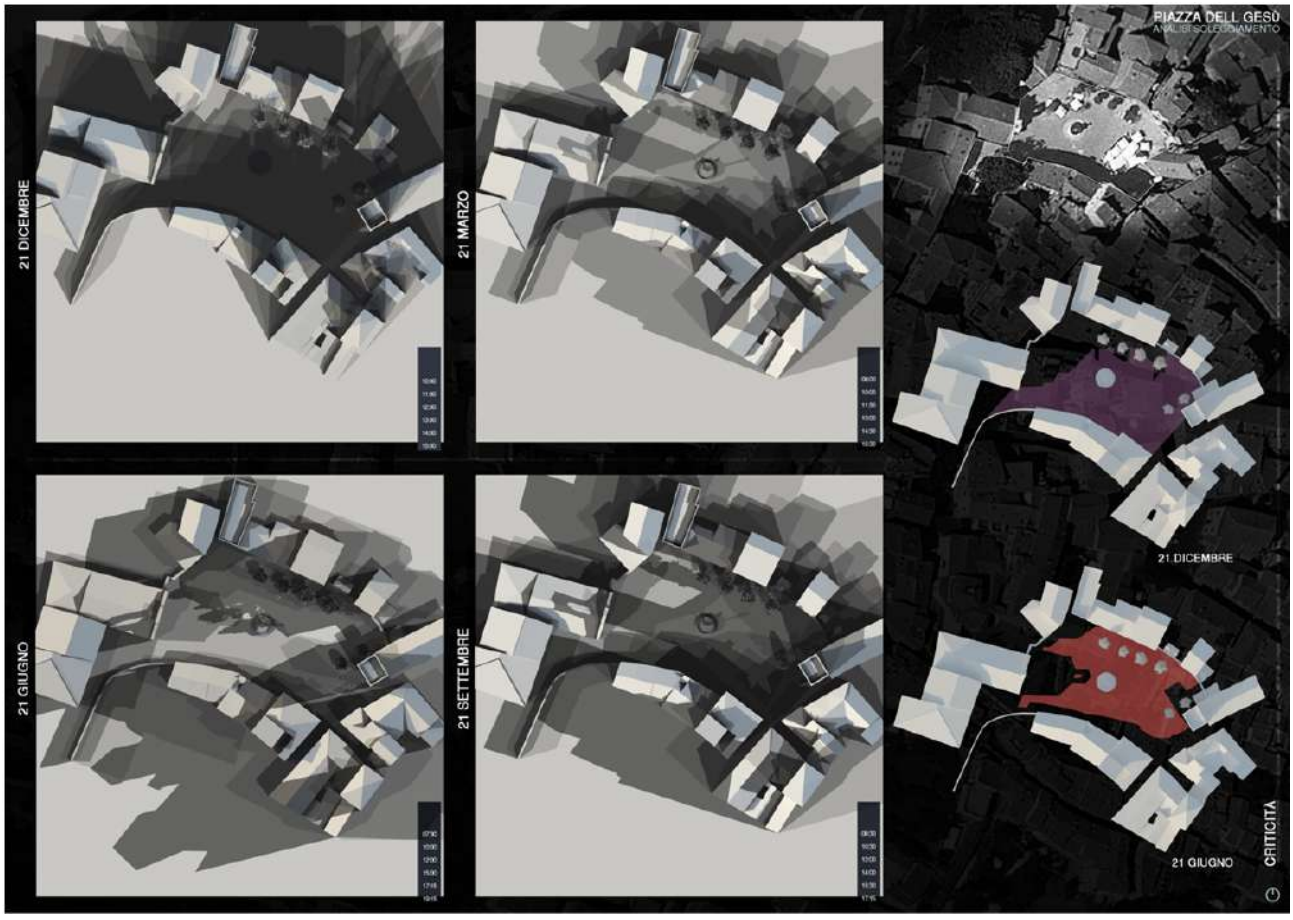

Figure. 7. Piazza del Gesù: Shadows Overlapping. The analysis of sunshine shows the presence of two critical thresholds. The first, on December 21st, sees the square completely shaded, the second, on June 21st, sees it entirely sunny. In the remaining months the values are essentially weighted. (Source: M. Maretto).

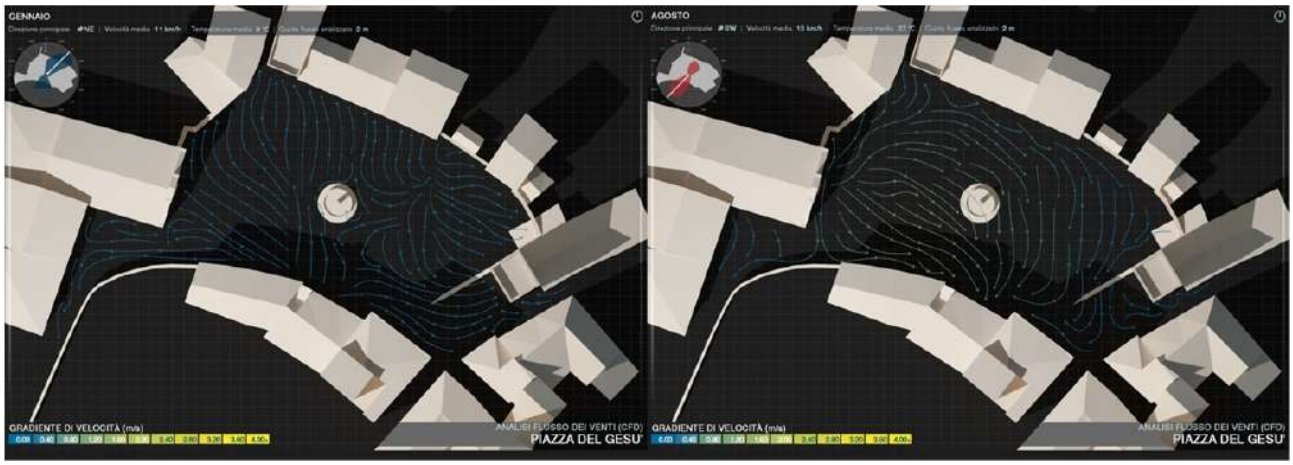

Figure. 8. Piazza del Gesù: Wind Flows Analysis. The analysis shows that in the winter months (January threshold) there is a prevalence of cold winds in the South-North direction, while in the summer months (August threshold) a prevalence of hot ventilation flows in the West-East direction. (Source: M. Maretto).

To complete the environmental assessment, attention was paid to the applied choice of lighting bodies. Lighting had received several functions including different lighting effects or different scenarios depending on prevalent night use of the squares as well as to contain energy consumption. The choice of LED bodies was combined with the use of devices to detect the presence of moving subjects in order to differentiate public lighting on two levels.

On the one hand, lighting fixtures have been designed to guarantee minimum night-time illumination, on the other a second level of lighting fixtures has been designed. The latter, at lower altitudes, are activated in the presence of bodies in motion ensuring always diversified lighting scenarios. All this goes to the advantage of considerable savings in public lighting and avoiding night-time over-illumination, the "light pollution" of the historic city (Figures 9-10).

Consideration of thermal comfort conditions in outdoor micro-urban spaces as one of the mean factor can be deployed as part of a conscious outdoor design practice but has lately proven to be complex and challenging. Nikolopoulou, Baker and Steemers (2001) revealed that while microclimatic parameters strongly influence thermal sensation, they cannot fully account for the wide variation between objective and subjective comfort evaluation. Therefore, considering thermal sensation for outdoor space indexes, along with climatic indexes, is vital for better address design choice and in order to assure comfortable outdoor space conditions for end users. Nevertheless, the actual situation in software capabilities is still limited. It is advisable to deploy instruments in the early stages of the design phase in order to provide a predictive feedback about the foreseen solutions with reference to outdoor thermal comfort for end users.

Furthermore, to get to a performance optimization in terms of environmental micro urban design for outdoor space, practitioners need to understand that an early design stage evaluation with regards to outdoor conditions can impact significantly the way micro urban scale work. This is the ultimate aim of achieving a coherent, rational, liveable and environmentally conscious outdoor urban public spaces (Maretto, 2014).

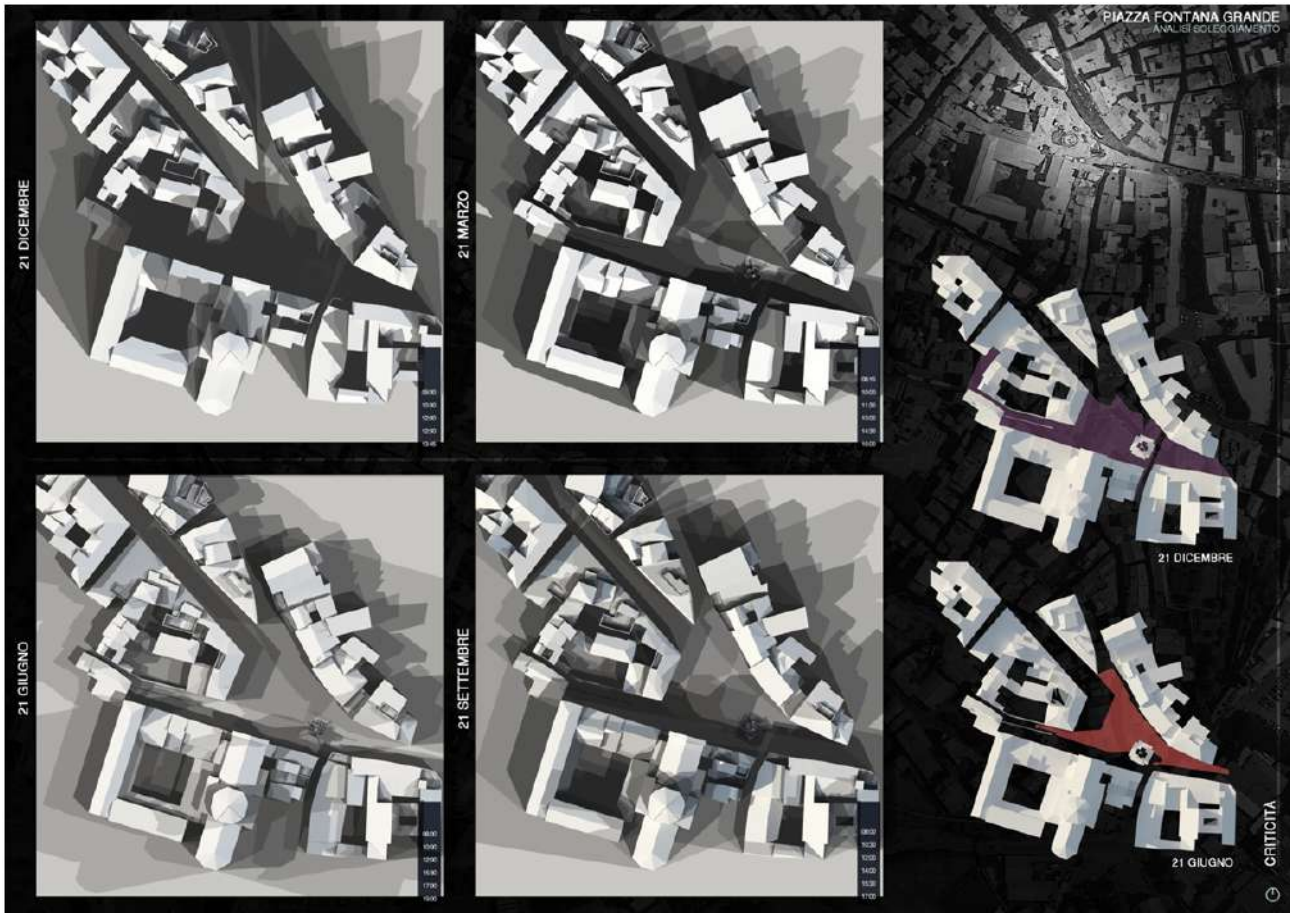

Figure. 9. Piazza Fontana Grande: Shadows Overlapping. The analysis shows how the entire square is subjected to excessive shadowing in the winter season (December 21st threshold) and to excessive sunshine in the summer (June 21st threshold). The first is concentrated above all in the lower part of the square, the second in its central areas (Source: M. Maretto).

Figure. 10. Piazza Fontana Grande: Wind Flows Analysis. The analysis shows that, in the winter season (February threshold) there is an excessive ventilation in the North-South direction while, in the summer season (August threshold), a number of warm East-West flows are added (Source: M. Maretto).

Figure. 11. Design sketches of Piazza del Plebiscito (right), Piazza delle Erbe (middle) and Piazza San Lorenzo (left) (Source: M. Maretto).

The Architectural Project

The project aimed to research seven squares, and evidently follows the results of the analyses carried out at the morphological-environmental level. On this basis, some guidelines have been chosen for the design of the squares to be further developed according to the specific character of each public space. In fact, we felt it was extremely important to preserve the identity of the individual squares within a unitary organic design. Thus, common to all projects is a distinction of public space in preferential traveling areas and rest areas. The latter, in particular, were then hierarchized and differentiated according to the needs found in the different squares. More "structured" rest areas have been designed in correspondence with the main monuments through a paving in clear basalt slabs, the realization of fixed travertine shaped seats and where there is not already an historical fountain, equipped with a mirror of water (Figure 12). The presence of water immediately seemed to us to be a relevant identity indicator as well as an effective instrument in its own right to control the microenvironment. Concerns remain with those areas that play a particular urban role but are not directly affected by buildings of public importance. Here, too, the use of a light basalt denotes their eminent pavement role, but the design of simpler fixed seating, shaped like a parallelepiped and the absence of the water mirror, clearly hierarchizes them with respect to the previous ones. In these cases, the insertion of lines of turf will be foreseen, between the joints of the basalt, to underline the more "local" character of the public space (i.e. Piazza del Gesù) (Figure 13).

Figure. 12. Piazza del Plebiscito (above) and Piazza del Gesù (bottom): Architectural project and Environmental Analysis (Source: M. Maretto).

Finally, special areas for the *dehors* have been designed by inserting longitudinal Corten elements inside the basalt flooring (between one slab and another) in order to identify, in a visible but not dominant way, the ambits intended for commercial spaces (bars, restaurants, etc.). These areas receive a role of the overall square design and integrate themselves perfectly with the architectural and functional qualities of the public space, even in the event of temporarily absence of *dehors*.

The main pedestrian routes are designed with the use of dark basalt slabs to facilitate their visual perception and avoid coming into conflict with the rest of the pavement. As a rule, the direction of the textures of the slabs (both of the paths and of the squares) is set to favor the accessibility and use of the square and when necessary, it is further strengthened by the presence of thin Corten lines (i.e. in Piazza San Lorenzo and Piazza delle Erbe).

In order to avoid cutting the slabs as much as possible to facilitate their installation and containing the relative costs, the points of convergence between different textures were treated with the insertion of small (not stabilized) stone pebbles (Figure 14).

These areas contribute to the increase the permeability coefficient of the square and correspond to the areas through the introduction of specific tree species, generating "natural" systems of environmental control that are well integrated in the overall urban design. These trees, mainly Fraxinus Onus and Tilia Platy-phyllos, on the one hand,

follow the bioclimatic and livability requirements of the public space, and on the other hand, enhance the historic compactness of the building walls.

Figure. 13. Piazza del Gesù detailed view.[2] (Source: M. Maretto).

Figure. 14. Piazza del Plebiscito detailed view.[3] (Source: M. Maretto).

[2] The design theme is, in this case, to give identity to the small square by putting the few elements that characterize it into a system. The analysis of pedestrian movement flows told us of a mainly pedestrian square dedicated to leisure and free time, with a tangent path that branches off from the Matrix route on Via di San Lorenzo, heading north, to reach the valley floor. The Chiesa del Gesù and a historic fountain divide these two areas. The environmental analysis also highlights the presence of excessive summer sunshine and cold south-north winds in winter and warm west-east in summer. The choices then led to the creation of a tree-lined front (cedar leaf trees) on the north side in order to protect the commercial areas from the winds and to ensure good summer shade. Thin lines in Corten follow the course of the basalt stone slabs and trees in order to strengthen the perception of this side of the square. At the same time, a basalt pavement, interspersed with green lines, was used to characterize the central area around the historic fountain, though leaving the visual axis of the church façade free as a thematic element of the square.

[3] The first design theme was to integrate the three great Matrix routes of Via San Lorenzo, Via Cavour and Via Roma into a large urban design capable of giving identity to what is, without doubt, the most

As with many wonderful French, Spanish and Italian historical centers (Avignon, Arles, Barcelona, Valencia, Cortona, Lecce, Catania and many others) the arboreal element is carefully selected and positioned so as not to overpower the view of the urban fronts but, on the contrary, to enhance the value of the square as a civil space par excellence (Maretto, 2019) (Figure 15).

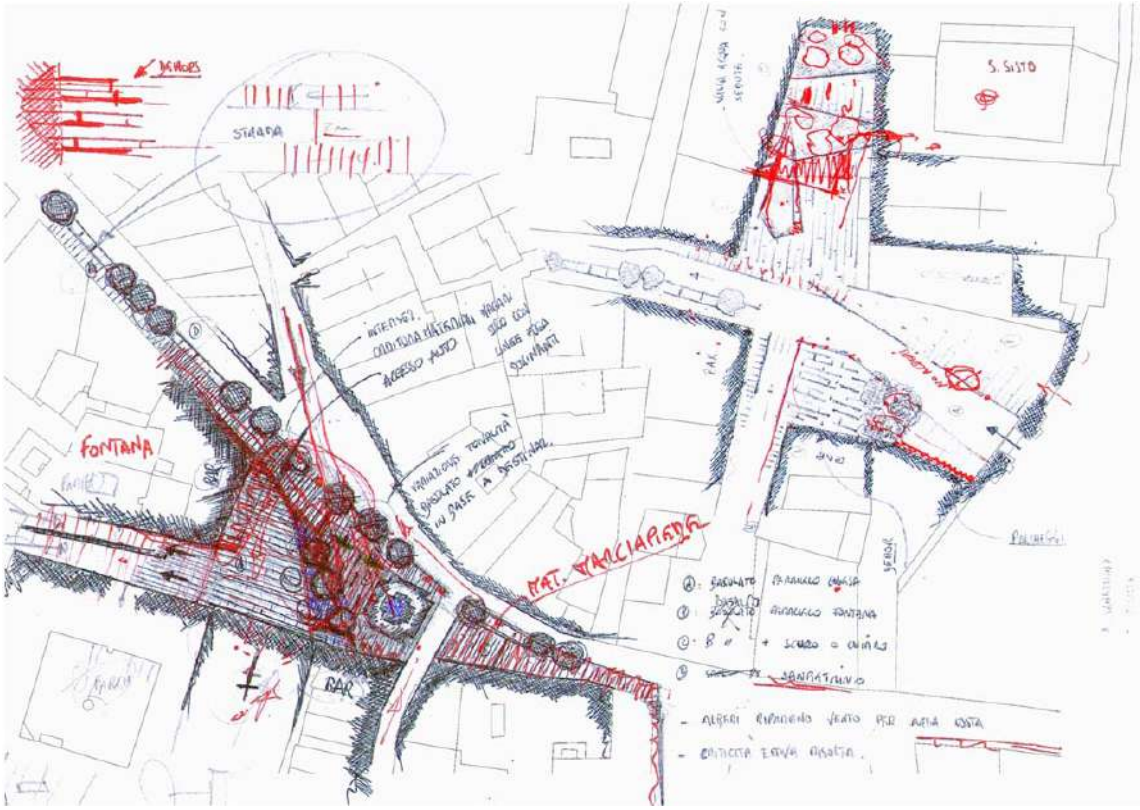

Figure 15. Design sketches of Piazza San Sisto (right) and Piazza Fontana Grande (left) (Source: M. Maretto).

important square in Viterbo. For this purpose, the same material was chosen (in different shades) to highlight the pedestrian areas and another for the driveways, placing a large fountain at the intersection of materials and axes. The second design theme was to give a "logical order" to the spaces of the square. To this end, the analysis of the Pedestrian Flows was decisive. On the one hand, it showed us what the main paths of pedestrian movement were. On the other hand, it highlighted the need to hierarchize and identify better the rest areas which is today very chaotic. Without prejudice to the fundamental connection, physical and perceptive, with the large Palazzo dei Priori, it was thought to create a pertinence space "de 'Priori", in light basalt, in order to encourage permanence in front of its large porch and reinforce its prospective value. Next to this, a paved space was then designed, with green lines between the dark gray basalt slabs, to mark the parterre of the Palazzo della Questura. In parallel, an area characterized by thin lines of Corten and light basalt slabs has been placed to reinforce the commercial spaces on the side of the Town Hall. The third design theme taken into consideration was obviously the environment. The analysis has shown us the incidence of a strong summer sun and of annoying winter winds towards south west- north east. For this reason, in addition to the morphological choices, three rows of trees have been thought. On the one hand, they protect the square from excess winds and summer sunshine. On the other hand, they enhance the role of a great urban backdrop for Piazza del Plebiscito and the Palazzo dei Priori. The fountain is, in turn, an important environmental mitigator helping to improve the levels of outdoor comfort throughout the square. The project of the square combined the analyzes carried out on a morphological level, of daily use and environmental in a single urban design.

The different combination of all these elements, in the different squares, depends on the morphology, the use and the urban role that every public space exerts within the city as well as by the case specific environmental needs.
For this reason, it was considered necessary to intervene as little as possible in Piazza San Lorenzo, limiting the project to the study of the landing of elevators and the placement of a fountain with controlled artistic splashes in the centre of the public space. For Piazza del Plebiscito the intervention was more consistent, both for the considerable size of the urban space, for its significant civic role as it is the most important urban centre of the old town. The result is a plurality of solutions within a basic unitary design able to return, from time to time, the individuality of each specific urban environment without ever losing the sense of belonging to the common historical identity of Viterbo (Figure 16).
From the point of view of vehicular traffic and flow, we suggested the adoption of a Restricted Traffic Area for the entire historical center, using (and implementing) a large parking area outside the city wall. In any case, all the roads are kept in basalt blocks whose texture varies, from diagonal to orthogonal, depending on the importance of the road. Only a few "short term" parking areas have been planned at Piazza San Sisto, Via Garibaldi and Via Cavour (near Piazza Fontana Grande), Piazza del Plebiscito and Piazza della Morte in order to meet the need for rapid parking for specific uses of public space. Finally, all the architectural barriers have been eliminated, allowing a unitary use and perception of public space. In this way the urban space lends itself to a diversity of functions, including, for example, the possible pedestrianisation of the Piazza delle Erbe-Piazza della Morte axis or of the system of the three squares, Piazza delle Erbe-Piazza della Morte-Piazza Fontana Grande, in particular periods of the year (i.e. Christmas, Easter, Summertime etc) (Figure 17).
For lighting improvement, a system has been designed on three different levels. Firstly, it directly functions as a contributor to the liveability of the public space by paying particular attention to its widespread graduality. Secondly, it is aimed at the calibrated lighting of the main monuments, such as palaces and fountains. Thirdly, it is aimed at the readability of the new urban environment through "mark steps" (in correspondence with *dehors*), for example, under-bench LEDs, low lighting for water and trees. In this way, each of the squares offer during night use different possibilities to the end users. Various perspectives have been emphasized and curated as part of the urban environment in a natural and dynamic way.
Last but not least, as for the *dehors* the design choice was to minimize their visual impact using light shaped Corten elements for chairs and tables, furnishing elements, information panels and so forth**.**

Figure 16. Piazza Fontana Grande (above) and Piazza San Sisto (bottom): Architectural project and Environmental Analysis (Source: M. Maretto)

Figure 17. Piazza Fontana Grande, detailed view.[4] (Source: M. Maretto)

[4] The design theme is characterized by the preliminary need to transform Piazza Fontana Grande into a real square. The presence of the important Matrix axis of Via Cavour, in fact, reduces its formal

Conclusion

As mentioned in the introduction, the city is a complex organism made out of "fabrics". The social, economic and cultural fabric finds their dynamic expression in the physical form of each of the seven public spaces. They are a witness of different levels of relationships, change over time, both material and immaterial. The main task of architecture is then, in our opinion, to understand these "links" (and the processes that underlie them) by providing the physical conditions for their development within a shared value system.

The experience on the seven squares in the historic centre of Viterbo allowed us to develop and deploy a methodology aimed at the three fundamental ambits that characterize a public space. First, the physical one of architecture that defines it on the perceptive level (the "hardware"); second, the immaterial one of those who live and use the space every day (the "software"). And the third, the environmental one that covers everything and influences everything (the "environment"). For these reasons different urban morphology tools (including the Flows Mapping) have been combined with those of human behavior analysis within a specific public space and with the lasted available environmental analysis tools. Overall, the three components have interacted surprising well in synergy largely due to the use of GIS. The environmental attributes were constantly superimposed on the pedestrian flows to understand their different degrees of interaction while the "form" of the spatial envelope, their hierarchies, axes, volumetric data and identity values were constantly verified in relation to the changes of the first two. All of this has made possible, in our opinion, to design living spaces that were, at the same time, aware and respectful from the point of view of the identity, efficient from an energy point of view but also open to maximum flexible to the natural evolution of the ever evolving conditions of the city uses.

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perception and hierarchizes its use. Nevertheless, it is a strongly nodal square, third as Value of Nodality in the hierarchy of the historical center of Viterbo. It too is characterized by the presence of a church and an important historical fountain which, in this case, is the theme of the square. The analysis of pedestrian movement flows shows that, alongside a strong viability of the Via Cavour axis, a large part of the stay happens, randomly, between the church, the fountain and some shops located on the left side of the square. The right side, despite the consistent flow of pedestrian passage, does not allow any pause remaining strongly hierarchical. The environmental analysis shows, instead, as main critical points a strong summer sunshine and the cold winter winds towards North-South. In order to give greater perceptive unity to the space, we first thought of expanding the sidewalks of Via Cavour, creating a sort of "square-passerby" in dark basalt with thin lines of Corten to characterize (as in the other squares) the stopover areas at the service of commerce (non-existent today). This part was then integrated with a rest area, in clear basalt and grassy lines, placed in front of the large fountain, acting as a hinge between the square-passerby and the churchyard. The presence of new trees has finally allowed to protect the square from excessive summer sunshine and winter breezes, leaving also the warm east-west summer winds which, reduced in intensity and together with the fountain, can perform an effective refreshing action. Once again, the morphological investigation and everyday use of public spaces, together with an accurate environmental analysis, have been the basis for the urban project.

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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Roofing and thawing the sub-Arctic city. Towards the conceptualisation of well-being through urban surfaces

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Abstract
An increasing amount of sub-Arctic population is living in cities and settlements. Despite the urbanisation, seasonality still affects the rhythm of life and willingness to spend time outside of home, which, in turn, affects health and wellbeing of the population. In addition to built artefacts, the materiality of sub-Arctic urban environment consists largely of changing weather conditions and seasonality, including phenomena such as thawing, freezing, snow, ice and slush, which have diverse effects on humans using the urban spaces, yet are not often part of conceptualisations of urban space that are formed in southern climates. In this paper, the relationship between sub-Arctic urban form, climate and users of the urban realm is critically re-evaluated using the concept of surface. Based on a review of the literature, the proposed approach gives agency not only to the weather, but also to different types of people inhabiting the urban space. This paper argues that the proposed approach takes better into account the varied nature of sub-Arctic urban spaces and their affordances as an entity: from privatised, roofed and weather-neutralised shopping centres and arcades to sledding hills, skating rinks and other winter-related spaces. This kind of conceptualisation could be beneficial when developing soft mobility plans for northern regions. Encouraging physical activity has direct effects on the physiological health of the population, but in addition to that, the approach attempts to acknowledge personal control of different user groups as a central aspect of wellbeing, which makes the viewpoint more holistic.

Keywords: sub-Arctic climate, well-being, affordance, surface, urban design, everyday life

To cite this article:
Oikarinen, E. (2020). Roofing and thawing the sub-Arctic city. Towards the conceptualisation of wellbeing through urban surfaces. *The Journal of Public Space*, 5(2), 45-62, DOI 10.32891/jps.v5i2.1281

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

1. Introduction

In recent years, the role of nature (meaning the most often greenery) in urban environments has been researched from socio-spatial, cultural and technical viewpoints (Watson, 2017; Loughran, 2016), which have enlarged both the nature's and the inhabitants' role as active agents in the urban environment. Yet, there is still a lack of such approach for the 'white space' – snow and ice specifically, which are prominent features in northern climate zones. This is most certainly linked to research of green space, but in similar vein that 'blue space', meaning the bodies of water, has been argued to become rather an analogy than a subcategory to green space (Volker & Kistemann, 2011), white space also requires an approach of its own.

The northern urbanity is much younger than, for example, Mediterranean urbanity, which has raised questions on the suitable northern urban structure – more specifically sub-Arctic and Arctic cities. Geometric and compositional properties of traditional European architecture (such as open spaces, treed alleys and boulevards) have been deemed inappropriate for cold, snow-ridden towns and cities (Pressman 1996). Thus, the northern urban realm has been a site for many kinds of competing ideologies in recent decades. In the spirit of Modernist mega structures in the latter part of the 20th century, northern urban cores were extensively protected with roofed spaces, malls and passageways – leading into large commercial environments, such as skyway system in Montreal. To oppose the development, the so-called Winter City Movement coined up in the 1980s opposed the energy-intensive, protected indoor spaces in the spirit of New Urbanism: the ideal sub-Arctic city became small-scale, dense and walkable. Ideally, the climatic comfort was achieved through microclimatic considerations instead of intensive energy use (i.e. Kuismanen, 2008). Norman Pressman, an advocate for the concept of so called 'winter cities' since the 1980s, maintains that we should not consider winter as merely something to *protect* people from, but also *expose* people to the positive aspects of the climate – local climate is a productive aspect of design (Pressman, 1996). For example, sub-Arctic climate also provides recreational opportunities, which have been acknowledged by northern cities in recent years as endeavours to activate the urban life and economy during the winter season (i.e. City of Edmonton, 2012; City of Oulu, 2014). Winter is not necessarily a new function requiring more space or repurposes, but a condition which affects the use of space and activity patterns in general. In sub-Arctic climate, the weather is a major determinant of people's decision-making about outdoor activities (Ebrahimabadi et al., 2015). This, of course, has also implications for the health and wellbeing of the inhabitants of sub-Arctic cities. Physical inactivity is considered to be the 4th leading cause of death worldwide contributing to mortality (Kohl et al., 2012) – thus, from the point of view of physiological health it is important to design environments that encourage exercise for different groups of people. Exercising outdoors in natural environments is also beneficial for various aspects of mental health (Thompson Coon et al., 2011). However, physical activity is conditioned by psychological aspects, such as perceptions and emotions (Eliasson et al., 2007), and personal control has been found to be an important mediating variable to reduce the negative psychological effects of environmental stress (Li, 1994). These viewpoints are often not discussed together.

The World Health Organisation (WHO) introduced a broad definition of health already in the late 1940s. According to WHO, health is not only the absence of disease but a

state of complete wellbeing in a physical, mental, and social sense. Urban design cannot be fully charged with delivering human health and wellbeing objectives, but it can support humans in their choices: i.e. drugs, overeating and under-exercise are some of the factors of modern life that determine the pathological pattern of disease despite of the high standards of living. The possibility to choose and change the environment is central to wellbeing: health promotion could also be defined broadly as a "process of enabling individuals, groups or societies to increase control over, and to improve their physical, mental, social and spiritual health" (Eriksson & Lindström 2007, p. 943). Defined in this way, the climate control is not just about functionality of the urban realm but concerns broader socio-cultural needs. In addition to the needs of the individuals, according to the New Urban Agenda (United Nations, 2016), the future cities should be people-centred and participatory, for example, engender a sense of belonging and ownership, but at the same time protect the planet.
Referring to the definition of wellbeing as active participation and ownership, as defined above, I argue that these aspects have not been adequately discussed in the research literature on urban space and climate. This discussion is important since it seeks to enlarge the concept of public realm to include humans as active actors in their own wellbeing. Through a review of the literature, this paper aims to develop a conceptualization of climate and its consequences on urban realm on a micro level, as a site for everyday life of the inhabitants – as practices and performances instead of systems or structures (de Certeau, 1980). The paper argues that this lived reality and socially produced entity of urbanity (Lefebvre, 1992), which is marked by a rhythmic, temporal structure and repetitive actions (Lefebvre & Nicholson-Smith, 1991), holds potential to look at sub-Arctic urban environment from a new epistemological perspective. The paper begins outlining the recent research on the relationship between sub-Arctic climate, urban spaces and wellbeing impacts. Then later it moves on discussing the concept of surfaces and its potential in discussing the impacts of climate and weather on experiencing the urban space. The paper also illustrates the theoretical discussion with photographs from sub-Arctic city centres of Oulu, Finland, and Luleå, Sweden (2016–2018) (figures 2–10). Luleå, a city of 46,600 inhabitants, is located about 110 km south of Arctic Circle. Oulu is bigger with its 199,500 inhabitants and the distance to Arctic Circle is around 160 km. Finally, it is proposed that looking closely at bodily, everyday life experiences in urban environment might help with defining its desired qualities and eventually might help with forming holistic design strategies for the sub-Arctic cities.

2. Sub-Arctic climate, urban form and their implications on wellbeing

This section collects recent empirical research and viewpoints discussing the relationships between sub-Arctic climate, urban form and inhabitants. The focus is on research done in the sub-Arctic climate zone, but some more general theories explaining the relationship to the users and observers of urban space are included as well, when applicable.

2.1. Climate and the perceived spatial composition of the public realm

During the winter season, sub-Arctic public space is physically changed by the covers of the season – like snow, slush and ice. This reduces ease of understanding of the public

realm and townscape, spatial structure and pattern of streets (Chapman & Larsson, 2019). Thus, seasonality and climate become a part of the spatial arrangement (Chapman 2018). In other words, the immaterial features of landscape become a part of the material design of the urban form (Labadini, 2017). Chapman et al. (2019) argue that urban realm in the winter is both more ambiguous for the observer because of piles of snow and hidden road surface markings, for example, yet also provides new opportunities, such as shortcuts through the frozen bodies of water.
It is not only the microclimate itself that people perceive but also the spatial settings in which it happens (Lenzholzer, 2010). Spatial qualities and space type, such as different materials and heights of the buildings, change the experience (Lenzholzer, 2010; Eliasson et al., 2007). Lenzholzer's research (2010) in a moderate climate in Central Europe suggests that most microclimate perceptions in relation to space are accurate when compared to physical measurements. However, sometimes the physical circumstances and perception are not congruent: this concerns for instance people's overestimation of wind influences and their association of 'cold' colour tones with a cold thermal experience, which is not necessarily based on physical reality (Lenzholzer, 2010). In addition to colour, naturalness also affects the experience and people reportedly enjoy the cold weather more in natural settings compared to urban (Westerberg, 2000).

2.2 Climate and the willingness to perform certain activities
Like in all climates, also in the sub-Arctic climatic zone the climate and weather have direct health effects. There are certain specific conditions related to northern environment, such as seasonality affective disorder (SAD). Following the broader definition of health and wellbeing, bad weather affects mobility and accessibility of the urban environment in general, resulting in decreased amounts of being outside. On the level of an individual, there is an established connection between regular physical activity and individual health and wellbeing (Kohl et al., 2012). In general, the modern lifestyle, entangled in monitors, discourages exercise and activity both in work and leisure hours, it is stated that people spend 90% of their lives within buildings (Evans & McCoy, 1998). In cold climates the rate is even higher: in Finland people spend 4% of their time outdoors during winter, and most of it during their leisure time (Mäkinen, 2007). Weather is a major determinant on people's decisions about outdoor activities and soft mobility in cold climates (Embrahimabadi, Nilsson & Johansson, 2015). Winter reduces connectivity for soft mobility by reducing the number of routes and pathways and limits the useable space in the public realm. Main barriers to soft mobility are icy surfaces and rain, as well as coldness, darkness and wind. Snow and snow-covered surfaces have the least impact (Chapman, 2018). The relationship between functional use and microclimatic conditions has been confirmed by several studies (see Eliasson et al., 2007) which show that comfortable weather conditions, i.e. high temperature, clear sky and access to sunlight increase the number of people present in an urban space in a sub-Arctic climate. Ebrahimabadi (2015) issues provision of sheltering from the wind, maximising solar access, and managing snow as the most crucial for improving environmental comfort in sub-Arctic climate. Seen in this way, climate becomes a background which hinders or favours certain affordances and activities but is not the main feature of the environment as such. In other words, climate controls activity. Carmona et al. (2003) have named this 'climate-sensitive urban design': microclimate is seen to affect how accessible the (non-climate-related) design affordances are for the

user. For example, a park bench might be a desirable place to sit when it receives the rays of sun during a warm summer day – but it might be completely inaccessible when covered in snow and not maintained during the winter.

2.3 Climate and temporal activities

Northern environments do have certain productive qualities, which enable experiencing the environment differently. Activities such as skiing, skating and sledding expand functionality of the climate from being a mere background for activity. Despite the soft mobility challenges that winter season poses, ice roads crossing the frozen bodies of water, for example, can be also perceived as positive affordance provided by the winter season (Chapman et al., 2017). The sub-Arctic climate also provides recreational opportunities, which have been acknowledged by especially northern cities in recent years as endeavours to activate the urban life and economy during the winter season (i.e. City of Edmonton, 2012; City of Oulu, 2014).

Contrasting the previously mentioned climate as a hindrance to activity, people enjoy experiencing different weather conditions – for instance, wind in the hair or dancing in the rain (Eliasson, 2000). The changing seasons are perceived as positive by some sub-Arctic inhabitants – and embracing it provides a more sustainable, diverse and pleasant environment for inhabitants (Jauhiainen & Mönkkönen, 2005). On the other hand, perceptions of a 'good weather' differ, depending on people's origin and cultural background (Thorsson et al., 2007). An approach that actively includes the experiences of climate within the design schemes has been named as climate-revelatory (Lenzholzer, 2012).

2.4. Climate control and the values guiding urban design

Jan Gehl (1971) presents a simple theory on how the microclimate influences social life in urban areas through dividing activities into necessary and optional. A social environment, according to Gehl, must have physical qualities that invite people to slow down, such as a favourable microclimate. If these qualities are absent and the microclimate is not pleasant, people just do what they feel necessary. Necessary activities are often a priority in urban design, yet optional activities are more vulnerable and therefore need special attention (Westerberg, 2000). However, it is culturally defined which activities are valued as necessary and which fall into optional. In order to prevent diseases related to high standards of living, a substantial amount of recent research has focussed on how to support year-round connectivity for soft mobility (i.e. Chapman 2018; Chapman et al. 2019). The question is also socioeconomical: Whom does the maintenance and control of wintry urban realm serve? In recent years, some municipalities in Nordic countries, especially in Sweden, have adopted gender-neutral ploughing strategies (99% Invisible 2019) – meaning that soft mobility routes often preferred by women are cleared before roads after a snowstorm. However, this kind of feminist perspective has not yet been specifically discussed in the context of sub-Arctic climate in academic research.

3. What kind of model for sub-Arctic urban realm?

Research states that climate considerations currently have low impact on urban planning practices in the sub-Arctic region: seasonality (Jauhiainen & Mönkkönen, 2005) or

comfortable microclimate (Ebrahimabadi et al., 2015) are not given enough consideration by planners. This is partly understandable, since the research outcomes discussed in the previous section also oppose each other. On the one hand, climate is an experiential feature that adds new functions and experiences to urban realm. On the other hand, its effects should be reduced.

It is also notable that malls, passageways and other roofed typologies that gained popularity in the 20th century are currently not examined as part of the wellbeing impacts within urban design – the optimal climatic conditions are found from somewhere less protected, often emphasizing the benefits of nature. In contrast, public health projects have noted that indoor spaces are central parts of socio-natural systems (Biehler and Simon, 2010). This kind of polarisation between outdoors and indoors follows a broader discussion on urban space and its decline (i.e. Carmona, 2010). The critique of the decline of public space seems to be dichotomised: some critics focus on over management – an approach that manifests itself in what can be seen as commodification and homogenization of space. Other critics paint an opposite picture of under management of external public spaces, of a rubbish-strewn, poorly designed and insecure public realm. Also, discussion about winter maintenance seems to fluctuate between this dichotomy. The white space of the winter is difficult to comprehend, which leads to suggesting for example light projections to define space during the winter season (i.e. Chapman & Larsson, 2019) or controlled indoor environments. At which point does maintenance turn into over management? Are all the indoor public spaces automatically over-managed and therefore not suitable to act as public spaces? These questions persist as long as we aim for controlling the space and climate *for* its users as passive targets of design solutions.

On the other hand, the ideal of constant climatic conditions – most easily achieved through roofed, indoor spaces – implicate that the city is considered as a building, and urban squares as 'rooms' in that building. This becomes problematic when cities are still obviously part of the surrounding nature, and ubiquitous natural processes still affect the urban areas (Lenzholzer, 2010). Therefore, urban design should develop a novel design paradigm. One that would be more inclusive of the climate processes and people's perceptions (Lenzholzer, 2012) as well as bridge the inside and the outside of buildings as overlapping climatic zones, while acknowledging the materiality of the climatic phenomena instead of succumbing to the primacy of the visual (Roesler, 2016).

To overcome the previously mentioned oppositions, I propose combining the effects between urban realm, climate and inhabitants (see Figure 1). An examination of mundane everyday life through surfaces on which it happens, combines climate-revelatory elements and protected indoor public spaces into one socio-natural entity. More specifically, an integrated network of nature- and culture-based wellbeing affordances related to urban surfaces.

4. Towards a conceptual framework: Surfaces of sub-Arctic urban space

Especially during the last few decades, material turn in human and social sciences has revived interest in material relations and the role of materials in constituting the human world. Through material perspective, spaces are not seen as voids that accommodate activity, but as sites of constant exchanges between different matters. One of the conceptualisations is by James Gibson (1979) as he categorizes space into medium,

substances and surfaces. Medium, most often air and gas, differentiates itself from solid substances, by affording the movement of solid bodies through it. It is also transparent and transmits light. (Labadini, 2017). Surfaces can be comprehended as an interface through which the environment is experienced through its qualities such as colour, texture, hardness, roughness, temperature, and so on. This comprehension might happen in substances or medium but are perceivable by human bodies on surfaces (Labadini, 2017). Surfaces can be only experienced through haptic vision: close-up, affective and kinaesthetic (Ingold, 2017).
Tim Ingold (2017) gives a more active role to surfaces. He criticizes Gibson's conception for seeing the role of the surface as an interface between the relatively solid substances of the earth and the relatively volatile medium of the air. According to Ingold, surface should be seen as a variation intrinsic to the surface itself: the ground surface persists not in spite of reactions between substances and medium, but *because* of them. In the sub-Arctic urban realm, we perceive snow, rain and other climatic phenomena partly because they act with (urban) surfaces. This kind of viewpoint is close to a notion of *milieu* – both surfaces and milieu try to describe "a discontinuous and opaque field animated by the continuous emergence of sensual clues, in which humans are immersed" (Labadini, 2017, p. 46). Conceived in this way, the urban form becomes not primarily geometric but *environmental*. This kind of post-Cartesian notion of space is fruitful in understanding the climate and its effects in spaces, and the immaterial emerges as an integral and constitutive part of the space.

Figure 1. Surface as a concept can be positioned in the intersection of climate, urban realm and the wellbeing of inhabitants. (Source: Essi Oikarinen)

In addition to connecting atmosphere and physical characteristics, in this case namely climate and urban form, surfaces can be also seen as sites for meaning. Tim Ingold (2017) argues, that the meaning of objects does not lie in their depths, but we need to look at the surfaces more carefully, perhaps as the real sites for the generation of meaning. He goes so far as to connect the experience of ground and air as a crucial way of *knowing* and ties human culture intrinsically to the materiality surrounding it (Ingold, 2010; 2012). Surfaces become complex, multifarious zones of exchange where materiality becomes entwined with representations, sensations and affects (Forsyth et

al., 2013). The way we treat the surfaces – in other words, control the weather – can be also seen as a direct expression of ecological as well as aesthetic and moral values. Both absence and presence of human traces on the surfaces of the earth are devices for taking claims to space (Brown, 2014).

In order to examine the instrumental use-value of the surfaces especially for wellbeing, I turn towards the concept of affordance. Gibson (1979) proposed that people recognize opportunities for action in the environment by perceiving the affordances of either objects within the environment or the environment itself. For an environment to be preferred over others it must afford the functions that are important and meaningful to individuals and might also afford activities that other environments do not support (Clark & Uzzell, 2002). The concept of affordance suggests that the affordances persist within the object even when no one is using them, and even if no one designed these particular uses. Even pleasure and beauty can be considered as environmental affordances (Grahn & Stigsdotter, 2010) because they reflect an assessment of the environment in terms of its compatibility with human needs and purposes, which consequently affects effective human functioning in the settings. This illustrates well both the complexity and the usability of the concept as affordances aim to overcome the artificial dichotomy between an actor and the environment. In this sense, affordances can be hard to specify, but they rather form a conceptual framework for the relationship between built environments and humans over time, especially with respect to the form, function, and meaning of architectural elements. (Maier et al., 2009).

Figure 2. Ice sculpture on the market square highlights the seasonality of the urban space. (Oulu) (Source: Essi Oikarinen)

Figure 3. The heated pavement of the pedestrian street keeps the walking conditions similar all year round. The surface eases walkers and strollers to access the street in all weather conditions yet it is aesthetically poor (Oulu). (Source: Essi Oikarinen)

Figure 4. The pavement in front of the City Hall is heated. The limits between heated surface and snow-covered surfaces raise questions about hierarchies: who is the walkability and ease of moving meant for? (Oulu) (Source: Essi Oikarinen)

Figure 5. The sidewalk next to the brick and mortar commerce windows is heated to provide easy access to the shops. The snowy section in the middle of the wide pedestrian street enables winter transport (Luleå). (Source: Essi Oikarinen)

Figure 6. The warm indoor street of a shopping mall affords a warm place to socialize. A street musician and a couple distributing religious leaflets are located just outside the entrance, apparently not feeling welcome by the controlled environment. In addition to sitting, people also use the indoor street created by the shopping centre ground floor as a warm shortcut from one street to another (Oulu). (Source: Essi Oikarinen)

Figure 7. Family is warming up in a vestibule before the shopping centre opens in the morning (Luleå). (Source: Essi Oikarinen)

Figure 8. Market square is empty during the winter. The maintained, sanded surface is strictly limited. For the rest of the area, there is no official winter maintenance, which is announced with signs, yet footsteps in the snow show that people have also taken shortcuts instead of using the official route (Oulu). (Source: Essi Oikarinen)

Figure 9. A 'no winter maintenance' sign and fence will not stop using the routes also used during the summer season if they provide a shortcut (Luleå). (Source: Essi Oikarinen)

Figure 10. Christmas lights add a hint of seasonality to otherwise static indoor space in a shopping centre (Luleå). (Source: Essi Oikarinen)

Table 1. The table summarises notions on the affordances of different surficial conditions of sub-Arctic urban realm during the winter season. The order is from the most processed to the most 'natural' surface.

Surface type	**Spatial examples**	**Distinguishing characteristics**	**Positive affordances**	**Negative affordances**
Roofed, protected	Shopping mall, arcade (Figures 6, 7,10)	(Often) commercial space, where free lingering is controlled.	Warming, using as a shortcut.	Only well-mannered staying is allowed.
Defrosted	Defrosted pavement, salted road (Figures 3, 4, 5)	Paved or asphalted surfaces that are kept permanently in their 'summer state'. The user is attracted to use certain routes.	Easy, equal soft mobility options are available (such as skateboarding) during all seasons.	Aesthetically detached from the nature, aesthetically poor.
Sanded	Paths, passages for light traffic (Figure 8)	Sand on snow or ice.	Easy, equal walking imitates the summer setting in its functionality. enables i.e. bike riding all year round.	Winter modes of moving such as sledding or skiing are not supported. Small stones get into shoes.
Manufactured snow or ice	Skating rink, sledding hill, ice sculpture (Figure 8)	Formations and surfaces that enable wintery ways of moving or touching.	Play, movement, faster means of transport (i.e. pulling a child in sled).	Not equally accessible for everyone.
Non-maintained (i.e. snowy or icy)	Iced water bodies and other deformations of nature, forests, non-winter-maintained paths and routes (Figure 9)	Surfaces that have no winter maintenance, or surfaces that are completely deformed by nature, such as iced lakes.	Places become more accessible, possible to use shortcuts (i.e. through iced lakes), enable new perspectives to the city, enable occupation of unstamped terrains.	Not equally accessible for everyone. (Piles) often reduce the flat and accessible surfaces in the city.

Current conceptions of health and wellbeing acknowledge the need for control over one's own physical, mental, social and spiritual health, which provides a good starting point for looking at wellbeing through affordances: humans are given an active role in their endeavours towards achieving health and wellbeing. Mundane surfaces of everyday life rarely draw attention to themselves, are often not of "spectacular novelty, technical

exceptionality, iconic imagery or transgressive audacity" (Ingold 2017, p. 100) yet they form the stage for human life – and are also a stage where to perceive weather events. Table 1 summarises notions on the affordances of different surficial conditions of sub-Arctic urban realm during the winter season.

5. Discussion: Wellbeing affordances of sub-Arctic urban surfaces

Examining the urban surficial situations on a mundane everyday micro level reveals arbitrary situations, which do not follow from any comprehensive plan. The inhabitants of the space have more agency than traditional conceptions of urban space acknowledge. Sub-Arctic city surfaces get re-made all the time because of seasonality and weather changes – and inhabitants have active role in re-making them. Winter urban realm is often maintained with different level categories and increasingly focussed on mobility – but this kind of planning is often slightly larger in scale. The urban grain becomes coarser during winter (Chapman et al., 2019) – but this is seemingly not the case of everyday activity. People stop to warm themselves in vestibules while waiting for something or cross through warmed indoor spaces on their routes. They create paths where there was an access during summer as well or continue using passages and stairs that are not maintained during winter and sometimes closed with fences and signs, even if this means slightly more difficult moving conditions – to mention only some of the non-planned uses. Producing active and inviting environments all year round requires understanding of small scale and in-between situations of the wintry urban realm. Examining urban realm as an entity of surfaces instead of, for example, the dichotomy of protection and exposure, the conception of 'good' environment becomes broader. Artificial environments which are free from the effects of weather, such as shopping centres, have been criticised for the privatisation of public space and the erosion of the public sphere (Chiodelli & Moroni, 2015), extending the use of control systems used in private spaces to public spaces (Boddy, 1992) or, specifically in the context of northern cities, resulting in placeless environments not stemming from their cultural context or possessing genuine meaning for inhabitants (Pressmann, 1996). While the critique can be also opposed (i.e. Chiodelli & Moroni, 2015), shopping centres are not discussed systematically as contributors of wellbeing, but rather through control. Even though some activities within these semi-public and private indoor spaces are controlled, people still have some control over their own activities, and find affordances that benefit their own wellbeing yet are within the allowed range. This includes, for example, using the routes through shopping malls as warmed shortcuts. These reveal tactics of urban survival and enjoyment. This kind of approach supports including climate as a central part of culturally and socially produced places.

6. Conclusions

Through a review of the literature, this paper proposes surfaces as a useful perspective for discussing to sub-Arctic urban realm and its health and wellbeing-enhancing features. The concept of surface also acknowledges the activity happening in the space, connecting urban form, climate and the inhabitants. It provides a perspective on how the initial intentions or objectives of the design relate with how the artefact is actually used – which cannot be approached by looking at the planned environment only, or just

the spaces themselves as physical entities. In this way, 'thinking through the weather' diverts clearly from the traditional form-based discussions of urban design and architecture. Sub-Arctic urban space cannot be conceived as dichotomies such as indoor vs. outdoor space or even through public vs. private. This also brings up Matthew Carmona's (2010) point on the over and under management of urban realm: the spaces can also have various uses and the limits of public and private, for example, get blurred. This kind of examination could be central, for example, when developing soft mobility plans for northern regions. Could commercial space have some further imposed claims in sub-Arctic climate? Could the private actors be demanded for more? Also, the in-between spaces resulting at the entrances of warm indoor spaces might require a more detailed consideration in design. Private institutions, such as shopping malls, also play part in forming the public sphere (Chiodelli and Moroni, 2015). In the future, further conceptualisations of the micro-relationships of urban realm might also benefit from testing the concept also at edges of the city. There, environments are even more seasonal, since the nature is often more present.

Sub-Arctic climate is just one among many, and in this sense, the proposed direction of examining the effects of climate on urban life might be applicable elsewhere, as well. On the other hand, sub-Arctic climate is a zone where no particular urban language exists (at least explicitly stated), but the solutions originate from warmer climates. As climate is so strong part of the urban realm, this kind of re-examination of relationships between urban form and climate and users could result in completely new urban aesthetics.

This paper is explorative by nature; therefore, the proposed framework should be tested with further research. While presenting a surface-based approach to urban space, this article also opens up a lot of questions, for example regarding sustainability. What would be the most economical way to organise the urban realm? Are energy-intensive, warmed and roofed spaces ecologically viable, if they also encourage people to consume less or use the means of soft mobility? Also, examining different user groups with differing needs would be highly beneficial.

Traditionally, public space is thought to act as communication space. When closed indoors, it does not communicate ecological values and detaches people from their surroundings. The relationship to nature and its processes is central and can also eventually enhance socio-technical performance of a system (Anusas & Ingold, 2013). Therefore, this paper also primes viewpoints on experiencing nature. Including climate-revelatory elements in design can communicate the ever-changing patterns of microclimate; make them more 'experience-able' and thus also raise people's awareness of the microclimate patterns themselves (Lenzholzer, 2010). What should the relationship between climate-revelatory elements and environments detached from the effects of climate be in an ideal urban space?

As pointed out in this paper, knowledge on experiences and preferences is often hyper local, and therefore contrasting with the knowledge on environment and climate (Younger et al., 2008), which are often discussed in the context of (global) climate change. By letting the climatic effects show also in the urban realm, contemporary western societies could be more connected to nature. Neither is climate change just about large area adaptation, but as much about practical and aesthetic small life relations – which this paper aims to conceptualise.

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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Public-private interaction in low-rise, high-density Tokyo: a morphological and functional study of contemporary residential row-houses

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Abstract
The focus of this paper is liveable, low-rise high-density urban morphologies of residential architecture and urban planning practices in Tokyo. Over the last several decades, historically established qualities in cities worldwide are increasingly sacrificed in favour of globalization–led 'universal' typologies. Tokyo is not an exception: it is gradually changing to a high-rise, high-density built city environment. From a morphological point of view, the paper demonstrates bioclimatic and cultural disadvantages of such developmental paradigm shift in Tokyo. Presented case studies elaborate upon the ways in which low-rise high-density environments and subsequent urban forms better facilitate human interaction and, consequently, can aid in reducing social isolation and contribute to mental well-being.
Presented case studies, observed over the period of six years depict how residential environments created by row-houses can be seen as a collection of adjoining private spaces. The emphasis is on the interconnected set of phenomena: low-rise high-density morphologies, climate-responsive semi-exterior spaces, facilitating human and public-private interaction. The conducted morphological and functional analysis shows how design requirements of bioclimatic responsive semi-exterior space fully coincide with those of desirable public-private interface and human interaction. However, site-specific constraints critically affect spatial configurations of low-rise high-density developments in contemporary Tokyo, emphasizing the requirement for case-by-case attention in design and management of such places. Only design processes conscious of spatial management aware of the potential embedded in the design process can enhance socio-cultural interplay and bioclimatic performance.

Keywords: well-being, residential architecture, place management, bioclimatic sustainability, Tokyo

To cite this article:
Sano, S., Filipović, I., Radović, D. (2020). Public-private interaction in low-rise, high-density Tokyo: a morphological and functional study of contemporary residential row-houses. *The Journal of Public Space*, 5(2), 63-88, DOI 10.32891/jps.v5i2.1285

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

1. Introduction: Current status and issues of Tokyo. High-rise High-density.

The focus of this paper is on liveable, low-rise high-density urban fabric of residential Tokyo. Liveability, as a concept, encompasses numerous qualities and predetermined features (see: The Economist's Global Liveability Ranking, Mercer's Quality of Living Rankings, Monocle's Quality of Life Survey etc.), with some publications noting comprehensive assessment methods (Tan et al., 2012). However, there is still no definitive agreement on particularities necessary to achieve liveability, or about their relevance or methodological assessment (The National Association of Regional Councils, 2012; Veenhoven, 2006). For the purposes of this research, liveability is defined as the possibility for unhindered interaction between various actors in the city, as well as the blurred demarcations between public and private spaces. Additionally, in the context of this research, we use the Japan Property Central KK (2011) definitions of low-rise as any building below four floors (on average ground floor plus two storeys) and high-density is defined by the floor aspect ratio (FAR) over 200%. To illustrate, the highest ratio in Tokyo is 1300% which applies to commercial land in the Yurakucho/Marunouchi area around Tokyo Station (Japan Property Central KK, 2011).
"Over the last several decades, historically established quality was increasingly sacrificed, in favour of 'universal' typologies, which are, in the name of globalization and single bottom line, destroying cities worldwide" (Radović, 2012. pp.107., for further discussion on globalization effects see: Exenberger et al. (2013), Khazaee et al. (2015), Kara (2019)). Some areas in Tokyo, such as its central three wards and waterfront areas are gradually losing the low-rise high-density spatial qualities and a particular feel which characterizes this city and its life. As previously noted, spatial density is defined by the Floor Aspect Ratio (FAR) calculated as a building's total floor area (gross floor area) to the size of the piece of land upon which it is built. Simple numbers can illustrate the core problem: the average size of one property in the waterfront area is 7,123 square metres, compared to that of 218 square metres for the rest of Tokyo. The average number of storeys there is ground floor plus 6.3 compared to the ground floor plus 1.6 (Tokyo Metropolitan Government, 2016).
Consequently, Tokyo is gradually changing, and dense, low-rise urban fabric is getting replaced by high-rise high-density developments. A 2019 meta-analysis of 180 studies on a vast number of economic outcomes of urban density concluded that urban density had net positive effects but had some regressive distributional effects, which is to say, a negative impact on lower-income residents (Ahlfeldt and Pietrostefani, 2019).
In Japan's capital city and in a dramatically ageing and depopulating country, high-rise apartment buildings have become a dominant trend. According to the Statistics of Tokyo created by Tokyo Metropolitan Government (2019), between 2008 and 2015, the number of buildings in Tokyo increased by 38,218 for residential buildings, but decreased for all other building types. And the number of buildings of more than 30 storeys has increased by about 50% in Koto-ward (the ward includes the waterfront area). "*Now* […] *the urban return phenomenon is intensifying, the housing construction promoted by developers creates the situation there are only high-rise apartment buildings with large open spaces.*" (Maki et al, 2019, p. 36)
According to the recent report from the Ministry of Health, Labor and Welfare (2008), residents of the high-rise apartment buildings in urban areas, especially elderly people, tend to be drastically confined. This extends to both real and metaphorical terms: an

average net size of an apartment in Tokyo is approximately 40-65 square meters, usually housing a family of three or more members. In addition, as the households are predominantly multigenerational, larger occupancy is expected. As an ageing society (Statistics Bureau of Japan, 2019), with the world's longest life expectancy (World Health Organization, 2020), older adults have fewer opportunities for interaction within their immediate communities and the city design practices do not facilitate or take into account such activities. This urbo-architectural type allows for less contact with the outside world and subsequently social isolation is more likely (Ministry of Health, Labor and Welfare, 2008). Social isolation is one of the factors that can lead to an increase in the risks of mental illness (Clifford, 2018). If a person suffers from said problems, he/she will likely become reclusive and socially isolated, entering a vicious circle of isolation and illness (Ministry of Health, Labor and Welfare, 2008). According to the research conducted by the Building Research Institute of the Japanese Ministry of Construction, high-rise apartment buildings are 'psychologically problematic' (Watanabe, 1989). An analysis of experiences of the homemakers living in various housing typologies provides conclusive evidence of direct relation with mental well-being (Petermans, 2019, Rice, 2019). The reasons are simple: according to Watanabe (1989), the residents of high-rise apartment buildings are not aware of changes in outside brightness, do not hear the sound of rain, miss on outdoor events or the movement of people, cannot see flowers and trees, in stark contrast to the residents of detached houses. For the residents of high-rise apartments, the amount of external stimuli is exceptionally low, because the ground-level is not only physically but also psychologically distant. All that makes the residents of such neighbourhoods psychologically distant from each other. That study identifies living in high-rise high-density as psychologically isolating.

Figure 1. Illustrative examples of High-rise High-density Residential Environments: (a) Water front area of Tokyo (Source: yano@mama.akari.ne.japan[1]); (b) Large open spaces without social interaction (Source: Thirteen-fri[2]); (c) High-rise interior space without external social interaction (Source: edvaldocostacordeiro[3])

[1] Available at: *https://commons.m.wikimedia.org/wiki/File:Towers_of_Shinonome_-_%E6%9D%B1%E9%9B%B2%E3%82%BF%E3%83%AF%E3%83%BC%E3%83%9E%E3%83%B3%E3%82%B7%E3%83%A7%E3%83%B3%E7%BE%A4_-_panoramio.jpg* [Accessed 8 Dec. 2019]. Colour-change (to blank and white) by author.

[2] Available at: *https://ja.m.wikipedia.org/wiki/%E3%83%95%E3%82%A1%E3%82%A4%E3%83%AB:MM_-_Grand_Central_Tower_P1R.jpg* [Accessed 8 Dec. 2019]. *Trimming and colour-change (to blank and white) by author.

[3] Available at: *https://pixabay.com/ja/photos/%E3%82%A6%E3%82%A3%E3%83%B3%E3%83%89%E3%82%A6-%E5%AE%B6%E5%85%B7-%E3%83%AB%E3%83%BC%E3%83%A0-3042834/* [Accessed 8 Dec. 2019]. Colour-change (to blank and white) by author.

Urban precincts with multiple residential towers tend to be designed with large open spaces at the ground level. Planning regulations/policies demand that, when the upper limit of the floor area ratio is reached, the building coverage rate must be lowered. If a developer designates the resulting open spaces as 公開空地*koukai-kuchi* (literally: open vacant space), it becomes legally possible to raise the total floor area (Building Standards Act (Japanese building regulation) No.59-2). Many developers use this legal loophole and, as a direct consequence, a number of open spaces at the foot of residential towers remain vacant (Figure 1b) But, lacking spatial definition and specific use, such spaces are often not used at all, thus failing to perform as places for social interaction.

The motivation of developers to set up 'open vacant spaces' is simple: the goal is to increase the total floor area, not to produce high-quality public spaces for people (Suzuki, 2014). The equation is simple: increased floor area equals increased profit. All efforts go towards reduction of maintenance costs and complaints from future tenants and neighbours, not towards solving the reasons for dissatisfaction. According to Sasao (2019), this problem occurs not in 'open vacant spaces', but likewise in public spaces, such as parks. Various activities which one would expect simply get prohibited (e.g. eating/drinking), on the grounds of avoiding maintenance and management costs.

For instance, a common ban gets placed upon children playing or jogging. In extreme cases, even conversation is not allowed. Public spaces were not conceived for people and social interaction and, subsequently, these are spaces without people through which residents only pass by. Without reasons to stay, they will not linger unless necessary. The low level of social interaction in high-rise residential developments is, thus, not limited to the interior; exterior spaces suffer the same fate.

This paper presents an alternative to the high-rise high-density trend, reintroducing the low-rise high-density paradigm which is indigenous to Tokyo and Japanese cities at large. Triggered by the above-described socially triggered challenges of the new trend, low-rise high-density environments introduce combination of spatial, socio-cultural and climatic characteristics of low-rise high-density Tokyo, and efforts towards sustaining and perpetuating said qualities.

Well-being, an important concept for this research, will be brought into an active connection with architectural planning and design, linking it holistically to a number of factors. Well-being presents a state of happiness and contentment, with low levels of distress, overall good physical and mental health and outlook, or good quality of life. In simple terms, well-being can be described as judging life positively and feeling good (Diener et al, 1997, Veenhoven, 2008). Employing previously established concepts, the research presented in this paper will try and answer the question whether it is possible to design architecture that facilitates well-being utilizing a holistic approach that will include, but is not limited to: the users' experience, urban planning and management practices, residential operational practices and bioclimatic architecture. The following case studies will illustrate how it is possible for those facets to converge in an unplanned/spontaneous way, yielding positive effects, but note how no joint effort to institutionalize and/or codify such experiences has been made so far.

2. Theoretical Background: Low-rise High-density

2.1. Low-rise High-density urban typologies in Tokyo

According to Radović (2012), the urban spaces of Tokyo have historically had low-rise and high-density spatiality. Even though high-rise and high-density urban developments represented by residential towers are taking over, Tokyo still keeps its predominantly low-rise, high-density spatiality.

Tokyo is composed of small land units; the land of Tokyo is shared by 1.8 million landowners. (1.7 million individuals and 0.1 million corporate bodies), according to Kitayama et al (2010). The average plot area of a single property in Tokyo is 218 square metres (Tokyo Metropolitan Government, 2016). At morphological level, Tokyo is a dense assemblage of those small units.

The city is predominantly low-rise, with ground floor plus two floor high buildings constituting 70% of all buildings, with exception of the central three wards of Tokyo, Chiyoda-ward (15%), Chuo-ward (20%), Minato-ward (35%). The average number of storeys of buildings is ground floor plus 1.6. (Tokyo Metropolitan Government, 2016)

As further elaborated, spaces within low-rise urban fabric, private and public, blend seamlessly, without clear boundaries or an underlying logic.

2.2. The Street: Where Public and Private Interact

A number of theorists such as Jinnai, (1995), Sorensen, (2004), Brumann, (2015) tried to explain and define the underlying logic of urban fabric of Tokyo, often in relation to other cities and other cultures. The following references capture some of the dominant discourse.

> '*Unlike the urban structures one finds in Europe that were created with a series of walls, Tokyo consists of an assemblage of independent buildings (grains).* […] *The majority of the land is filled with narrowly segmented, privately-owned living spaces. In these residential areas, spaces that anyone can pass through blend together with private spaces and many of the most private spaces allow a clear of sight from the outside.*'
> (Kitayama et al, 2010. pp. 10 and 131)

That is where

> *"Ambiguous border between the public and private realms* […] *spontaneously emerges, from a kind of collaboration between public and private and nature.* […] *Spaces like this are real* ad hoc *creations. (…) And that is a very interesting, peculiar, practice in Japanese urban space."*
> (Kuma, 2012, p. 15)

Urban spaces of Tokyo are, thus, recognized as a collection of small spaces in a low-rise, high-density environment, and they have been operated and used privately in response to the Japanese natural environment and its climate in particular. This is where we encounter the expression 'bioclimatic architecture'. The term summarizes a number of differing general terms as the single planning definition – that is a group of design decisions that offer appropriate living conditions within buildings by the minimal use of technical units 'the group of machinery' that require energy consumption of non-renewable resources (see e.g. Grondin, 1959, Vazquez, 2009, Almusaed, 2014). In bioclimatic terms, the defining extreme is the tropical summer, as the vernacular responses echo those of the cultures to the South of the archipelago – light structure,

low thermal mass, an emphasis on natural ventilation, openable wall surfaces, elevated floor, in-between "縁側*engawa*"[4]spaces which accommodate semi-indoor/semi-outdoor living, etc.
Tardits (2014, pp. 213 and 256) argues:

> "*Like cities in the United States and Africa, Tokyo's public spaces take on different meanings and forms from those in Europe.* [...] *Agora, forums, plazas, parks, etc. did not appear in Tokyo during the Edo period*[5]*. Public representation has not developed in Tokyo*".

In Japan, the notion of 'public [space]' is a relatively new, imported construct. As Maki et al (2019, pp. 145) pointed out, "*The reason why today's Japanese people don't utilize open spaces is that outward urban planning (that does not take into account Japanese cultural background) is forced to apply.* […] *Japan's post-war years are not over yet*".
Subsequently, what is culture-specific public space for Japan or Tokyo? As mentioned by Kitayama et al (2010), the fabric of Tokyo is finely divided, filled with privately-owned spaces where public and private are mutually interpenetrating. Taking that into account the qualities associated with public-ness and human interaction within small-grained, densely interwoven realms of private and public life can be observed. While plazas and parks were imported to Japan after the Meiji restoration (modernization of Japan after 1868), streets were always spaces for public expression in Japan. Previous research also points out at cultural specificity of Japanese "路地*roji*", narrow alleys, where everyday life unfolds. The role of climate-culture nexus in creation of the, 'seamless transition/integration of private and public spaces' (hereinafter: public-private interaction) is confirmed, critical in the definition of the overall Japanese urban condition.
Characteristic to urban spaces of Asia, including Japan, is the presence of "あふれ出し *Afuredashi*", privately-owned items (that would normally be stored inside the private property) within the alley space (Tardits, 2014). Some of *Afuredashi* examples are pots and plants, household and garden maintenance items such as brooms, rakes, mops, buckets, gardening tools, etc, as well as other various items stored in sheds or storage units, compared to other Western countries. These elements increase utilization of alleyways and stimulate social interaction among residents (e.g. interaction between neighbours while pruning the plants and/or greenery within the boundaries of semi-public spaces or cleaning and general upkeep of said spaces.) (Aoki, Yuasa and Osaragi, 1994).
While it can be argued that the presence of private items in public space exemplifies the dominance of private over public, such interactions (private and public overlapping) increase the opportunities for socialization, at least among residents of the neighbourhood.
Aoki & Yuasa (1993, pp. 53) pointed out:

[4] Engawa: Traditional spatial element of the Japanese architectural space, which is the intermediate area between the interior and the exterior. Engawa has a use as a space to go in and out, to move between rooms, to see outside, to welcome visitors, and so on.
[5] Edo period: The period between 1603 and 1868 in the history of Japan. The period came to an end with the Meiji Restoration (modernization in Japan) starting from 1868.

"*In Edo period, the urban blocks of Tokyo were subdivided by roads (alleys) on the premise of private use of public road including even main roads.* [...] *Operation of road was originally premised on the collaboration of neighbors*", while Tardits (2014, pp. 107 and 174) stresses how "*The Edo government entrusted the citizen with the day-to-day management of the city, left the city overcrowded* […] *In Tokyo, there is no duality of official 'public' and unofficial 'private'* […] *Public roads are often violated by private acts and 'tamed'".*

Figure 2. Roji in Tsukishima (Source: Rubber Soul[6])

2.3. Semi-Exterior Spatial Nature in Response to Humid Subtropical Climate

Japan's humid subtropical climate, predominant in the majority of the country, strongly influences the broadest cultural fabric of Japanese society (Kusanagi, 2015). The famous saying in Japan *家のつくりやうは、夏をむねとすべし* (*Ie no tsukuriyauwa, natsu o mune to subeshi)*" means "A house should be built with the summer in mind". This sentence is noted in the essay "*Tsurezuregusa*" by Yoshida (1330-1331) and is widely known (Keene, 1998).

Traditionally, Japanese architecture had an open spatial feature that integrates interior and exterior spaces in response to the humid subtropical climate. Kusanagi (2015, pp.37) notes the climate of "Japanese Islands, almost the whole area of about 2000km from north to south is humid subtropical climate (Cfa)[7]".

This classification and subsequent architectural practices are in accordance with bioclimatic architecture and concepts of 'passive' design. In the times before 'active', technological climate-control took over, everyday life in semi-exterior space ("軒下空間 *Noki-Shita-Kukan*")[8] where direct sunlight is blocked and winds go through created 'public-private interaction'. In contemporary Japan, however, "common areas" (entrance hall, common corridor/steps, elevator hall, an area where different types of functions are mixed), become one of the obstacles.

[6] Available at: *http://photozou.jp/photo/show/1517641/141889284* [Accessed 8 Dec. 2019].

[7] World maps of Köppen-Geiger classification. Available at: *http://koeppen-geiger.vu-wien.ac.at/* [Accessed 8 Mar. 2020]

[8] Noki-Shita-Kukan: Space under eave and space under roof and massing.

(a) (b)

Figure 3. (a) Former Iwasaki House in Taito-ward, Tokyo (Source: mrhayata[9]);
(b) Anonymous house in Japan (Source: kontenten[10])

2.4. Barrier of Public-Private Interaction

'Common Areas' can be defined as a space located in-between private spaces, or between private and public spaces. Such spaces have the capacity to enable social interaction, initiated by any party and, thus, acting as a semi-private space. Unfortunately, this is not its contemporary condition; instead, the private and public spaces are kept apart. The explanations, as is the case with shortcomings associated with high-rise buildings, are to be found in building regulations. The designated common area is assumed to be used by an unspecified number of people. This increases the risk in the case of fire and introduces a set of risk management measures (e.g. evacuation). As a result, the boundary with the private areas must be divided by a fireproof wall. The consequence being that the common-use areas are divided by the firewall located between the private and public spaces, preventing its seamless transition/integration.
The second obstacle in reaching the potential of this space is again grounded in regulation – i.e. the question of management: who manages the 'designated common area'? Since this area is not a privately-owned space, the management ought to be handled by a non-tenant. The job of the manager is, again, preventing problems and complaints. Therefore, the number of prohibited actions increases, the same as with open spaces of high-rise developments, making the space difficult for anyone to use. Ironically, the space for *everyone* becomes the space for *no one*.
Another issue surrounding the spatial management and residents' interaction can be found in previously noted spatial consequences of imposing the sharing of common areas in a building complex. Imposed spontaneity is seldom successful and continues to be a challenge for architectural designers and spatial managers alike. The fact that the space is clearly marked as a 'designated common [use] area' is synonymous with 'you must share' and 'you must interact with other people here'. The author's experience as an architect shows that people will refuse to use spaces thusly designated and managed (expanded upon in Section 3).
Firstly, the users need a space that can be appropriated as their own, to be utilized as they see fit. Then, the desire of expanding one's space may emerge, which leads to another form of space-sharing. In order to share, it is necessary to communicate with

[9] Available at: *https://www.flickr.com/photos/mrhayata/3826681124* [Accessed 8 Dec. 2019]
[10] Available at: *http://photozou.jp/photo/show/1190304/240798820* [Accessed 8 Dec. 2019]

other people and any communication is interaction. Socialization then occurs naturally. In this paper, the focus is on private space/personal space and the possibility to overcome the problems embedded in current 'designated common/public space for nobody' reality. The focus will move to existing apartment buildings, residential environment with private spaces without common areas, and towards the establishment of spatial condition that possibly stimulates the emergence of 'public-private interaction'.

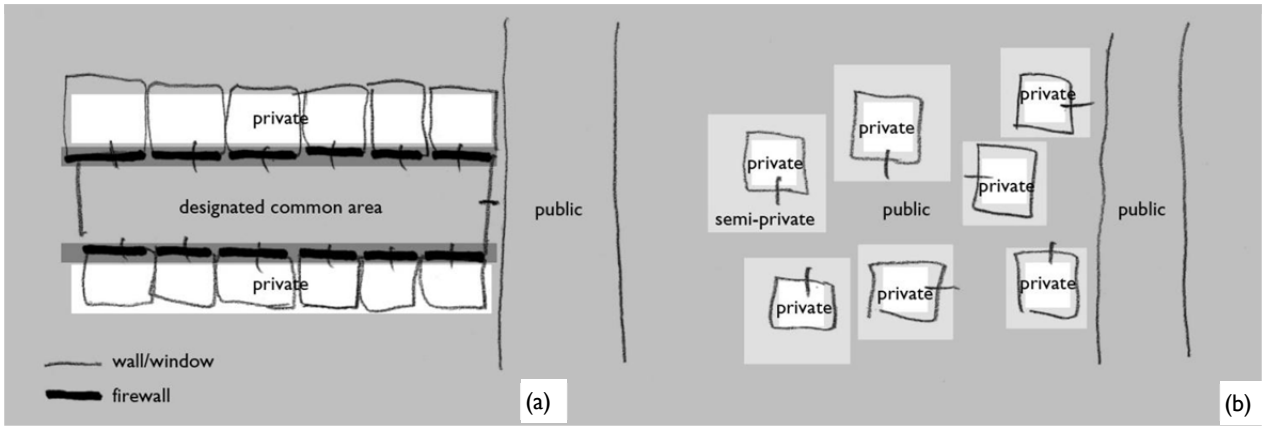


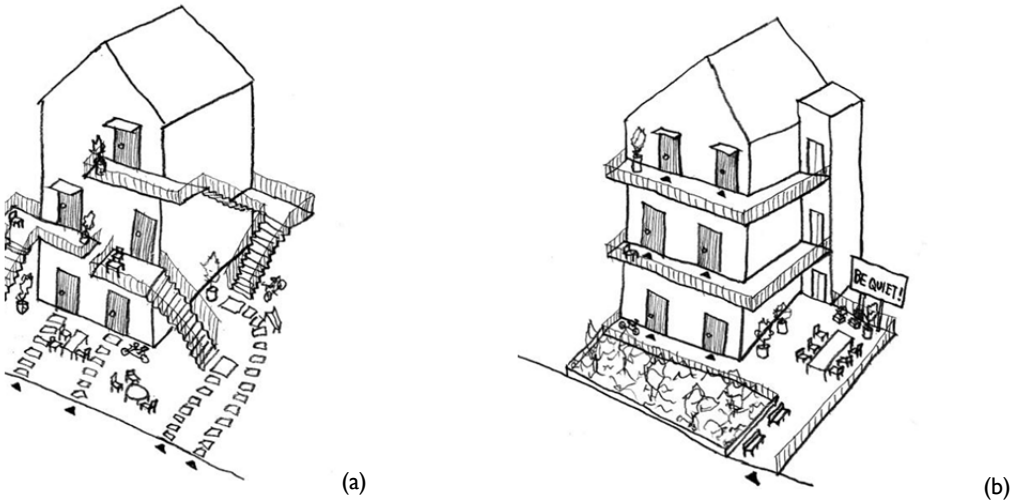
Figure 4. (a) Fireproof Wall in Designated Common Area; (b) Seamless Transition of Private and Public. (Source: Author, 2019)

2.5. Residential Environment of Public-Private Interaction - Row-House

Japanese building regulation (Ministry of Land, Infrastructure, Transport and Tourism. Enforcement Regulations of Building Standards Act. Major building uses 08020, 08030, 08040.) categorizes apartment buildings into the following three groups: (1) 共同住宅 *Kyodo-Jutaku* (communal housing); (2) 寄宿舎*Kishuku-Sha* (dormitory) and (3) 長屋 *Nagaya* (row-house).

Communal housing is an apartment building with common use areas, such as corridors, halls and elevators. *Dormitory* is an apartment building with shared sanitary block (kitchen, bathroom, etc.). *Row-house* is an apartment building without common areas. It consists only of several private spaces.

In the living environment of the row-house, public space (pathways) is directly connected with private spaces. This is a low-level space without common areas (including elevators), a space where indoors and outdoors private spaces are densely packed. One could argue that this urbo-architectural type has the capacity for formation of living with significant level of public-private, indoor-outdoor interaction. This potential will be explored using examples from practice, applying the previously elaborated three spatial hypotheses based on the nature of predominant urban character of Tokyo: low-rise high-density (row-house residential environment); climate responsive semi-exterior space; and public-private interaction (abolishment of designated common area).



Fugure 5. (a) Row-house/Apartments without common use area;
(b) Communal Housing/Dormitory/Apartments with common use area
(Source: Author, 2019)

3. Learning from Practice

The first case is a row-house residential environment designed by the author of this study. In order to respond to the Japanese architectural particularities, definition of public space used in this paper is conditional and culture specific. Alternatively, it can be viewed as defined as semi-private space, but this designation lacks the previously mentioned particularities of the Japanese cultural and morphological context. Public space here includes (1) common spaces in residential areas and (2) not only publicly owned spaces (in Japan, only roads or parks) but also to the accessible private land connected to them. *Dragon Court Village* (Figures 7, 8 and 9) is a two-storey apartment building (row-house) in residential district of Aichi prefecture, Japan.

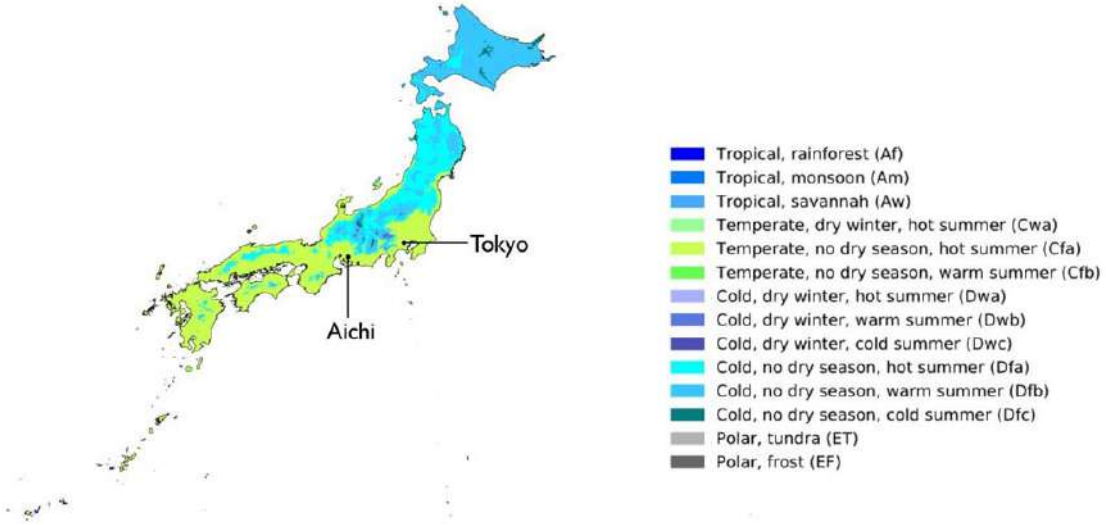


Figure 6. Present and future Köppen-Geiger climate classification maps at 1-km resolution. Nature Scientific Data. (Beck et al., 2018[11]; the location of Tokyo and Aichi, were added by the authors)

[11] Beck, H.E., Zimmermann, N. E., McVicar, T. R., Vergopolan, N., Berg, A., & Wood, E. F. (2018). "Present and future Köppen-Geiger climate classification maps at 1-km resolution". Available at: *https://commons.wikimedia.org/w/index.php?curid=74673722* [Accessed 8 Dec. 2019].

The total floor area is 508 square meters, with a total of nine units. Its building was completed in 2013. Each dwelling unit can be accessed directly from the street, and there are no designated common areas such as common corridors or common halls. The main dwelling space is on the upper floor, and on the ground level there are small rooms/entrances and staircases only. Therefore, the ground level is mostly comprised of *piloti* spaces, open to the surroundings.

Figure 7. Dragon Court Village (Source: Hideki Ookura)

The characteristic found in this building is the dispersion of small rooms as annexes in the *piloti* space. In order to go to the annex from main dwelling space, residents go out from the entrance and walk through the *piloti*. The *piloti* space is a semi-exterior space where the upper massing casts a shadow and where the breeze flows. The airflow is designed and confirmed by CFD (computational fluid dynamics) analysis, guaranteeing bioclimatic comfort between the annexes.

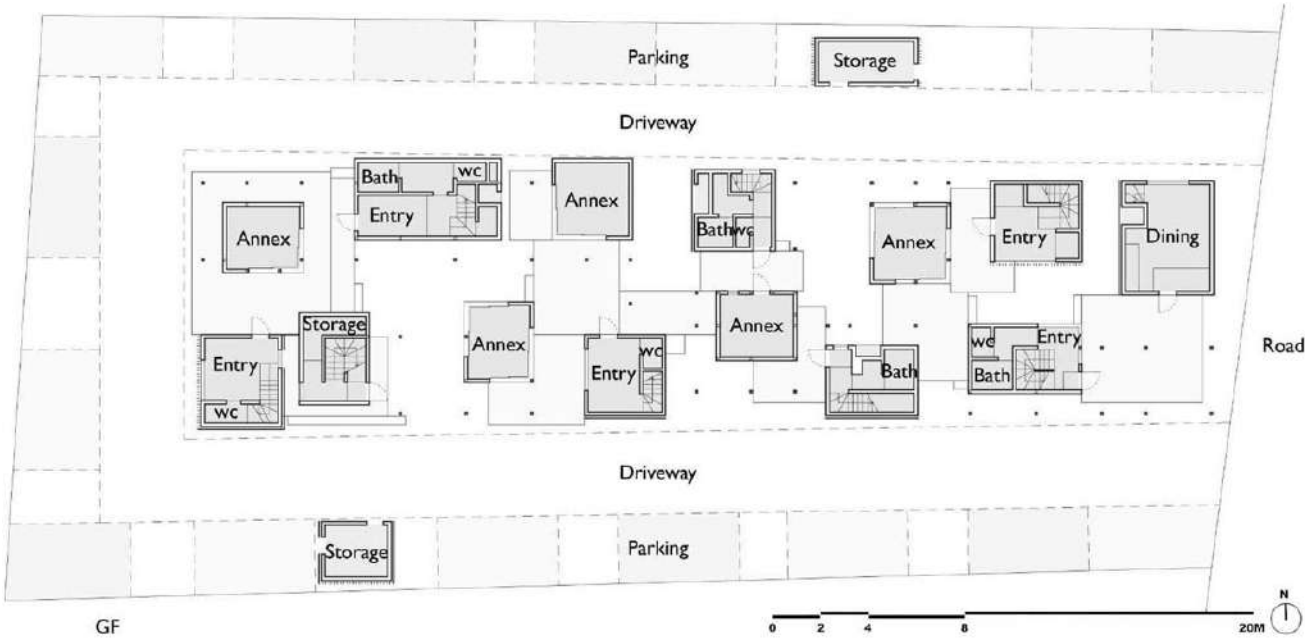


Figure 8. Ground Floor Plan (Source: Eureka)

Figure 9. Rendered Longitudinal Section (Source: Eureka)

Not long after the building completion, residents have started transforming the *piloti* space into a lively place, in their own way. Each resident placed around their entrance a mailbox, umbrella stand, potted plant, bicycle, and so forth. The life of the residents had overflowed in front of each residential unit (*Afuredashi*), as it did in the old residential areas of Japan. Some of the residents have set up small flowerbeds.

The residents are mostly families – husband and wife (just one family has a child), a few residents are singles, and approximately half of the units were used as office space combined with dwelling. Most of the occupants were office workers (e.g. designer). Although the types of the residents are diverse, every resident started to enjoy life in their own way through *Afuredashi*-making. One of them, Ms. Y, started a small vegetable shop business in the annex on the ground level, while living on the upper floor. Because Ms. Y utilizes her space as a vegetable shop, she is always present as a store manager in the *piloti* space. That makes space safe and inviting, and the number of outside visitors who come to buy vegetables increased. She gradually expanded her vegetable shop using more of the *piloti* space. But then, some changes occurred. Other residents also started actively utilizing their annexes and some of them made small interventions (e.g. adding a mezzanine floor for more storage, putting sheetrock on the wall for the display of goods). Such actions made the number of visitors increase further.

A year after the building completion, Ms. Y began to run a weekend flea market. Mainly customers gathered, making friends among other self-employed members of the community. Additionally, coffee shops, snacks, clothes shops, and other shops opened, creating a modest, festival-like atmosphere. In the *piloti* space, divided by the entrance and the annex, small shops opened. The vacant space became a rest space and a playground for children. As all these activities were temporary in character, there was no conflict to be observed, neither was any reprimand issued by the property manager. Other resident joined in the flea market initiated by Ms. Y and her friends, expanding the visitor number to include acquaintances and friends. The ground level (exterior/semi-exterior space) of the apartment building, gradually began obtaining a public quality, meaning anyone could visit and participate in the events.

Figure 10. *Afredashi* in Dragon Court Village, 2014 (Source: Hideki Ookura)

Figure 11. Weekend Flea Market in Dragon Court Village, 2017 (Source: Hideki Ookura)

3.1. Low-rise High-density

As many residents used the annex on the ground floor, connected with the room on the upper floor (office, store, etc.), these spaces understandably developed a strong interdependence. Even though the annex is spatially modest, it is possible to confirm the merit of its smallness. Also, as previously noted, during the flea market, each store opens in every individual part of *piloti* divided by the entrance and the annex, and the vacant space became a rest space and the children's playground. This produced favourable results due to the high-density space configuration, creating numbers of small and convenient and easy-to-use spaces inside and outside.

3.2. Climate responsive semi-exterior space

The *piloti* area is designed as a semi-outdoor space where strong sunlight is blocked, and the wind passes through. Climate-responsively designed spaces in warm and humid climate encourage people to stay outside and to interact. The tendency of people staying in the semi-outdoor space was particularly remarkable at the time of the flea market, but people also stayed during times when there were no special events. Since almost all the *Afuredashi*, except signboards, were installed in the semi-outdoor space, this space was also effective in making the external space rather private-like.

3.3. Public-Private interaction

Because the *piloti* spaces were not originally designed for a specific purpose, the residents needed to consider its utilization purposes. According to the research on the alleys of Tokyo (Tsukishima, Chuo-ku, Tokyo) by Aoki & Yuasa (1993, pp. 53), "*Spaces that are open to the exterior are more likely to be used privately, by putting Afuredashi, rather than spaces that are closed*". Aoki & Yuasa (1993) state this tendency occurs not because "*an area for private use is generated because there is an enclosed area (there is an area that is easy to personalize)*", but because "*Since there is no area in the open space in advance, using*

it for private use will result in private domination, and as a result, private domination will be strengthened", Aoki & Yuasa (1993, p. 52). In other words, "*the residents are not passively receiving the given space environment, but are actively working against the environment*", Aoki & Yuasa (1993, p. 53). This statement has been interpreted as positive, because the residents proactively define their own living surrounding, a practice not common in Japan. The user actively discovers the possibilities of the space without defined functions, so utilization of the space becomes more active, as the usage is discovered (by the user) thereafter. In this sense, 'non-functional' space is easier to use, due to their lack of a designated function. In this way, each resident applied their own setup to their spaces, influencing the neighbours' mental wellbeing through increased social interaction. As a result, shared spaces were created, or the entire area became a common space. From this observation, it can be said that the private space and the common space are not divided, but their functionality is continuous or mixed, and the rules and manners of the space were decided and utilized by the residents themselves. This is completely different from the 'designated common area' described above. Normally, the unwritten rule of this designation, in architectural and planning practices, for the given architectural typology is an area that is mainly utilized as a buffer or a transitional zone. Active usage and continued evolving of activities are uncommon, but it was not considered disruptive by the residence manager. Therefore, its usage was activated without perception of activities being in opposition to the guidelines and being prohibited.

3.4. Challenges of Spontaneous Usage of Semi-Outdoor Spaces

The following figures (Figures 12 and 13) show the transition of private areas (completed in 2013) to the present (as of 2019) that has been formed in outdoor or semi-outdoor spaces by comparing the range in which *Afuredashi* appeared.

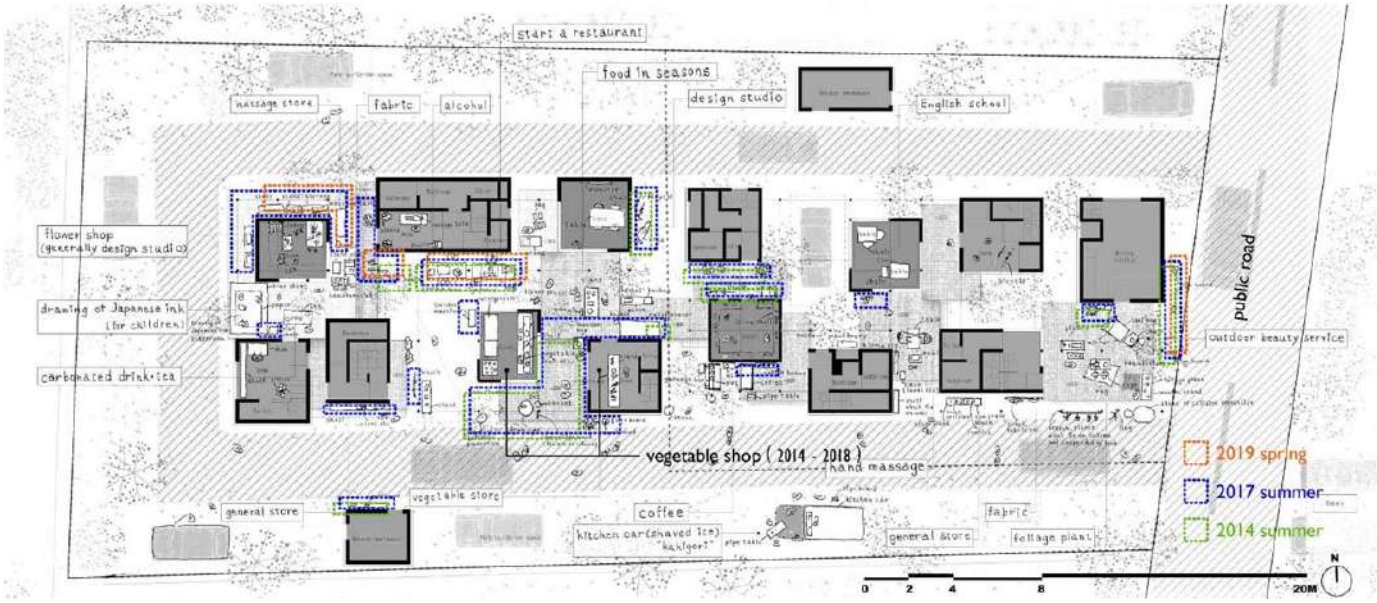


Figure 12. Transition of the Privately Used Area *Afuredashi* (2014, 2017, 2019) floor plan (Source: Author, 2019)

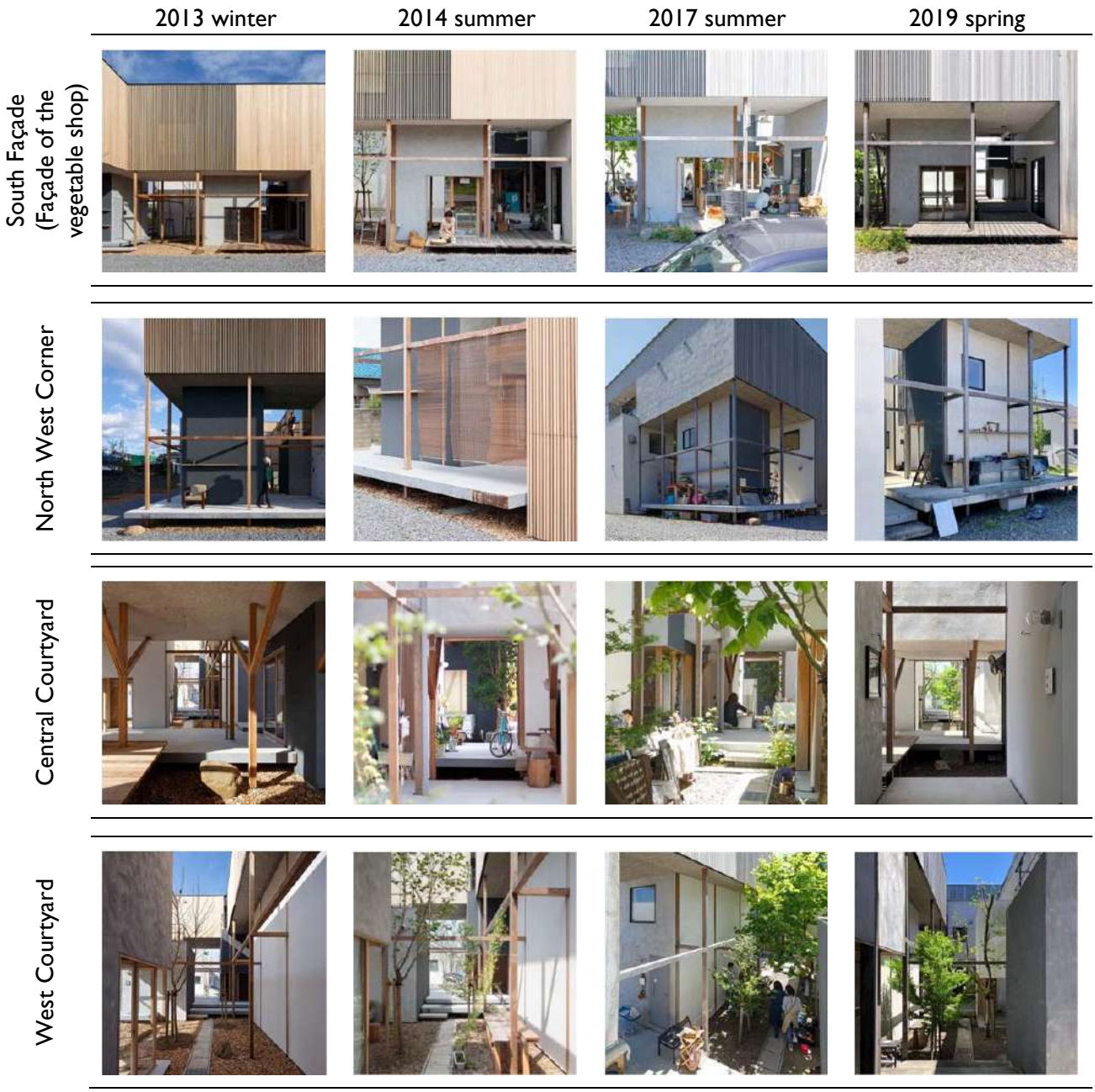


Figure 13. Changes in Spatial Operation of Private-Use Designated Areas (note the *Afuredashi* elements) (Source: Author (2019) and Hideki Ookura (2013-2017))

All semi-outdoor spaces were the location where the *Afuredashi* elements appeared. This is consistent with Aoki's (1993) *Afuredashi* observations. Also, many of the *Afuredashi* are on the west side of the site (opposite from the main road). It is also observed that more private areas were formed as far as possible from the main road. The same tendency is also noted in Aoki's study (1993), there are more *Afuredashi* near the centre of the alley (location farthest from the entrance) rather than the space near the entrance. However, the fact that several *Afuredashi* elements are located on the sites' west side has a lot to do with the location of the vegetable shop likewise located on the west side. Because the private territory had been increasing until 2017, as of

2019 the existence of *Afuredashi* elements could only be partially confirmed. This is believed to have been caused by the relocation of Ms. Y and the magnitude of her influence. Ms. Y relocated in 2018, and it is thought that this event is the major factor for the *Afuredashi* decrease in the 2019 spring. It is interesting that, although it was expected that the *Afuredashi* around her residence are removed, the amount of *Afuredashi* of the entire site have reduced too. So, a correlation between the residents' influence has been noted. The disappearance of the *Afuredashi* that used to exist signifies that the expansion of private usage onto the external space has not been established. It is ideal for private elements (e.g. Afuredashi) to spontaneously 'spill out' and eventually turn the (previously underused) space into a place fostering human interaction, but this did not happen. The hypothesis of this research, an opposite to the high-rise high-density paradigm, theorized that the low-rise high-density spatial and morphological dispositions can generate public-private interaction and can also foster human interface, so it was partially confirmed. But the question that remains is 'how to verify this claim?'

4. Case Study II: Minagawa Village

Based on the examination in Section 3, a Tokyo case study which has a similarity to Dragon Court Village in terms of the architectural type, is selected to verify the feasibility and effectiveness in the contemporary situation. In the process of the selection of the case study, literature review of all the row-houses was carried out based on the Japanese architectural magazine *Shinkenchiku*[12] for the period of 10 years (2009-2018).

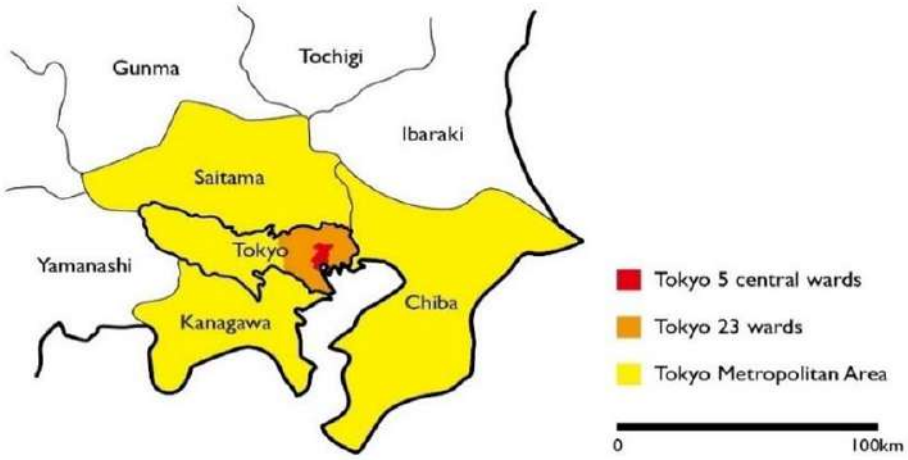


Figure 14. Tokyo Metropolitan Map (Source: Author)

There were 69 cases in Tokyo Metropolitan Area (Tokyo, Kanagawa, Saitama, and Chiba). Among those cases, 56 cases (81%) were in Tokyo's 23 wards, and 13 (19%) were elsewhere. In more detail: 8 cases in Tokyo's 5 central wards, 48 cases in other Tokyo 18 wards, 5 cases in Tokyo (outside 23 wards), 8 cases in other Tokyo Metropolitan Area (Kanagawa, Saitama, and Chiba).

[12] Shinkenchiku: Japanese architectural magazine that has the longest history in Japan, first published in 1925.

Since there are no elevators in row-houses and all are low-rise (less than or equal to ground floor plus two storeys), the number of floors is not the subject of discussion. The focus is on 'semi-exterior' spaces. As previously mentioned, semi-exterior is the space adapting to the humid subtropical climate, blocking sunlight and allowing airflow. In addition, it is recognized as an important parameter which ensures the outdoor quality for staying, connecting private with public space. There were five cases with semi-exterior space with more than 20% of the total floor area. Most of the surveyed cases (81%) were in the 23 wards of Tokyo. But the site areas in central Tokyo were comparatively smaller and in order to efficiently secure the maximum total floor area, they are box-shaped, with no room for semi-exterior spaces. Even if there is a semi-outdoor space, it is not a space under the eaves, it is a space open to the elements. There were many cases with a courtyard, but there were few 'semi-exterior spaces' with a roof or overhead mass. This indicates that in urban areas priority is given to minimizing the construction costs (rising due to the reconstruction after the 2011 Great East Japan Earthquake and construction demand for the 2020 Tokyo Olympics[13]). Thus, a simple box-shape is applied as a design strategy. The tendency to go against climate responsive spaces in low-rise and high-density is observed as well as the trend of high-rise, high-density development. 'Boxing-up' is one of them. Of the five cases with semi-exterior space of 20% or more of the total floor area, there were two cases in the five central wards of central Tokyo. Two cases are Minagawa Village in Shibuya, Tokyo and Yoyogi Terrace in Shibuya. Minagawa Village applies rental row-house system. On the other hand, Yoyogi terrace is also row-house managed by division of ownership. Regarding the ownership pattern, like Dragon Court Village, Minagawa Village is chosen as a case study.

Figure 15. (a) Free Space (on the left) and garden (centre); (b) Roof Covered Semi-Exterior Space (Source: Author)

Primarily, the background on the design process and the architectural brief of Minagawa Village will be presented. Minagawa Village is located in Omotesando (Jingumae, Shibuya-ku, Tokyo). The wooden house built in 1957 was repurposed as an apartment building, completed in 2018 and designed by Toyoaki Kamimoto, a founder of

[13] Construction Material Price Index. Available at: https://www.zai-keicho.or.jp/price_relative/ [Accessed 08 Mar. 2020]

Saiseikenchiku Laboratory. The site area is 454 square meters, the building area is 238 square meters, and the total floor area is 421 square meters. It is a six-unit building complex, consisting of a four-unit row-house (residence combined with office), a café, and a retail shop. Four residential units and a café are connected via 'Free Space' facing the garden. Since Minagawa Village is row-house, this type of free space is not the common entrance/designated common area. The four residential units and the café have independent entrances; detailed explanation to follow.
According to Kamimoto interview notes (8 April, 2019), the architect himself[14] was involved in the renovation works. The owner held a competition in which proposals were sought from multiple professionals in order to decide on the consulting company for this property. While the others proposed rebuilding, only the Kamimoto team proposed renovating and won the competition.

Figure 16. Minagawa Village Floor Plans (Source: Saiseikenchiku Laboratory)

The wooden house built in 1957 had been used as an apartment complex with repeated extension and reconstruction works. Some of the works were illegal because of the lack of building permission and completion inspection; it was understandable that other teams suggested the existing building be demolished and rebuilt. The existing building was not only illegal, but also did not satisfy the building regulations for this site and was not economically feasible. However, by legalizing the existing building, Kamimoto, as explained in the interview, proposed an "*architecture and its mechanism to create a new community that cannot be achieved by a new building*"[6], and the proposal was accepted by the owner. Kamimoto' offices relocated to Minagawa Village for ten years after

[14] The semi-structured interview with Kamimoto was carried out on the 8th April 2019 at the Free space in Minagawa Village-Style. Participants were Mr. Toyoaki Kamimoto (Principal architect at Saiseikenchiku Laboratory); Ms. Milica Muminović (Assistant Professor, University of Canberra. Her research extends the professional experience through studies conducted in Japan about identity, places, spaces in between architecture and urban design, public and private, with an emphasis on residential architecture in Tokyo); Ms. Ryoko Iwase (Principal architect / Landscape designer at Ryokoiwase. She works as an architect designing architecture, landscape design with public space in Japan; Satoshi Sano (Author and Principal architect at Eureka)

completion, and he recruited the tenants and managed the shared spaces. Kamimoto is also currently involved in managing the entirety of Minagawa Village.

Figure 17. (a) Frontal Street of Minagawa Village; (b) View from the Street, Minagawa Village (Source: Author)

Figure 18. (a) Free Space, Minagawa Village (Source: Author); (b) Rice-cake Making Event in Minagawa Village (Source: Saiseikenchiku Laboratory[15])

5. Discussion

Considerations in regard to the public space inducing interactions in the case study will be discussed in the following section. This discussion is based on four points of views mentioned in Sections 2 and 3: low-rise high-density, climate responsive semi-exterior space, public-private interaction and operation of space.

5.1. Low-rise High-density

Similarly to the Dragon Court Village, Minagawa village has human-scaled, small and dense spaces assembling semi-exterior space and exterior space in a low-rise architecture with ground floor plus one or two storeys. The feature that the exterior space is divided to have spatial continuity is also similar in character. As Kamimoto noted in the interview "[…] *space composition of row-house becomes (almost inevitably)*

[15] Available at: *http://minagawa-v.com/wp-content/uploads/2018/12/IMG_3548@2x.jpg* [Accessed 5 May. 2019].

elaborate and complex, but the spatial extensibility and redundancy that are generated by the complexity in space composition" (Kamimoto interview notes, 08 April, 2019). Minagawa Village is equally complex and highly dense. Since people have lunch in exterior/semi-exterior spaces, "low-rise high-density space" particularities help to attract people to exterior/semi-exterior spaces.

5.2. Climate responsive semi-exterior space

Minagawa Village's 'Free Space' is a large 縁側*Engawa*-like space which can also be used as a semi-exterior space integrated with the garden. *Engawa* is the traditional spatial element of the Japanese architecture, which is the intermediate area between the interior and the exterior. *Engawa* is utilized as a space to go in and out, move between rooms, observe the exterior, to welcome visitors, etc. In other words, it is a 'non-functional but versatile' space, which is also observed in the free space of Minagawa Village. When all the sliding doors are open, the space becomes a climate-responsive semi-exterior space, allowing airflow.

Tables and sofas are placed under the roof, forming a comfortable space in another semi-exterior space of Minagawa Village. The presence of these two semi-exterior spaces makes it easy to utilize the central garden (an exterior space without a roof or similar elements).

In addition, the temperature is lowered by the trees in the central garden and the airflow in the semi-exterior space makes it more comfortable, regarding temperature. The exterior and the semi-exterior spaces synergistically form a climate-responsive environment, providing people with opportunities for outdoor habitation and interaction.

Figure 19. (a) *Engawa* Traditional Roof-covered Exterior Space (Source: karitsu[16]); (b) Minagawa Village Roof-covered Space (Source: Author); (c) Dragon Court Village Piloti Space (Source: HidekiOokura)

5.3. Public-Private interaction

There is a big difference between Minagawa Village and Dragon Court Village regarding Public-Private interaction. Specifically, the presence of *Afuredashi* elements is the point of interest: such elements were observed in the Dragon Court Village, but not in Minagawa Village. As it is the case with Dragon Court Village, it takes a certain amount of time after its construction before the *Afuredashi* elements appear, so even in Minagawa Village, *Afuredashi* emergence will occur over time, and the private area might

[16] Available at: *https://www.flickr.com/photos/karitsu/8075303228* [Accessed 8 Dec. 2019].

be formed spontaneously. However, the two cases show a significant difference in spatiality, demonstrating that the difference greatly influences the formation of the private areas in the semi-exterior and outdoor space.
The following figure (Figure 20) is the field note quoted from the research of narrow alley in Tsukishima, Tokyo, by Aoki and Yuasa (1993). It concludes that from the comparison of the number of *Afuredashi*, the open exterior space 'Semi-Open type' that allows passing through (rather than the dead space with high closed-ness of 'Semi-Closed type') has a tendency to be more likely to be used privately such as spill overs elements of *Afuredashi*.
The two results represent the major difference between Dragon Court Village and Minagawa Village. Dragon Court Village allows people to pass through the massing or the exterior perimeter, categorized as Semi-Open type. Alternatively, Minagawa Village is conceptualized as a Semi-Closed type. The tendency noted by Aoki and Yuasa (1993) was also applied to Dragon Court Village and Minagawa Village, and *Afuredashi* were observed at Dragon Court Village, but hardly observed at Minagawa Village. That is, in the Semi-Open type, a private area is likely to be formed spontaneously in the exterior space, whereas in the Semi-Closed type, its formation is relatively difficult.
Therefore, if human interaction is to be created through the formation of a private area opening to the exterior and utilized as public space, Semi-Open type space is better than other types, as pointed out by Aoki and Yuasa (1993). Yet, the construction of low-rise, high-density redevelopment in modern Tokyo is carried out only on small or irregular sites with a small distance between developments. In such cases, the space configuration of the Semi-Open type is difficult to achieve, and then Semi-Closed type is adopted in the current situation, in Tokyo.

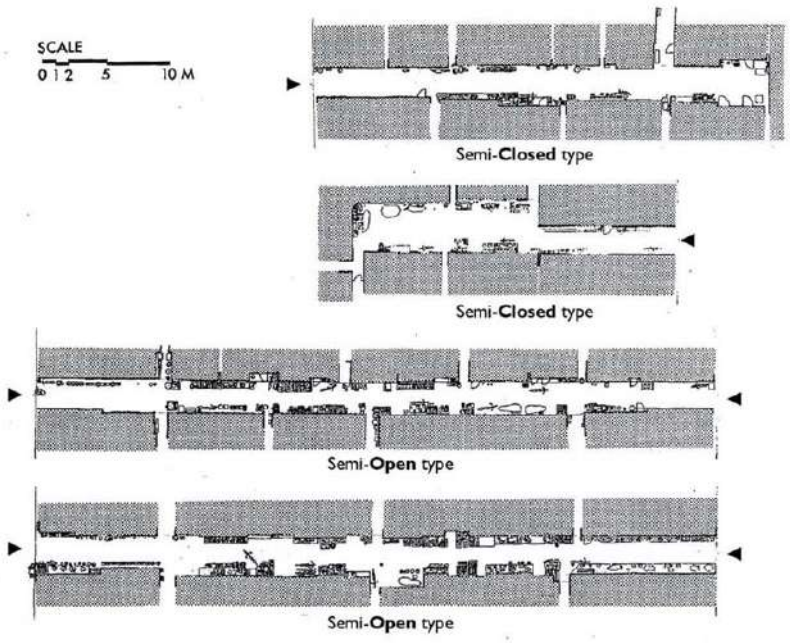


Figure 20. Field note of *Afuredashi* in Roji (Aoki, Y. & Yuasa, Y., 1993)

Nevertheless, according to the interview with Kamimoto (Kamimoto interview notes, 08 April, 2019), although Minagawa Village, possessing Semi-Closed typology, does not

have *Afuredashi* elements, so the public-private and human interaction are produced in this low-rise, high-dense environment with semi-exterior space thanks to his active management. It demonstrates that though the formation of a private area in exterior and public space is unlikely to occur spontaneously in Semi-Closed types, active operation makes it possible to facilitate public-private and human interaction. However, even in the Semi-Open type Dragon Court Village, *Afuredashi* (the formation of a private area outside) does not always exist, and the occurrence was triggered by a key user. Even in the Semi-Open type, the operation of space is desirable to induce collaboration.

In conclusion, low-rise, high-density, semi-exterior space has the potential to create public-private and human interaction, if certain conditions are met (e.g. designing semi-private spaces that will facilitate interaction between residents and neighbours, innovative spatial management strategies, etc.). However, when dealing with small-scale, low-rise, high-density redevelopments in contemporary Tokyo, the space configuration tends to be a Semi-Closed type due to site constraints. Thus, not only the morphological conditions of low-rise, high-density and semi-exterior, but also the active operation are required to produce public-private, human interaction.

5.4. Spatial Management

The following section elaborates on the particularities of spatial operation. The relationship between the type of management and the ease of spatial sharing, discussed with Mr. Kamimoto (architect and manager of the property), is a very important argument. Certainly, there is relevance in discussing the spatial management, but on the other hand, the size, shape, and nature of the space are considered to have a great influence on fostering interaction, both spatial and social. It is the effect brought about by the spatial characteristics of low-rise and high-density, and public-private interaction that is achieved by the exclusion of designated common area.

"*People cannot use the space unless they are actively involved*" (Kamimoto interview notes, 08 April, 2019), is an understandable statement, but another person manages it, for both Minagawa Village and Dragon Court Village, even though the space is shared and used by residents. In Dragon Court Village, day-to-day managers and operators are the residents, including Ms. Y. However, to be precise, there is a manager who is the owner/landlord of the building and the property. The owner/landlord lives in the adjacent property. In Minagawa Village, Kamimoto clearly declares that he oversees the management because he is the assigned manager. (Kamimoto interview notes, 08 April, 2019) Other tenants might also have the habit of cleaning the area around the entrance. However, even if there is no 'self-management' and fully managed/operated by Kamimoto's office, tenants are familiar with Kamimoto and his employees and are familiar with spatial management. Thus, it would be possible for other residents to use the space, while communicating with the manager.

5.5. Possible Future Urban Design Strategies

The similarities found in Minagawa Village and Dragon Court Village can be thought of as occurring in large numbers for other architects, buildings and urban spaces as well. There is a limited number of architectural/urban spaces where a single architect can be involved. Even if an architect is involved in the design of small spaces of low-rise and high-density as much as possible, contribution to society through their involvement is

negligible. However, if architects such as Kamimoto (Minagawa Village) and this study's author (Dragon Court Village) influence each other, it is sufficient and possible for the low-rise, high-density small spaces to be grouped together, gradually forming an urban-scale spatial environment. This is a bottom-up approach (architect-led) to urban design, contrasted by the top-down urban developments that involve clearing-out land and extensive redevelopment, destroying the cultural sustainability and human interaction.

6. Conclusion

This paper examined public spaces that create human interaction to reduce social isolation and achieve mental well-being in contemporary societies. It also demonstrated the effectiveness and the feasibility led by the approach to low-rise, high-density in terms of climatic and cultural characteristics in Tokyo, which was different from high-rise, high-density urban development. The key approaches were low-rise, high-density, climate responsive semi-exterior space, public-private interaction, spatial management. The case study succeeded in creating human interaction, and although its effectiveness could be confirmed, there was a problem that it was temporary and was not sustained. As a verification of the feasibility of designing and building in Tokyo, in the urban area of Tokyo, there are not so many cases that adopt the approach of 'low-rise, high-density'. This is because area efficiency is maximized, and the construction cost is minimized. Although the feasibility of designing and building in Tokyo is not high at least as of 2019, there are cases where the approach of 'low-rise, high-density' has been realized like Minagawa Village, and certain effects for creating human interaction is confirmed. However, when using a small-scale, low-rise, high-density approach in contemporary Tokyo, the space configuration tends to be a Semi-Closed type due to site constraints. Thus, 'Low-rise High-density, Climate responsive semi-exterior space' requires the incentive reflected in various spatial strategies for the creation of public-private interaction and human interaction. Besides, regarding the Semi-Open type space where public-private interaction occurs spontaneously and *Afuredashi* is formed, operation of space is suggested for sustainable space utilization.

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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Green public spaces in the cities of South and Southeast Asia.
Protecting needs towards sustainable well-being

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Abstract
The significance of green public spaces is well documented in relation to social inclusiveness, human health, and biodiversity, yet how green public spaces achieve what Gough (2017) has termed 'sustainable wellbeing' is less understood. This contribution presents preliminary results from a study of green public spaces in four mega-cities of South and Southeast Asia: Chennai (the Republic of India), Metro Manila (the Republic of the Philippines), Singapore (the Republic of Singapore), and Shanghai (the People's Republic of China), cities that have climates ranging from tropical, to subtropical and temperate. The conceptual framework brings together social practice theories with human development theories, methodological implications for the study of park usage, and Protected Needs. This study sets out to understand how parks satisfy human needs by uncovering practices in relation to activities and material arrangements. Central to the research design and sampling strategy is a desire to understand park-related practices in all of their diversity, and accounting for how different activities are carried out by diverse groups of people. The paper presents exemplary results showing that parks provide a space in which a multitude of needs are satisfied, and that parks cannot be substituted by other settings such as commercialized spaces. The paper will conclude by discussing tensions between types of park usage, and in relation to commercial encroachments on public space.

Keywords: South and Southeast Asia, protected needs, parks, well-being, sustainability

To cite this article:
Sahakian, M., Anantharaman, M., Di Giulio, A., Saloma, C. Zhang, D., Khanna, R., Narasimalu, S., Favis, A. M., Alfiler, C. A., Narayanan, S., Gao, X., Li, C. (2020). Green public spaces in the cities of South and Southeast Asia: Protecting needs towards sustainable well-being, *The Journal of Public Space*, 5(2), 89-110, DOI 10.32891/jps.v5i2.1286

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

I. Introduction

Nowhere but in the cities of the Global South is it more pressing to think about public space in relation to climate. In the hot and humid contexts of South and Southeast Asian cities, anthropogenic processes are leading to climate change and local pollution. Further, concrete constructions, air-conditioning dependencies, and fuel-based forms of mobility are leading to hotter microclimates in cities as opposed to surrounding areas, or what is known as the urban heat island effect. The notion of 'microclimate as artifact' (Roesler and Kobi, 2018) draws attention to how the climate as an object is socially constructed and materially-embedded, related to how we plan cities and urban spaces. The prevalence of air-conditioned shopping spaces in the cities of South and Southeast Asia is leading to a homogenization of climate control as the most desirable form of microclimate (Sahakian, 2014; Hitchings and Jun-Lee, 2008), reinforcing class inequalities in relation to who has or is denied access to such spaces, and further structuring leisure activities around commercial spaces. Against this backdrop, studying the role of green public spaces in relation to these climatic and socio-economic contexts becomes all the more pressing.

Green public spaces, in this paper, refer to outdoor spaces which involve some level of biodiversity and are publicly accessible. We draw from Habermas (1989) and Urry (1995), respectively, in seeing the 'public' as a sphere where private people come together, and 'space' as an extension and reflection of society. In this understanding, a green public space can also be privately managed and owned. 'Green' refers to the biophysical dimension of the space, such as biological and microclimate diversity, as opposed to artificially cooled indoor spaces. Public spaces have been studied in the past in relation to biodiversity and social inclusion, building on earlier literature on public spaces in relation to democracy (Lefebvre, 1967), yet rarely are the environmental and social dimensions of sustainability studied together. There is therefore a need to bridge an understanding of ecological factors (Wolch et al., 2014; Kowarik, 2011; Gross, 2010; Cornelis and Hermy, 2004) with questions related to access and social equity, including socio-economic, gendered, and ethnic variables (Boone et al., 2009; Seeland et al., 2009; Abercrombie et al., 2008; Barbosa et al., 2007; Krenichyn, 2006). Further, understanding green public spaces as contributing to microclimate diversity is relatively understudied (Tavares in Roesler and Kobi, 2018).

Gough's notion of 'sustainable wellbeing' (2017) is a useful starting point for bringing together an understanding of sustainability that integrates both environmental and social considerations. Sustainable wellbeing involves meeting human needs (thus going beyond human health) while accounting for planetary limits. Gough distinguishes preferences from needs by stating that "meeting needs will always be a lower carbon path than meeting untrammelled consumer preferences financed by ever-growing incomes" (2017: 13). With a view to meeting human needs, Max-Neef (1989) and colleagues introduce the notion of satisfiers: for this paper, we argue that green public spaces act as synergic satisfiers, in that they can serve to meet several needs. Therefore, the main proposition of this paper is that public spaces are crucial to 'sustainable wellbeing' in cities, as they not only harbour biological and microclimate diversity, but also promote individual need satisfaction as well as societal benefits such as: social inclusion, democratic engagement, and opportunities for leisure and livelihood generation, among others.

Our main research question is: in what way do green public spaces contribute to sustainable wellbeing as synergic satisfiers? We focus on four coastal mega-cities in

South and Southeast Asia: Chennai, Metro Manila, Shanghai, and Singapore. In order to study the role between public spaces and wellbeing, we turn to approaches from philosophy, and the sociology of consumption. In the section below, we present our conceptual framework and methodological approach. The research findings are then discussed by city, followed by a conclusion where we describe the unique threats posed to green public spaces in these cities.

2. Conceptual framework

Human wellbeing is a key consideration in sustainability debates (Robeyns and van der Veen, 2007). Yet, as demonstrated in the extensive literature on human wellbeing (Alkire, 2010), quality of life, and happiness, how to conceptualize wellbeing is subject to diverse interpretations (e.g., Cummins, 1996; Dolan et al., 2008; Doyal and Gough, 1991; Ryan and Deci, 2000; Max-Neef et al., 1991; Nussbaum, 1992; Ryff, 1989; or Veenhoven, 2008). In relation to sustainability, distinguishing between legitimate needs and non-legitimate desires on the one hand, and between needs and 'satisfiers' – understood here as the products and services, infrastructures or institutions necessary for meeting needs – on the other hand, is a core issue (Di Giulio et al., 2012). This distinction proceeds from different theories of wellbeing, ranging from Nussbaum's capability approach (1992) to Max-Neef et al.'s needs-based approach (1991) and Costanza et al.'s (2007) integration of a capability and a needs-based approach. The main premise of these theories is that humans have universal needs and that these needs should also reflect cultural and historic contexts. This emphasizes the significance of satisfiers required for meeting needs, which are contextual and specific to varying institutions and cultures (Gough, 2015).

There is little research on the role of green public spaces towards societal wellbeing – especially on their potential to provide satisfaction for several needs, what Max-Neef and colleagues (1991) termed 'synergic satisfiers'. Rao and Min (2017) suggest that public spaces can serve "to foster a sense of freedom, for the pursuit of leisure activities, and to congregate for political and social activities" (p. 20), but conclude that further empirical evidence is needed for assessing whose needs are being satisfied. Needs satisfaction can also lead to conflict: green public spaces may allow for members of the poor and working classes to perform livelihood activities and live private lives, which may create a tension with middle- and upper-class groups who uphold aesthetic ideals and view these spaces as solely viable for leisure. Studying the cross-class dimensions of how people use and benefit from green space, and the conflicts embedded in these uses, is a productive line of inquiry. For this study, the notion of Protected Needs and a corresponding list of needs was utilized (Di Giulio and Defila 2020, see Annex 1). This list builds on objective theories of a good life and an intensive review of the literature, and the needs are classified as 'protected' in that they can be protected by society whereby "individuals and states have an obligation to provide conditions under which people can – now and in the future – satisfy their objective needs, and/or conditions that do not make it impossible to satisfy these needs" (Di Giulio et al., 2012).

The role of public parks in relation to social inclusion and biodiversity is limited in Asia, as shown by research in Hangzhou, China (Wei, 2017), Taiwan (Wu and Song, 2017) and India (Baviskar, 2003). A comparative study between parks in the United States and

China makes the case that green spaces are an environmental justice issue (Wolch et al. 2014), further underscoring the necessity of linking public spaces, needs, satisfiers and societal wellbeing. Research suggests that access to green public spaces can provide health benefits, and therefore lack of access, often experienced by low income groups, is also a societal justice issue (Lee et al 2011; Mitchell et al. 2008; Maas et al., 2006). There is robust literature on how green public spaces can exclude poorer communities, or lead to green gentrification (Gould and Lewis, 2017; Wolch et al., 2014; Arabindoo, 2011), excluding the presence of poor, working class and people of colour, either directly or by increasing the price of real estate in surrounding areas. Implicated in this are different notions on what practices are deemed appropriate for green public spaces. Overall, there is a dearth of empirical research on what types of practices occur in green spaces, by whom and how these are linked to the satisfying of needs – underlining the importance to better understand the practices of green public space 'users'. Limited empirical research exists on how people interact with public spaces in emerging economies, including the material arrangements of these spaces, people's dispositions and ways of using these spaces, and the social norms governing these practices.
This is why, in our research, we adopt a social practice approach. Practice-based approaches decentre individual attitudes and values as determinants of consumption behaviour, and instead place social practices at the centre of analyses. In one definition, social practices are routinized activities made up of material arrangements of spaces, people's dispositions and social norms, executed by skilled practitioners (Sahakian and Wilhite, 2014). Practices are the means by which people satisfy their needs, while also signalling social distinction and belonging (Anantharaman, 2017; Carfagna et al., 2014), two vital ways of establishing community. Thus, the practice lens offers a valuable way by which we can understand how people satisfy needs in and through green public spaces. The spatialized nature of satisfying needs through the performance of social practices is understudied, and could serve as a way of linking consumption studies to questions around the use of urban space.

3. Methodology

In order to understand in what way green, public spaces contribute to 'sustainable wellbeing', the research design involved understanding: 1) How do people practice green public spaces in daily life; and 2) Towards what needs and for whom do green public spaces act as satisfiers? The qualitative research in parks in the cities under study involved a two-pronged approach: first, we asked people a series of questions related to their park practices; then, we invited participants to reflect and react to the list of Protected Needs (Di Giulio and Defila, 2020, see Annex I; used in English, and translated into Chinese and Tamil by team members). For park practices, we designed the interview guide around elements of social practices, involving 1) people's competencies and dispositions (e.g. what they like or dislike, how they feel about being in different areas, their most or least favourite spots, where they feel safe or unsafe, what they believe is meaningful to their lives), 2) material arrangements of these spaces (e.g. lighting, infrastructure and other facilities, landscaping), as well as 3) social norms and regulations (e.g. explicit rules or implicit guidelines about what people can or cannot do in the space, who can use or not use the space and in what occurrence). For this paper, we focus on material arrangements in relation to the activities associated

with the 'going to the park' practice. For need satisfaction, the research teams printed a list of Protected Needs and presented it to the interviewees or read it to them, to discuss which needs are generally more or less relevant to them. We then asked whether the activities they carry out in the park allow them to satisfy one or several of these needs. We also discussed how the park relates to other spaces in the city and what is unique about the park.

We began with a pre-selection of green public spaces in the four cities, including parks and beach-fronts, then agreed on criteria for the selection of at least two parks per city based on a consideration for the diversity of park users, the accessibility of the park in relation to the city and transport options, and the significance of the parks in relation to cultural heritage, biodiversity or other features. The involvement of diverse stakeholders in the park management was also considered, as was the research team's access to the park and prior experience working in that space. We excluded parks that are natural reserves, are only visited infrequently, or solely designed for tourism, or for a fee, privileging parks where people have an attachment to that space for leisure, social gatherings and, in some cases, income generation. We also aimed for diversity in park users, in terms of age, gender, employment, and particularly social class. Ten to fifteen interviews took place in each park[1].

4. Results

This section begins with an introduction to each research site, providing background information on their climate conditions and the role of green public spaces in urban development, and then an analysis of how and in what way the green public spaces meet Protected Needs in these contexts.

INTRODUCING THE RESEARCH SITES AND CONTEXTUALIZING GREEN PUBLIC SPACES

Table 1: Overview of four research sites; population, climate

	Chennai	*Metro Manila*	*Shanghai*	*Singapore*
Population	8 million	12.9 million	24.18 million	5.7 million
Climate	Tropical savanna climate	Tropical marine climate	Temperate, subtropical	Tropical rainforest
Mean annual temperature	28.6 °C	30.8°C	17.7°C	27.5°C
Area coverage	426 sq. km	619.6 sq. km	6 340.5 sq. km	722.5 sq.km
Population density	25,000 persons/sq. km	20,785 persons/sq. km	2,059 persons/sq. km	8,200 persons/sq. km
Park numbers and land coverage	525 parks Green cover: 15%	480 parks Green cover: 31%	243 parks Green cover; 20.8%	423 parks Green cover: 47%

[1] At the time of this writing, analysis of the data is underway; we present a preliminary analysis of a subset of the total interviews in the parks, along with observations.

a. Green public spaces in Chennai

Located on the south-east coast of India, Chennai (previously known as Madras) is India's sixth largest metropolis, and experienced significant growth and expansion since the liberalization of the Indian economy in the late 1980s. The hot season is from March to November, peaking in April-May at around 40 degrees Celsius. The monsoon season, from October to December, brings much needed rain to the city, which has recently experienced repeated cycles of drought and floods. In 2016, Chennai was hit by a cyclone that brought down a great number of trees across the city; many parks have not fully recovered their green cover (Ayappan et al, 2012). Land is at a premium and land-use planning a site of frequent contestation and injustice. In spite of so-called city master plans that have sought to structure the city's expansion, growth has largely been unplanned. Infrastructure and amenities, including green spaces, are unevenly distributed. In some cases, the removal of informal settlements along waterways has been carried out to purportedly create eco-parks, revealing how park creation has been used as a tool to justify displacement of the urban poor (Raman and Coehlo, 2012). Parks are owned by the Greater Chennai Corporation (GCC), and while there is a great diversity in the quality and size of the parks based on their location, there is little publicly-available information on the biodiversity and ecosystem services parks provide (a systematic review of the biodiversity importance of parks in Bangalore, India, provides some insight into the ecological importance of neighbourhood parks in Southern India, see Swamy et al, 2019). While the state manages most of these parks, certain parks in elite and middle-class neighbourhoods are managed by private companies as part of Corporate Social Responsibility programs. In some parks, civil society stakeholders, who tend to be middle class/elite, have taken an active interest in the local park and influenced decisions around management and access, sometimes to the detriment of other social groups.

b. Green public spaces in Metro Manila

Located on the northernmost island of Luzon, Metro Manila has a dry season lasting from November to April and a wet season from May to October. Having a wet and tropical climate provides more than adequate sunlight and rainfall to support green spaces within the city. The metropolis is comprised of seventeen local government units, one each for its sixteen highly urbanized cities and one municipality. Each local government unit is autonomous in planning and developing public spaces within their respective territories, with the National Parks Development Committee (NPDC) administering the development and maintenance of two major national parks in the capital city of Manila, the Rizal Park and the Paco Park. However, the private sector plays a significant role in shaping the outdoor spaces. Developers often engage in long term agreements with various cities across Metro Manila to convert large outdoor spaces and lands into malls, condominiums, office buildings, and residences. Among others, this results in the proliferation of privately-owned public open spaces whose existence are limited by the next building construction planned on its site. Increasing concrete coverage and loss of porous land have been identified among the leading factors leading to worsening floods in the city (Lagmay, 2017), contributing to the formation of an urban heat island: higher temperatures – as much as 2.96°C higher – in cities as compared to nearby rural areas (Tiangco, et al., 2008). Some non-profit private foundations (e.g., Winner Foundation, ABS-CBN Foundation) also manage parks in

cooperation with government agencies. Demolition and rebuilding of inner cities, the norm in Metro Manila's State- and capitalist-led urban revitalization, often result in the displacement of groups without land tenurial security, and the loss of cultural heritage structures (Saloma and Akpedonu, 2019). With ever more crowded streetscapes and perceived or real rising crime rates, heavily guarded and surveilled spaces such as condominiums and malls offer those who can afford them a safe refuge from the traffic, noise and pollution. In such spaces, maintenance of public areas is usually assured, unlike other sites where public space is commonly neglected, overrun by informal settlers, or simply does not exist (Saloma and Akpedonu, 2016).

c. Green public spaces in Shanghai

Shanghai is located on the eastern edge of the Yangtze River Delta, with the East China Sea to the east, the Hangzhou Bay to the south. With a subtropical maritime monsoon climate, the city boasts relatively cold winters (average low of 1 °C in January), and hot, muggy and rainy summers with an average high of 32°C; typhoons and rainstorms are common from late August till early September. Since China's economic reform in the late 1970s, Shanghai has experienced rapid expansion and urbanization, as it works to become one of the world's financial, trade and shipping hubs. This has triggered a series of ecological problems related to air and water quality (Shuqing Zhao et al, 2006), and has now stimulated demands from city-dwellers for better living environments and for more outdoor recreational areas. The Shanghai municipal government owns all 243 Parks in the city, with some key parks managed at the municipal level, while others managed by district authorities. The Shanghai Landscaping & City Appearance Administrative Bureau and Shanghai Forest Bureau issues park ratings on a scale of 1-5 stars; most parks have zero stars, some are rated between two to four stars; with very few parks (such as Shanghai Botanic Garden and Shanghai Guyi Park) receiving five stars. Park ownership and access regimes have changed in the past seventy years; prior to 1949 the city had few parks and some were private. The city took over all parks in 1949 but charged entrance fees till 2002, after which point most parks offered free entrance. Since 2011, parks have been gradually extended their open hours in summer, with some parks, including Zhongshan Park, now open 24-hrs a day.

d. Green public spaces in Singapore

Singapore is a tropical, island city-state located in Southeast Asia, with a rich cultural diversity reflected in the four official languages of Mandarin Chinese, English, Malay and Tamil. Located on the equator, Singapore experiences high temperature levels and additional heat from the urban heat island effect. Ranked 9th on the Human Development Index, Singapore is currently experiencing an aging population: the proportion of residents aged 65 years and over has increased from 8.7% in 2008 to 13.7% in 2018, with fewer working-age proportionally. An area of over 720 sq. km. has been reclaimed through intensive land use planning, leading to considerable stress on the natural environment, especially in terms of the extensive import of sand. The government goes to great efforts to address issues related to local and trans-boundary pollution, promoting electric vehicles and renewable energies, for example. Ambitious efforts are also underway to create 'a city in a garden'. The National Parks Board presently administers over 423 parks in Singapore, with a vision of "transforming Singapore into a biophilic City in a Garden and to create the best living environment

through greenery and recreation" (National Parks Board, 2019). A notable example is the Gardens by the Bay, a 101-hectare park with greenery and flora, brought from other climate conditions and supported through micro-climatic glass house technologies. The Park Connector Network is a major step taken towards linking residential and commercial areas of the city to a park, garden or another natural site. The National Environment Agency (NEA) also plays an important role in keeping the green public spaces, with various rules existing to avoid littering for example. Moreover, rooftop greenery and vertical farming has flourished in the recent past, albeit not always publicly accessible. Earlier studies highlighted that Singaporeans mainly used public parks for exercise and recreation (Yuen,1999); and that lack of access to parks, often experienced by lower income groups, can lead to societal justice issue (Lee et al., 2011).

GREEN PUBLIC SPACES AS SATISFIERS TOWARDS MEETING PROTECTED NEEDS

In this section, we provide first and exemplary insights on how parks meet Protected Needs (Di Giulio and Defila, 2020), for a diversity of people and in relation to material arrangements in the parks selected for this study. For this paper, only a subset of the data was treated, as analysis is ongoing. We focus particularly on Protected Needs (PN) 3, 4 and 7, and how material arrangements satisfy needs. We also consider how the parks relate to other spaces in the cities.

a. Results in Chennai

Chennai is a diverse city with significant neighbourhood-level variation across lines of class, language, caste and religion. To adequately capture this diversity in our sample, three parks were selected for study: Anna Tower Nagar Park located in an upper middle-class, planned neighbourhood, Nageshwara Rao Park, sited in the old-city centre surrounded by both residential and commercial establishments, and Perambur Park, a lower-income neighbourhood that was an erstwhile industrial suburb with a largely working class population While these parks are utilized by a diverse set of people, in terms of gender, age, and socio-economic background, temporal rhythms were observed in who used the park, when. In the early morning, parks are primarily the domain of middle-aged, middle class and elite individuals walking for exercise (generally more men than women). By mid-afternoon, the demographic shifts, with more women entering the parks for exercise, as well as a greater number of people coming to the parks for relaxation. In the afternoon, parks serve as a space for day labourers to nap and get some respite from the heat, as well as a place for students to gather. In the early evening, couples dot the landscape, parents watch children play, and exercise walkers return. Late evening sees the parks become more of a social space, with vendors selling food at the gates or inside the parks.

In a material reading of park practices, these diverse uses were enabled by park amenities. Park visitors who come for exercise utilized paved walkways and outdoor gym equipment. The parks were also equipped with benches for people to sit and gather, and lawns for larger groups to sit. All the parks also had play equipment for children and toilets for general use. Two parks had filtered water dispensers. Beyond these built amenities, park users benefited from shade provided by trees. However, not all parks offer the same services: Anna Nagar Tower Park and Nageshwara Rao Park had significantly more tree cover and shade than Perambur Park, which is located in a lower-income neighbourhood. Similarly, the play equipment and walkways in the parks

were in different states of repair and disrepair, pointing again to the significant differences in park quality and size. Use was also regulated by explicit and implicit norms. The parks studied were open between 5am and 6am, depending on the time of the year, and closed by around 10pm. Both Permabur and Nageshwara Rao Park were also closed during the day from 11am to 3pm, ostensibly to deter sleeping in the park. The parks studied do not allow vending within the premises, though some mobile vendors were observed serving park users local and home-made snacks. While we could not find explicit rules listed in all the parks, several park users indicated that it is against the rules to sleep in the park, bring pets inside, drink or smoke, or litter.

In terms of need satisfaction, only one out of the nine Protected Needs was not related to activities in the park by respondents (PN 8, to have a say in the shaping of society); in two parks, Nageshwara Rao and Perambur, PN9 (to be protected by society) was also not related to park activities. With a view to PN 3 (to live in a liveable environment), respondents cited the importance of trees in providing shade and something pleasant to look at, and contrasting the 'fresh and clean' air of the park to the busy and noisy street environments right outside. The natural landscape of the park was seen as unique; attracting users from beyond the immediate neighbourhood. Activities that were emphasized in this context were walking in the park, sitting in the park, and enjoying the environment. Satisfying PN 4 (to develop as a person) was linked with activities such as meeting friends, talking freely and openly, and relaxing in a space that is less controlled as other spaces such as home. In terms of PN 7 (to be part of a community), some come in groups, some come alone, but all enjoy the feeling of being with other park users – being connected to others, whether to gather with friends or simply experience being around others and practicing the park in similar ways.

The layout of all three parks permitted a diversity of activities by a diversity of people, occurring at the same time. The central areas of the park had play-areas for children, surrounded by benches, perched on which caregivers could watch children play and socialize with each other. The parks also had areas for group-games such as football and cricket, used primarily by groups of young men. Paved walkways covered the outer-perimeter of the parks with additional pathways crisscrossing the centre, offering the mostly middle-aged and elderly walkers several options for walking. In Anna Nagar Park, one pathway circled an artificial pond, leading to a partially secluded area with benches. Here, several young couples were observed, availing of the privacy to engage in casual acts of intimacy. The layout of all three parks enabled communal activities of different types; Nageshwara Rao park had two stage areas where youth groups could be seen practicing for a dance show, and all parks had several smaller group gathering areas. Beyond this, several parts of the parks are laid to lawn, and we spotted groups gathering to celebrate birthdays, and hold discussions that appeared more serious. However, older park users complained, however, about the lack of clustered-seating, meaning they did not have a good place to gather and talk.

Importantly, Anna Nagar park has a large and well-maintained public toilet block as well as drinking water. Access to water and toilets means users are able to spend extended periods at the park. These amenities were less available and well-maintained in the other two parks, where respondents complained that the toilets were dirty and drinking water unavailable. These attributes of the space, enabling extended hours of stay, were especially important to our working class and lower middle-class interviewees who lived in small homes and high-density neighbourhoods, where they did

not have easy access to privacy or spaces to play, and who did not feel comfortable or 'free' in the glitzy, air-conditioned malls designed for elite consumption. In relation to other spaces in the city, the green public spaces allow people to talk freely and feel comfortable, and less controlling as other spaces such as shopping malls, neighbourhood streets and, for some people, especially women, their homes.

b. Results in Metro Manila

Two parks were included in the study, Rizal Park and the University of the Philippines (UP) Academic Oval, and for both, the socio-economic profiles of park users were mainly lower- and middle-income group. Rizal Park, set in an urban area, does not have entrance gates (even though roving guards are constantly present) and thus welcomes a mix of the homeless people and jobseekers, who pass the day at the park, as well as people who access the park to earn a living – such as itinerant vendors and photographers. In contrast, users of the UP Academic Oval tend to be homogenous (i.e., alumni, faculty, students, and staff and their families and friends) since UP, though served by a public transportation route, is not accessible on foot from the nearest public space and, except, for the main entrance, require vehicle pass stickers. Both low- and middle-class groups tend to use the parks for exercise, relaxation, and family bonding. Students who are rehearsing group performances, engaging in sports, or simply hanging around are likewise a constant fixture in parks: Rizal Park due to its proximity to colleges and universities; the UP Academic Oval because it is located within the University of the Philippines campus.

In terms of material arrangements, parks, as open public spaces, have very few roofed structures, which means rains and floods, on the one hand, and hot, humid weather on the other, limit park usage. Access to clean public toilets is also another concern, with park users usually planning their stay so as not to have to use the toilet, or planning to end with a visit to a nearby fast food restaurant. Rizal Park, despite its urban setting, is home to a wide variety of wildlife, including a range of birds and over 3,424 trees (Gonzales and Magnaye, 2017); of particular significance is the Rizal monument, a memorial to the 19th century nationalist, José Rizal. Together with grassy lawns and shaded picnic areas, the trees in both parks provide some respite from the city's heat and noise. Park goers cite the cooler temperatures, the breeze, the abundant greenery, and quiet atmosphere as part of the reasons why they visit and spend time in the area. In terms of need satisfaction, only one of the nine Protected Needs was not related to activities in the park by the respondents (PN 2). For many park visitors, the park fulfils, first and foremost, their need for self-development (PN 4, to develop as a person), and activities satisfying this need include not only having a quiet time on one's own for thinking and reflection, but also running to rejuvenate the mental state. Some of these activities are, at the same time, activities satisfying PN 6 (to perform activities valuable to them), such as physical activities, or thinking and reflection. Furthermore, those who go to the park primarily to exercise usually do so on their own and do not see a need to be part of a collective, although they admit deriving inspiration and motivation from seeing others do what they themselves are doing (e.g., running, jogging). In contrast, PN 7 (the need to belong to a group or a community) is the primary need being met for those who visit the park to bond with family and friends. For park vendors and photographers, it is the need for life's basic necessities, or livelihood opportunities (PN 1), and for the homeless, the need for a liveable environment (PN 3) and to be

protected by society (PN 9). Having stayed in the park for quite a long time, they have formed social relationships among each other. We could observe no gender differences in park space usage, with both men and women feeling safe and free to pursue in the park whatever it is that does not breech any social norm, such as the public display of affection.

Park users, in general, recognize the right of others to the park. Low-income groups feel a sense of equality and appreciate it that one can stay in the park without having to spend for anything. While some park users complain of high prices of items sold by small-scale vendors, others, mostly occasional buyers, are happy to patronize them. The middle-income groups likewise do not feel threatened by the presence of homeless people who stay in the park the whole day, until it closes at night. The latter are usually neatly dressed and stay together in specific areas. Park users also tolerate groups who use the park to evangelize or to talk politics.

However, whereas the sense of security and being protected in parks is mostly attributed to the presence of security guards, the same presence can make others – such as the homeless and vendors – feel a sense of precarity. Another area, however, where park users differ is in the collection of fees: in comparison with lower-income park users, most middle- and upper-income users seem to prefer mutual coercion, such as the collection of fees toward a better management of the park commons. Thus, they would not mind paying for the use of clean toilets. Territoriality issues likewise arise when, over time, certain spaces become associated with a particular group. 'Old' and 'new' groups often find simultaneously asserting and contesting each other's right to space.

A few park goers claim that they prefer to spend time in the parks because there is much more to see and do as compared to an air-conditioned shopping mall, which have more access- and behaviour-controls. For people who deliberately go to the park to find a quiet space for reflection, the physical attributes of the park such as shady trees and cool breeze help them to be calm and feel more in tune with nature. With first-time travellers to Metro Manila from the provinces invariably including a visit to Rizal Park as a patriotic act, and with UP Academic Oval users pointing to the uniqueness of its arbour and sunken garden, parks are a site for natural and cultural heritage enjoyment when they harbour native plants and translocated heritage structures or built memorials, which are important aspects of national identity.

c. Results in Shanghai

In Shanghai, observations and interviews were conducted in two parks, Zhongshan Park and Daning Park. Built in 1914 and located in Changning District, Zhongshan Park (originally Jessfield Park) occupies 214,200 square meters (53 acres), and is a four-star rated park, with more than 30,000 trees of 260 species. A famous park in downtown Shanghai, the park combines English-style landscapes with the architectural style of classic Chinese gardens. Some of its well-known scenic spots are the Great Lawn, the Chinese Rose Garden, the Lake of Mandarin Ducks, the Lotus Pond, the Hill and Water Garden, the White Marble Pavilion. In contrast, the three-star Daning Park (also called Daning Lingshi Park or Daning Tulip Park) in Jing'an District is newer and was opened to the public in 2002. This is officially the largest centralized green in Puxi (west of Huangpu River), with 310,000 trees, 216,000 square meters, grass and other ground cover plants, and more than 200 species of plants. It has a man-made beach and

lake where people play, fish, and take wedding pictures, and ample green space for flying kites, exercise or jogging. The north part consists of hills, woodland, the big lake and beach. The southern stretch is an assortment of ponds, streams, swamps, and kitsch viewpoints. The east side of the park is the site of its predecessor, Guanzhong Park, and hosts a restaurant, several statues representing Chinese traditional legends and fairy tales, a few token bamboo paths. The middle of the park also has a garden, including tulip fields and fake Holland-style windmills, and several Roman-style features including a square where events take place. Daning Park hosts Shanghai's biggest tulip exposition or tulip festival, with what they say are millions of different tulips on display. Though the park is replete with artificial landscapes, the north entrance sign posted by the Shanghai Landscape Administration Bureau reads: "The ethereal, peaceful, picturesque nature landscape of Daning-Lingshi Park has become the favourite for urbanites, therefore it ranked top ten Greatest Sights in Shanghai during a 2005 activity held by Youth Daily, and is also recognized as one of 'Shanghai Civilized Parks.'"

Most people appreciate the current situation in the parks, including landscape, design, environment, facilities, infrastructures and the people they interact with. Generally speaking, park users appreciate the natural setting, such as the gardens, open spaces, lawn areas, and ponds or lakes, as well as park amenities such as pavilions, chairs or benches, and playgrounds, using these for exercise, rest, relaxation and meeting friends. Though toilet smell and hygiene conditions make international visitors uncomfortable, Chinese users get used to them. They feel safe and protected, moving about the park easily and freely, though regular visitors know to avoid a specific tree-covered hill area where several middle-age sex workers accost male passers-by. They speak freely or hear others speak quite freely about current affairs, barring religious and political issues, which they do keep as private conversation. There are no group or collective activities on these topics either. Regarding the park resources and management, they seldom complain; few criticize the management of parks, assuming their voice means little or nothing at all while the government and the administration will decide everything.

In terms of need satisfaction, all nine Protected Needs were related to activities in the parks by respondents. In relation to the park, PN 3 (to live in a liveable environment) was much more important than PN 4 (to develop as a person) and PN 7 (to be part of a community). Respondents mentioned a broad diversity of activities that they linked with satisfying PN 3, such as for example enjoying the environment, relaxing, doing exercise, doing nothing in particular, fishing, walking in the park, or sitting in the park - and some of these activities, such as walking, relaxing, and doing exercise, serve PN 4 as well. Regular users come to the park to joining in group activities such as dancing, boxing, Taiji, singing, a music band, playing chess or *majiang*, among others. Given the fact Shanghai is becoming a city with an aging population and little public space for the residents, elderly people use public parks as the first choice of their outdoor activities. For them, parks are also a place where they chat, see familiar people or strangers, maintain established social connections or maybe start new ones (PN 7).

Within the parks, there is no obvious social exclusion since parks are open to everyone, but it seems not easy to join in established regular group users such as the band, dancing team, opera group, among other activities. People appreciate what the park offers in contrast to the noisy and busy atmosphere outside the park, where within walking distance fast-paced shopping malls and air-conditioned spaces in the city often make them feel dull, stressful, oppressive or depressed. Parks are unique spaces in the

city – particularly for elderly people, but also for those who enjoy nature and group activities, such as dancing.

d. Results in Singapore

Research was conducted in two Singapore parks, namely Botanical Gardens and East Coast Park (ECP). While the botanical gardens are a vast, 82-hectare area, located in the heart of the city, the ECP has a total land size of 185 hectares, and a scenic coastline that stretches over 15 km, facing the east. The research team covered fifteen responses from each park and received interesting responses from a wide range of population in terms of the demographic profile of the respondents. The comfortable standard of living in Singapore has attracted a burgeoning expatriate community, constituting foreign workers and their families, not only from nearby Asian countries but also from the rest of the developed world. Despite the majority of respondents being Singaporean, other respondents hailed from nations such as Malaysia, Indonesia, India, the Philippines, China, Taiwan, Germany and Spain. Some of the primary purposes of park usage included walking, exercising, resting, meeting friends and having a picnic with family members.

In terms of material arrangements, the respondents cited the presence of water bodies as a highly appealing natural setting, both at ECP and Botanical Gardens. It is vital to make a distinction here, as the former is a coastal landscape with a beach and a jetty, popular for activities such as fishing and kayaking. The latter, on the other hand, is more of an educational establishment with exhibits displaying engaging information about the flora and fauna of Singapore; the water body here is a lake with birds and animals such as turtles and swans. A relative lack of noise and air pollution, as compared to the city centre, was cited as another reason for visiting the two parks. Rules have to be followed while visiting these parks and visitors are more or less aware of the rules, like for example – swimming is not allowed in the sea along the ECP, while feeding animals and camping are not allowed in Botanical Gardens among other rules mentioned.

In terms of need satisfaction and similarly to Chennai, only one out of the nine Protected Needs was not related to activities in the park by respondents (PN 8, to have a say in the shaping of society). PN 3, 'to live in a liveable environment', PN 5, 'to make their own life choices' and PN 9, 'to be granted protection by society' were most frequently selected as important and relevant needs by respondents in both parks. Most respondents linked the satisfaction of PN 3 to the activities that they perform at the park which include walking, doing exercise, relaxing, enjoying the natural heritage, or sitting in the park. The respondents also added that the coastal green landscape of ECP added to their wellbeing, whereas in Botanical Gardens, flora and fauna and the soothing water body with turtles and swans led to self-satisfaction. PN 4, 'to develop as a person', was linked with activities such as meeting friends or family, reading in the park (e.g., news, books), discovering oneself through meditation and contemplation, praying in the park or writing a journal in the park, and some activities, such as relaxing, enjoying the natural heritage (e.g., trees) or doing exercise served both, PN 3 and PN 4. At both parks, the most common activity was 'doing nothing in particular, like to sit or walk around the park', closely followed by 'like to rest and relax in the park, or sleep in the park'. Respondents linked many activities to PN 7, 'to be part of a community', and these covered not only meeting friends or family (e.g., for picnics, fishing, eating together, birthday celebrations etc.), and joining in group exercise, but also enjoying the

natural heritage, and sightseeing, or attending religious celebrations in the park (e.g. Holi).

According to our respondents, the lush greenery and soaring palm trees of ECP, the array of flora and fauna, the pristine environment of the Eco Lake and fresh air remains unparalleled in comparison to the concrete air-conditioned shopping malls, as these malls in no way feel as natural as these open breezy spaces. The parks seem to be unique spaces for relaxing and doing physical activities, and the natural features seem important to Singaporean identity.

5. Discussion and conclusion

In this study, we set out to understand how parks satisfy human needs by uncovering needs in practice, and in relation to material arrangements. What we have found across all of the research sites is the importance of green public spaces in satisfying a variety of the needs covered by the list of Protected Needs that we used, such as living in a liveable environment (PN 3), developing as a person (PN 4) or being part of a community (PN 7), but also others of these needs (see table 2). In presenting results, we focused particularly on PN 3, PN 4, and PN 7. The results for these needs show, first, that although the cultural contexts differ, and although the practices that are enacted in the parks differ from city to city, the parks tend to meet similar needs across the research sites. Secondly, the results point out the importance of the cultural and natural heritage in most of the parks: this heritage satisfies different needs and is thus synergistic with a view to wellbeing. In relation to material arrangements, different features are important in parks, such as benches, activity areas for adults and children, walking lanes, but also lighting and basic services such as toilets, water fountains, shade from the sun, or shelter from the rain. In all cases and as discussed elsewhere, it is the park practices which enable need satisfaction (Sahakian and Anantharaman, 2020, in press), made possible through certain material arrangements. A third point relates to the significance of recreative and non-commercial practices, such as walking in the park, sitting in the park, or doing nothing in particular, and in opposition to other spaces such as shopping malls. Finally, these results uncover that parks provide not only a space in which people can gather with friends and family for joint activities, but also a space in which people can experience the feeling of being with others, or of belonging to a community.

At the same time, green public spaces are a limited resource, both in relation to space allocation and types of usages. This leads to two main points of tension, in relation to competition between users, and in relation to competition for space, as we will now detail. Green public spaces as satisfiers for needs by one segment of society can compete with need satisfaction by other segments of the same society. In Singapore, potential conflict of interest prevails among social groups at East Coast Park: the older Singaporeans seem to be dissatisfied vis-à-vis the usage of the barbeque pits by Malaysian teenagers, on the grounds of excessive noise and littering, during a period when they seek peace and relaxation in a natural setting. For avoiding such conflicts, the government has set up a booking system to allow residents to reserve common public infrastructure for private use temporarily, and free of charge. In Chennai, conflicts between park users are mostly in relation to class: elite and middle-classes frequent parks for exercise, often at the exclusion of other park stakeholders such as

vendors who might sell goods outside the park or poor people who might want to use parks for other purposes. In Shanghai, parks during certain periods of the year can be simply over-run by people: having a space for respite from the busy city may necessitate more green public spaces, in order to satisfy the needs of residents as well as a growing migrant population.

Table 2. The Protected Needs that are satisfied in the parks.
Dark table cells = respondents say that the Protected Need is satisfied by practices in this park.
Number in the table cell = number of interviews in which the Protected Need is explicitly mentioned.

City/park	*Protected Needs 1-9*								
	PN 1	*PN 2*	*PN 3*	*PN 4*	*PN 5*	*PN 6*	*PN 7*	*PN 8*	*PN 9*
Chennai									
Anna Nagar Park		3	9	1		8	8		2
Nageshwara Rao Park	1	4	7	4	1	4	4		
Perambur Park	3	3	6	1			2		
Metro Manila									
Rizal Park	1			3		2	10	1	1
UP Academic Oval Park	2		6	4	1	4	6		2
Shanghai									
Danning Park	9	4	11	1		6		1	2
Zhingshan Park	3	5	10	2	3	9	6		1
Singapore									
Botanical Garden Park	5	4	11	6	5	4	9		2
East Coast Park	4	9	11	6	6	11	10		5

Parks also compete for space in the city, with capitalist-led pressure to build more condominiums and malls on public space, as well as the propensity of local governments to erect multipurpose buildings on green spaces, as is the case in Metro Manila. In this context, the creation of green public spaces is expensive and a great opportunity cost in relation to deals that could instead be made with real estate developers; hence if the national and local governments are to invest public funds into the creation and/or maintenance of public space such as parks and plazas, they must be assured that these places will be patronized accordingly. 'Green, Green, Green', a program that funds the development of public open spaces in the country's 145 cities, and which accompanies the national infrastructure development program, 'Build, Build, Build', is therefore a welcome development, albeit not without the bureaucratic limitations usually plaguing government initiatives. In Chennai, plans to create new parks often involve the removal of informal settlements or slums where the poor and working class live. For example, a recent decision to create an Eco-Park on the banks of the Adyar river in Chennai resulted in the displacement of several hundred households that were living on the banks of the river. Parks in Chennai are also under threat, as they are farmed out to

development projects to store material, such as for the Chennai Metro. In Shanghai, too much top-down planning, regarding the design, landscape, management, or rules and policies of parks, is leading to a homogenization of these green public spaces – which might also be a detractor for park users, and particularly elite groups. In Singapore, land leasing from Urban Redevelopment Authority (URA) has allowed for the implementation of a master plan towards greening the city, which seems to be effective in preventing encroachment; there seems to be no question of conflict of private space over public space arising for land. Although Singapore has placed an emphasis on its development as a green city and increased the land area dedicated to parks, the park provision ratio has consistently stayed below planning targets.

If green public spaces are to thrive in the cities of South and Southeast Asia, it is critical to underline how they provide need satisfaction for a diversity of people. Ultimately, green public spaces and their material arrangements offer distinct microclimates from other places in the city, including commercial centres. With air-conditioning usage contributing to both carbon emissions and urban heat island effects, it becomes critical to find ways to promote microclimate diversity – included passively cooled and shaded areas, which parks tend to offer. While they may promote healthier lifestyles and environmental biodiversity, as already demonstrated in the literature, they also meet a variety of other needs, as we have demonstrated in our study. What remains to be understood is how urban development projects can help maximize green public spaces as unique satisfiers for meeting the needs of a diverse group of people, while minimizing the use of resources for other spaces in the city that may not meet needs as synergistically – either because they focus on the needs of a privileged few, in gated communities for example, or provide forms of leisure that are energy-intensive and focus on desires rather than Protected Needs, such as shopping centres. We argue for placing Protected Needs at the centre of deliberations on the use of public spaces, while accounting for social- *and* micro-climate diversity.

Acknowledgment

This article draws from a research project funded by the Swiss Network for International Studies. We are grateful to the Institute of Sociological Research for supporting Prof. Manisha Anantharaman's stay at the University of Geneva as *Alba Viotto Visiting Professorship*. We would like to thank our research teams in each city, the special issue editors and reviewers, as well as all of the participants who agreed to be interviewed for our study.

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Annex I – Nine Protected Needs

In order to reflect on need satisfaction in relation to green public spaces and for this study, we engaged with a list of nine Protected Needs, a novel approach to provide a thick theory of the good life for the purpose of developing sustainability policies. To operationalise the notion of a good life, nine needs are defined as protected in that they are needs which "(a) deserve special protection within and across societies because they are crucial to human well-being, and that are at the same time, (b) needs for which a special protection is possible, because they are needs for which a governmental/community responsibility can reasonably be assigned" (Di Giulio and Defila, 2020).

These needs denote what individuals must be allowed to want (universal needs) and the possibilities individuals should be provided with (thick descriptions of these universal needs). The descriptions of the needs are sensitive and dynamic with a view to cultural context and development in history. Di Giulio and Defila provide descriptions that are specified for the cultural context of Switzerland and Germany. These descriptions are meant to serve as a starting point to adapt the list of needs in terms of culture and time. The nine Protected Needs are arranged in three groups:

"Group 1 focuses upon tangibles, material things (Protected Needs 1-3), group 2 focuses upon the person (Protected Needs 4-6), and group 3 focuses upon community (Protected Needs 7-9):

(1) To be provided with the material necessities for life
(2) To realize their own conception of daily life
(3) To live in a livable environment
(4) To develop as a person
(5) To make their own life choices
(6) To perform activities valuable to them
(7) To be part of a community
(8) To have a say in the shaping of society
(9) To be granted protection by society" (Di Giulio and Defila, 2020).

THE LIST OF PROTECTED NEEDS, IN THE FORMAT IN WHICH THEY WERE USED FOR THE INTERVIEWS

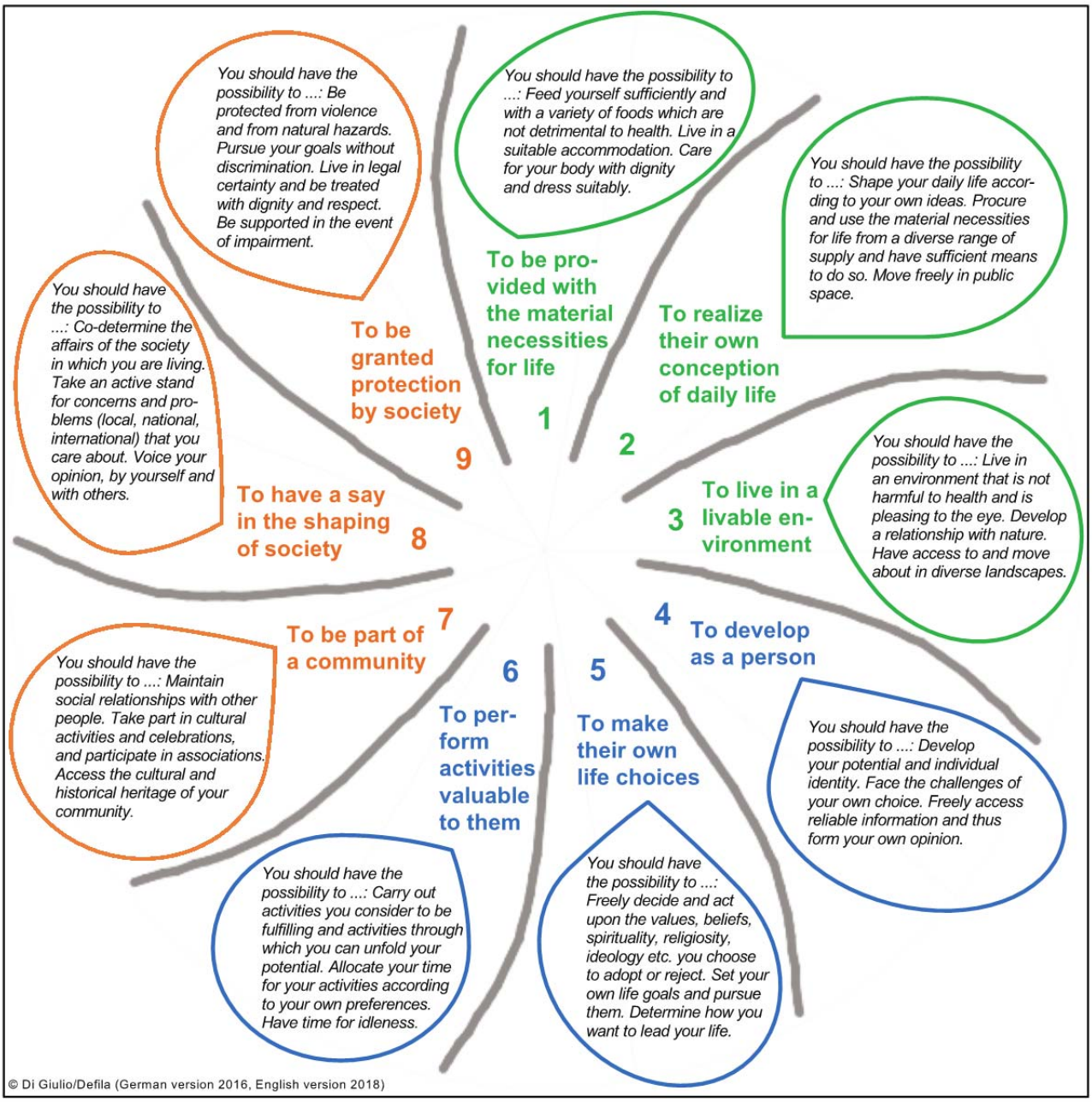

Figure 1: building on Di Giulio, A., & Defila, R. (2019). The 'Good Life' and Protected Needs. In F. D. Kalfagianni A., Hayden A. (Ed.), The Routledge Handbook of Global Sustainability Governance. London: Routledge. For the interviews, the thick descriptions of the Protected Needs provided by Di Giulio and Defila were summarized. These summaries have been collaboratively developed by Antonietta Di Giulio, Manisha Anantharaman, Marlyne Sahakian, and Czarina Saloma, based on discussions with the entire research team.

The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Research on the relationship between human behaviour and climatic characteristics in a public open space.
Survey and analysis in Saitama New Urban Centre area

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Abstract
In urban area, making the attractive public spaces is effective one way of creating a public life or increasing the value of area. In Japan, there have been many public spaces which are not well used because the flexible utilization of public spaces including road, park and river has been limited due to some regulations. However, in accordance with the revision of "Act on Special Measures concerning Urban Reconstruction" and so on, stakeholders have been able to review the making public spaces which are stimulated flexibility use because the utilization of public spaces have been permitted by private business operators or locally area management association. In case of practical and tactical public space making, it is necessary to gain a public consensus through stakeholders discuss what kind of good effect will be made by the alteration of public spaces by communication. Therefore, it is effective to visualize based on the data verification and accumulate the results for short-term and temporary alteration of public spaces such as social experiment. At the same time, integrating the consideration of thermal environment and wind condition will contribute to make more attractive public spaces. Therefore, this study aims obtaining the basic data necessary for making the attractive public spaces considering thermal environment and wind condition in Saitama New Urban Center Area which is central business zones. Specifically, this study progressed via the following steps: 1) activity investigation; 2) thermal environmental and wind condition survey and numerical simulation results; 3) analysing the relationship between 1) and 2). In addition, it attempts to make analysis focusing strong wind for high-rise building because the high-rise buildings are lined in many parts of Saitama New Urban Centre Area. Also, these results are intended to make use of designing attractive public spaces in Saitama New Urban Center Area.

Keywords: wind, solar radiation, pilot project, public open space, CFD, actual behaviour of users

To cite this article:
Matsuo, K., Izumiyama, R., Arai, S., Tanimura, A., Horie, Y., Nomoto, R. (2020). Research on the relationship between human behaviour and climatic characteristics in a public open space: Survey and analysis in Saitama New Urban Center area, *The Journal of Public Space*, 5(2), 111-128, DOI 10.32891/jps.v5i2.1155

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

1. Background and objective

In Japanese cities, many public open spaces have been recently developed to ensure a comfortable urban environment under the 'Urban Development Systems'[1] which are district plans that stipulate redevelopment promotion areas, specified blocks, high-level use districts, and planned development design system. In the metropolitan centre, attractive public open spaces have been purposeful developed to create a vibrant atmosphere that people find appealing. Until now there have been many public open spaces in Japan that have not been utilized to their full potential due to heavy regulation. The following types of public spaces are affected: roads, parks and river fronts. However, following the latest revision of the 'Act on Special Measures concerning Urban Reconstruction' (Tokyo Metropolitan Government, n.d.) and other related regulations, stakeholders can now review the development of public spaces. These spaces have been imbued with life due to permissibility of flexibility as they are privately operated by businesses or local area management associations. For example, the "Tokyo Municipal Ordinance on promoting the creation SHARETA-MACHINAMI of Tokyo (Izumiyama et al., 2015)" has been introduced for improving the image of Tokyo. Prior to the introduction of the new system, only public benefit events were permitted; however, now it is possible to open cafes, sell goods, and organize events that require a participation fee (Izumiyama et al., 2015; Izumiyama et al., 2016; Izumiyama et al., 2018). In case of tactical public open space, it is necessary to gain a public consensus through stakeholders and discuss the kinds of positive effects the alteration of public open spaces will have via communication or active engagement (Wai et al., 2018). Therefore, it is effective for stakeholders to visualize and accumulate the results for short-term and temporary alteration of public spaces such as the pilot project titled "Tactical Urbanism" (Lydon & Garcia, 2015). Many studies have analysed the relationship between temporary objects through small scale pilot intervention and consequently the change in human activity. For instance, the relationships between temporary objects related to parasol gallery and communicative or stationary behaviours of people were analysed at the underground pedestrian road opposite Chiba station (Li et al., 2012). The study finds that elucidated that setting of temporary objects and the making temporary spaces could change the underground pedestrian road, which is used just for the purpose of crossing into a lively space. Moreover, a study conducted at a mall in Ichiki-Kushikino city, Kagoshima, examined the effects of chair utilization rate and space uses by setting temporary parasol or chairs in a public open space (Okamatsu & Mouri, 2015); the findings revealed a relationship between types of events and chair utilization rate and uses. These studies have elucidated that the number of pedestrians or stationary people and their behaviours are related to the objects in public open spaces.

Furthermore, the factor of the number of pedestrians or stays around people and their behaviour is not limited to only chairs, tables, etc.; rather, it encompasses entirety of the micro-climate in public open spaces. Gehl and Gehl Architects (2009) regarded micro-climates as an evaluation tool for public open spaces. Morita et al. (2015) showed that when a pilot project is conducted at a wooden terrace (public open space), outside temperature and weather can strongly affect pedestrian route choices. In addition, Akagawa et al. (2007) analysed the relationship between the observed climate data (temperature, wind, and solar radiation) and the number of stationary people or visitors

[1] See http://www.toshiseibi.metro.tokyo.jp/cpproject/intro/description_1.html

at a large rooftop garden; this study revealed that the correlation coefficient between the observation results and the number of stationary people is high but negative, in public open spaces without a green shady area on a sunny day. Nakase and Kiyota (1988) recognized the relationship between thermal factors and stationary people in parks and surroundings in Osaka. They highlighted that the relationship between the stationary behaviours and the thermal factors (temperature, surface temperature, and shade) is relatively high during spring season.

Consequently, integrating the consideration of thermal environment (temperature, surface temperature, and shade) and wind condition is considered effective when comfortable public open spaces are designed based on pilot project learnings. However, in order to carry out such design and plans, it is necessary to better understand the climatic characteristics such as thermal environment and wind condition as not points but spatial distribution. This study aims to better understand the relationship between numerical simulation of spatial distribution results and investigation results of the actual user behaviour. Moreover, it also examines the creation of a street environmental climate map for human activity for planning comfortable public spaces considering climatic characteristics in Saitama New Urban Center (SNUC) area, which is a central business zone. For the purpose of this study, the human activity investigation data was obtained through the pilot project titled, "Public Life Fes Saitama Shintoshin 2018" in SNUC.

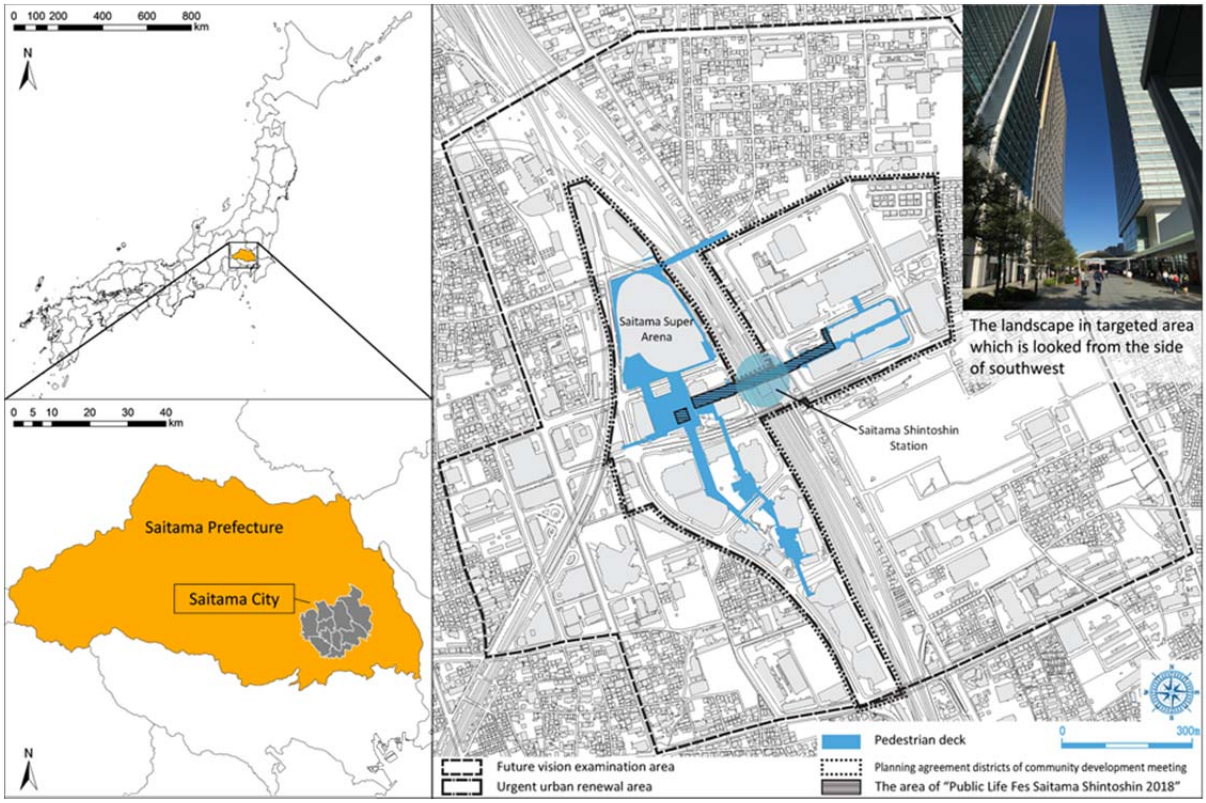

Figure 1. Outline of targeted area (Source: Authors).

Figure 2. Outline of pilot project area and location of wind fixed points observation (Source: Authors).

2. Research outline

2.1. Study area

'Saitama New Urban Center (SNUC)' was selected as the target area (Figure 1). SNUC was a district that was redeveloped as 'Land Readjustment Projects in Saitama New Urban Center' in 1986 (Urban Renaissance Agency, n.d.). In this project, public facilities were improved as part of the upgrade of the city function in which the former Japanese National Railways Omiya Yard forms the business core are of the city positioned within in the metropolitan area as an attractive new city centre that integrates the city functions, leading industries and the cultural hub of the central city area of Saitama. Currently, SNUC Station, high-rise commercial buildings or offices buildings, Saitama Super Arena, etc. were also planned and built. In addition, pedestrian decks connect these buildings. They were constructed on the second-floor level above ground. Currently, the 'SNUC Town Development Promotion Council' (Saitama city, 2014), which comprises members centred on landowners, has been founded in order to promote town development activities such as landscape maintenance and barrier-free planning and design principles. Nineteen years have passed since the city opened and there is a growing need for initiatives to improve the value of the area, such as aging of the city's infrastructure and renewal of signs, information dissemination of the area, and further public space utilization. As for the wind condition in this area, there are strong winds on

the pedestrian decks caused by the positioning of the surrounding skyscrapers. A preparatory interview survey revealed that many people consider the strong winds a serious problem in this area. The basic information related to SNUC is as follows:

- Developing area: 47.4ha
- Total floor area: 1,800,000m^2
- Total number of employed people: 57,000

2.2. Outline of SNUC pilot project

The pilot project, "Public Life Fes Saitama Shintoshin 2018" was conducted from October 15 to 24, 2018. The project objective was to promote daily utilization of the public open spaces for office workers, residents and visitors. For the duration of the pilot project, temporary objects were implemented in six target areas (Figure 2): "GARDEN DECK", "SHADE DECK", "PUBLIC LIFE DECK", "PLAY DECK", "NOMADO DECK" and "RELAX DECK." The six areas were set up based on the pre-survey results obtained in June which revealed issues in each deck that discouraged stationary behaviour. Each of the areas was designed and modified in such a way as to encourage people to stay and engage in stationary behaviours. Furthermore, the pilot project was hosted by landowners, surrounding companies, and the government. The content of the pilot project based on the pre-survey results of each area is described below.

GARDEN DECK: This area was a space where people passed through and no stationary behaviours occurred. Thus, the design concept was to create a relaxed environment where mall visitors and students who came and went could be soothed by the greenery. In order to make such a space, vegetation was arranged on the deck and lighting production was switched on at night.

SHADE DECK: In this space, stationary behaviours occurred in the evening as well as during the day when there was shade. The design concept was the creating of a relaxed environment where people would feel comfortable in the shade or enjoy the breeze. In order to make such a space, objects placed included tarp, chairs, and an existing bench.

PUBLIC LIFE DECK: In this area, a range of stationary behaviours occurred – except human conversation – as the area is near ticket gate and benches were installed that are wider that people not necessarily sit and face towards each other. The design concept was to create a main area that represents the essence of Saitama Shintoshin in which different industry groups can interact. In order to design such a space, long tables, chairs and a welcome board were installed.

PLAY DECK: No stationary behaviour such as taking short break occurred, but a device using the characteristics of the place was installed. The design concept was to create a relaxing environment where children could play safely. In order to set up the area, artificial grass was installed. Thus, stationary activity in this area constituted of child play on artificial grass and their parents talking or interacting nearby.

NOMADO DECK: The design concept was to create a relaxing environment where people can feel comfortable even alone. The setup included tables, chairs and a food stall. In this case, stationary behaviour included workers of nearby companies taking a break or having a professional meeting with food and drinks.

RELAX DECK: This design concept was also to create a relaxing environment where everyone including workers or visitors could relax. The setup consisted of a small outside office and a recreation space. Here, the stationary activity of people included workers from nearby companies having job meetings or even practicing yoga.

2.3 Method

This study was undertaken according to the following steps.

1. Investigation of the actual behaviour of users
2. Meteorological observation
3. Simulating of wind distribution and the amount of solar radiation distribution based on computational fluid dynamics (CFD) uses numerical methods and algorithms to analyse and solve problems involving fluid flow
4. Relation analysis of results of 1) and 3)
5. Climate zoning for development of street environmental climate map

3. Investigation of the actual behaviour of users

3.1. Number of pedestrians

The average number of pedestrians and their walking direction were investigated at 10 points in the pilot project area on October 19 (weekday) and 20 (holiday) (Figure 3). The weekday data revealed that the number of pedestrians was highest at point 4 and 5 while point 3 and 6 had the second highest numbers; the number of pedestrians decreased as the distance from station increased. Moreover, in the western area, the number of pedestrians was the highest at point 7, which is connected to the administration area, while it was the lowest at point 8, which is connected to the Saitama Super Arena. The weekday data revealed that the number of pedestrians was at its highest at point 5, and second highest at point 8. Relatively few people were walking to the south side of the pedestrian deck. And at point 2, the number of pedestrians increased more than weekday. Generally, the number of pedestrians was higher on a holiday than on the weekdays.

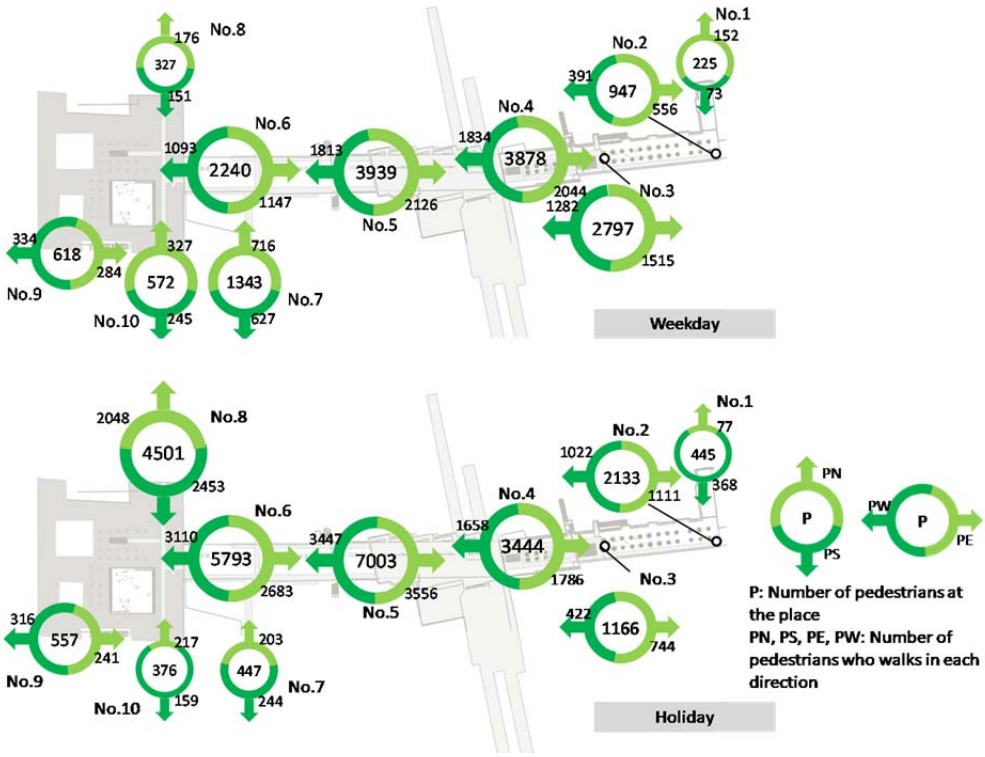

Figure 3. Number of pedestrians (Source: Authors)

3.2. Activity surveys

Human activities were investigated in the area on October 19 and 20. Figure 4 shows the spatial distribution of stationary people on a weekday and a holiday. The results indicated that most of the stationary people were located near the station and with relatively few people on the "NOMADO DECK". Furthermore, the number of stationary people during the holiday on the "SHADE DECK", "GARDEN DECK" and "PLAY DECK" was higher than that on weekdays. Figure 5 depicts the hourly number of stationary people according to some activity groups in the part of the "GARDEN DECK", "SHADE DECK" and "PUBLIC LIFE DECK".

Figure 4. Stationary people distribution (Source: Authors)

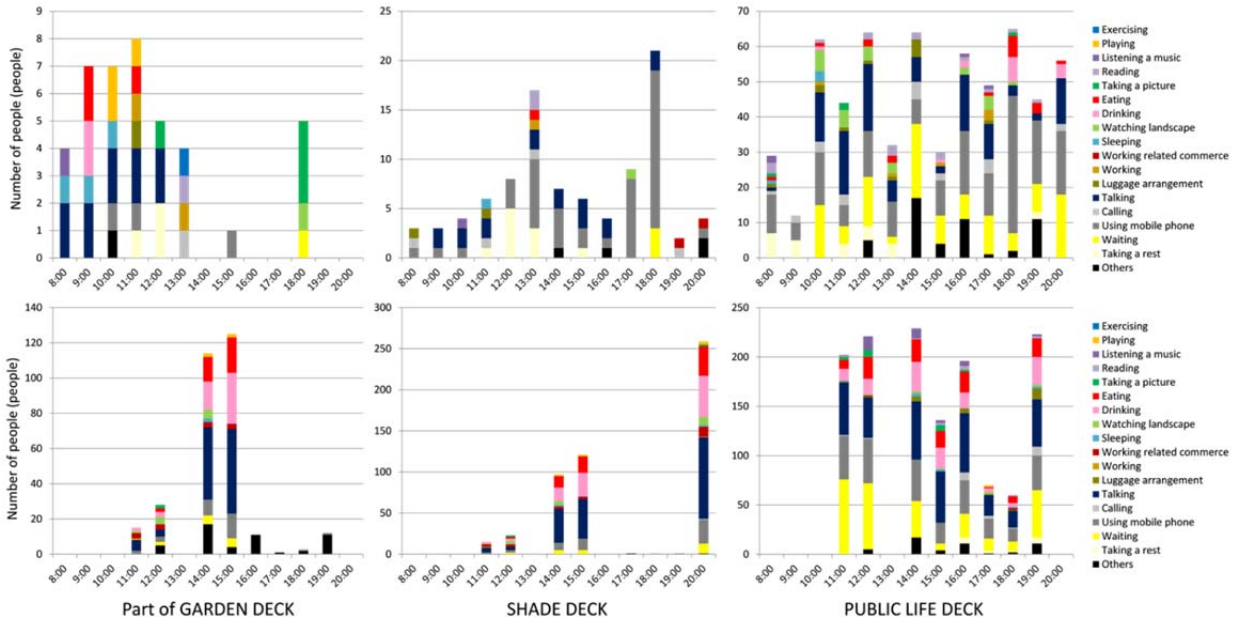

Figure 5. Hourly number of stationary people according to some activity groups (upper side is on weekday and lower side is on holiday) (Source: Authors)

The part of "GARDEN DECK" is the lower area of L-shaped area of "GARDEN DECK". On the part of the "GARDEN DECK" weekdays, the number of stationary people was relatively large in the morning and many people were communicating at any time. During holidays, the number of stationary people was relatively large at around 14:00 or 15:00.

On the one hand, on "SHADE DECK" during weekdays, the number of stationary people was relatively large at around 13:00 or 18:00 with many people using mobile phone devices. On the other hand, on holiday, the number of people who were talking, eating or drinking was larger than the number of people using mobile phone devices. On "PUBLIC LIFE DECK" the number of stationary people was the highest among the three zones and many people were observed waiting, although they were not necessarily sighted in other zones. Also, the number of people having conversation was the same as those using mobile phones devices or waiting for someone.
According to the above results, there were many pedestrians and stationary people in front of the station which indicates that the area is slightly different compared to other areas. The number of stationary people in the eastern part of the area was higher than that in western part. Regarding the types of activities, there were a many people having conversation or using their mobile phone devices. If weekday and holiday activities were compared, data shows that in comparison to weekdays, more people were drinking and eating during holidays.

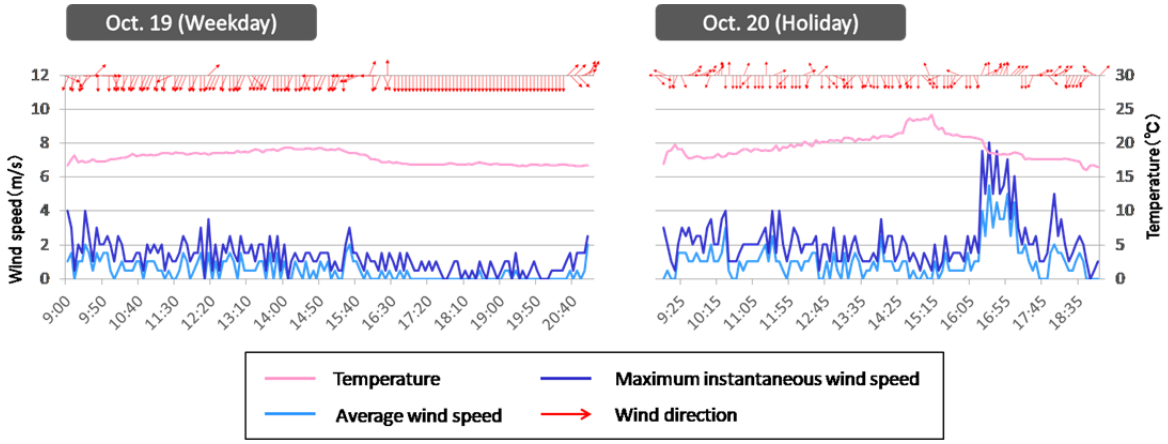

Figure 6. Maximum instantaneous wind speed, average wind speed, wind direction, and temperature on Oct. 19 and 20 in point I (Source: Authors; graphs generated based on open data)

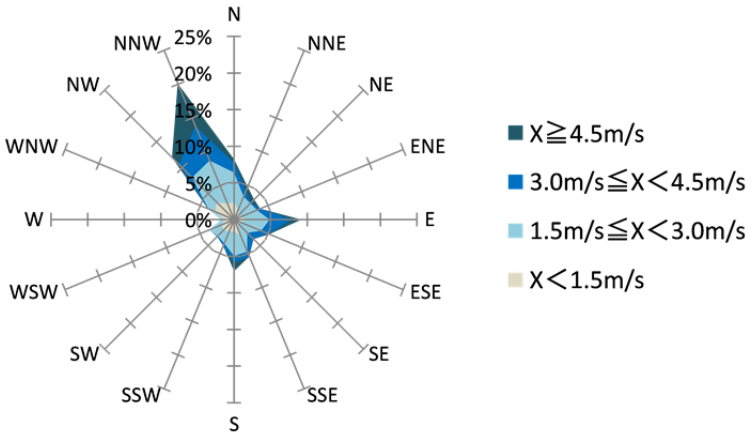

Figure 7. Wind rose by each wind speed class which is made by local meteorological station (X=wind speed) (Source: Authors)

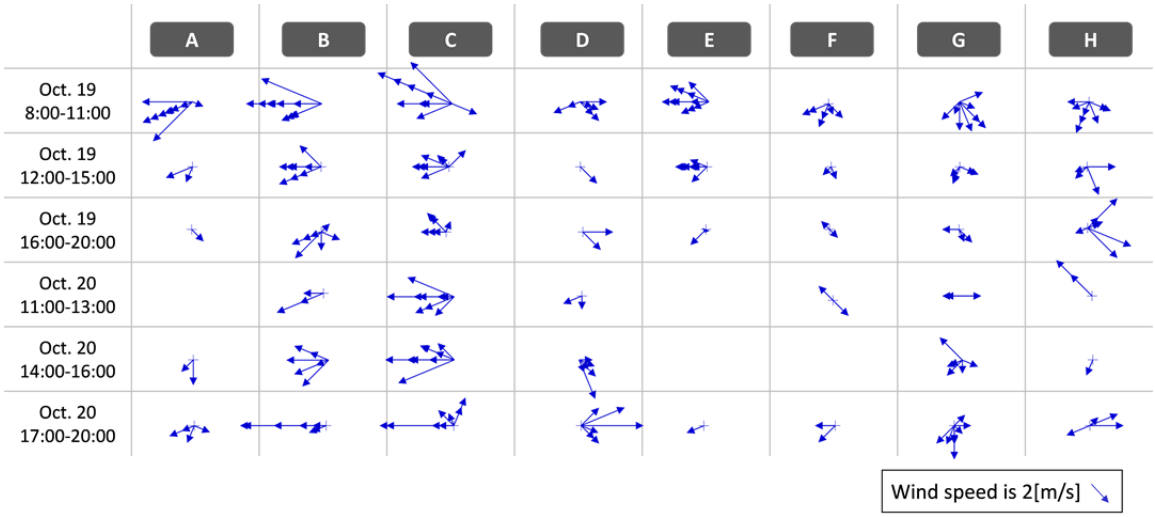

Figure 8. Wind direction and speed from points A to H (Source: Authors)

4. Meteorological observation

4.1. Fixed-points observation

According to Figure 2, nine (A to I) points for measuring wind directions and wind speed were considered. The wind direction and wind speed from points A to H were observed three times per hour. The wind direction, wind speed and temperature at point I were observed at an interval of 30 seconds, using the three-cup wind speed sensors supported by a data logger.

First, the results of maximum instantaneous wind speed, average wind speed, wind direction and temperature for point one were shown in Figure 6. The average temperature was about 20°C–25°C; the most frequent wind direction was north or north-northeast; and the maximum instantaneous wind speed was 6m/s and average wind speed was 2m/s. Temperature was the highest at around 15:00. It is considered that the observation point was located in the shaded area where high-rise buildings line up in the morning and was located in the sunny are in the afternoon. On weekdays the average wind speed was stronger in the morning than in the afternoon. On holidays the wind speed was strongest around 14:00 due to weather change at that time. Therefore, it was observed that strong winds usually blow from north or north-northeast in the morning across the target area. Also, Figure 7 shows the wind rose created by the local meteorological station using the hourly data in October. A comparison of the observed results and local meteorological station data revealed that the tendency of wind direction was almost same. The difference in the wind from the north or north-northeast seen in Figure 7 and the winds from the north or north-northwest seen in the local meteorological station data is considered to be due to the influence of the high-rise buildings surrounding point I.

Second, Figure 8 presents the results of wind direction and speed from points A to H: the wind speed from points A to E was greater than the speed from points F to H. From points A to C, the wind nearly blew from the north, but from points F to H, the wind blew from the east. It is considered that the wind blows from the north in the entire target area and the wind direction was different at each point due to the surrounding

buildings. Furthermore, the wind blew from the north in the low-rise buildings in the east area; however, it blew from east in the high-rise buildings in the west area.

4.2. Movement observation

Movement observation was conducted by walking with instruments across the target area every 2 hours (9:00, 11:00, 13:00 and 15:00). The temperature distribution was understood by linking temperature data (thermocouple) to GPS (Global Positioning System) based locational data. Figure 9 shows the routes of movement observation and observation results on 20th. Two kinds of routes show the round trip from the east side of pedestrian deck to the furthermost point to the west side of "RELAX DECK". These results show that, at 9:00, the temperature around the "GARDEN DECK", "SHADE DECK" and "PUBLIC LIFE DECK" was relatively high but the temperature around the "RELAX DECK" was relatively low. The temperature difference between the east and west areas was slightly higher at 11:00 and 13:00 than at 9:00. The temperature difference can be observed especially above the western part of the pedestrian deck. Potentially this is caused by the southern positioning of the pedestrian deck as it overshadowed by other buildings. At 15:00, the temperature difference between the eastern and western areas was slightly smaller than at 11:00 and 13:00, and the temperature on the northern side of "NOMADO DECK" which was relatively high. According to results for each time, the difference between the areas where the temperature was high and the area where the temperature was low in each time was largely influenced by the overshadowing effects of surrounding buildings. However, each time when the temperature difference between the eastern area and western area of the pedestrian deck was approximately 1 to 2 degrees, the temperature distribution did not have a noticeable difference.

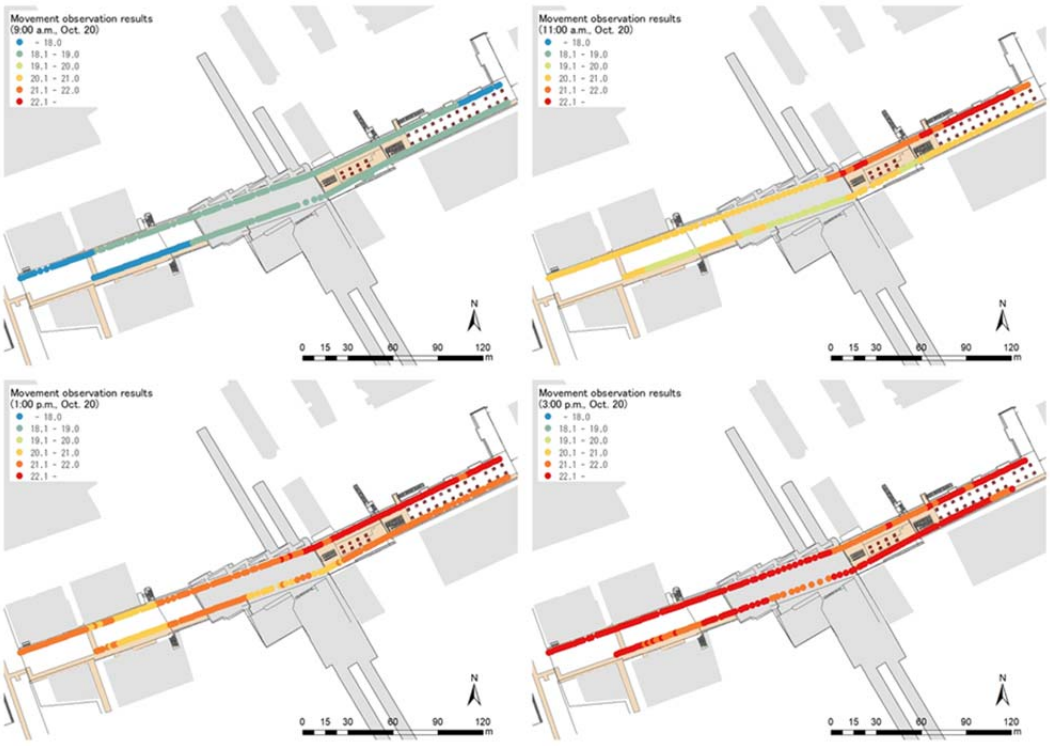

Figure 9. Routes of movement observation and observation results (Source: Authors)

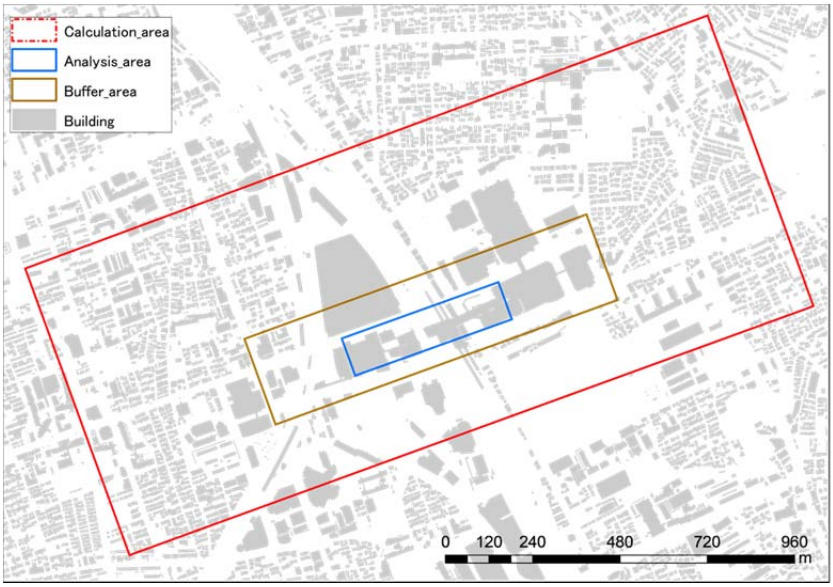

Figure 10. Calculation area, analysis area and buffer area in CFD simulation (Source: Authors)

Previous studies have shown that temperature, wind speed, and solar radiation have a significant effect on human behavior (Nakase and Kiyota, 1988, Akagawa et al., 2007). In this study, according to the above results of fixed-point observations and movement observations of wind and temperature, it was observed that the wind conditions in the target area vary depending on their strategic location. Furthermore, it was observed that the temperature difference is not so significant, but some temperature differences are considered to be due to the amount of solar radiation. Therefore, in the following chapters numerical simulations will introduced and discusses to gain a spatial understanding of the wind condition distribution and solar radiation distribution across the target area.

5. Numerical simulation based on computational fluid dynamics (CFD)

5.1. Usage model and calculation condition

The wind flow and amount of solar radiation was calculated using Autodesk computational fluid dynamics (CFD) 2019 (Albatayneh et al., 2017, Daemei et al., 2019). Autodesk CFD (formerly CFdesign) is a completely new thermal fluid problem design tool designed to make it easy for general designers to use CFD that has been used by fluid analysis experts. Many 3D CAD versions are available, such as Pro/ENGINEER, NX, Solid Works, Inventor, SpaceClaim, and Revit. In addition, it is possible to execute analysis in Autodesk CFD by outputting in the form of the intermediate file format Parasolid, ACIS in 3D CAD, or by linking through the included 3D modeling tool SimStudio Tools. Direct integration with 3D modeling kernels allows direct thermal and fluid analysis without data conversion. In addition, associability with 3D CAD is secured, it is possible to easily carry out multiple parameter studies with changes in dimensions, positions and shapes. As a result, it is possible to shorten the design period by repeating virtual prototyping, and it is possible to easily lead a solution to problems that are difficult to experiment on and visualize. In this study, the input building data of simulation was compiled based on the plan and field survey result by using Revit. The calculation area

was a rectangle within the target area (Figure 10). The size of each area is set by using previous studies as a reference (Takebayashi, 2015, Hayashi et al, 2014 & Houda, et al., 2017). Moreover, the target area was partitioned using the function in which suitable mesh size is calculated automatically. The calculation was performed in each mesh. First, for the wind flow simulation, the turbulent model was similar to the k-ε model. The wind-flow simulation in this study did not consider the heat. Furthermore, the local meteorological station hourly data was of the wind speed and the inflow condition was a wind speed of 2.2m/s (wind direction: north-northwest) with a height of 10m by power law (n: 2). Second, for the amount of solar radiation simulation, the emissivity (0.3) and sky conditions were set.

5.2. Simulation results

Figure 11 and Figure 12 show the results of wind speed, wind direction and amount of solar radiation. The results of wind speed and wind distribution used in the examples were collected at about 2 m height and the amount of solar radiation was collected at 9:00, 11:00, and 13:00. In addition, the comparison of wind speed and observation direction discussed previously elucidated that the difference between the simulation results is relatively small. First, focusing on the wind direction, the wind blows from north, north-northeast or north-northwest on the "GARDEN DECK", "SHADE DECK", "PLAY DECK". The wind blows from east on "PUBLIC LIFE DECK" and "NOMADO DECK" as the area is surrounded with low buildings. It revealed that on the "PLAY DECK" and "NOMADO DECK" area, the wind was blowing from the northern direction and changed to the east mainly due to the positions of surrounding buildings. Moreover, focusing on the wind speed, the wind speed on the "PLAY DECK" area, the south area of "NOMADO DECK", "SHADE DECK" area and "RELAX DECK" area was relatively high. On the "NOMADO DECK" area, the wind speed differed depending on the area.

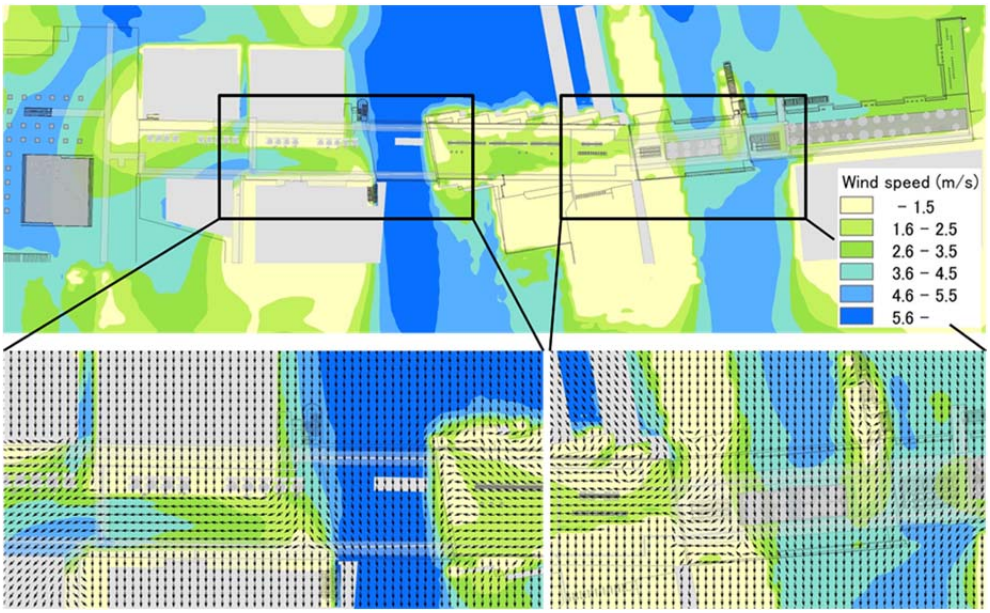

Figure 11. Simulation results of wind speed and wind direction (Source: Authors)

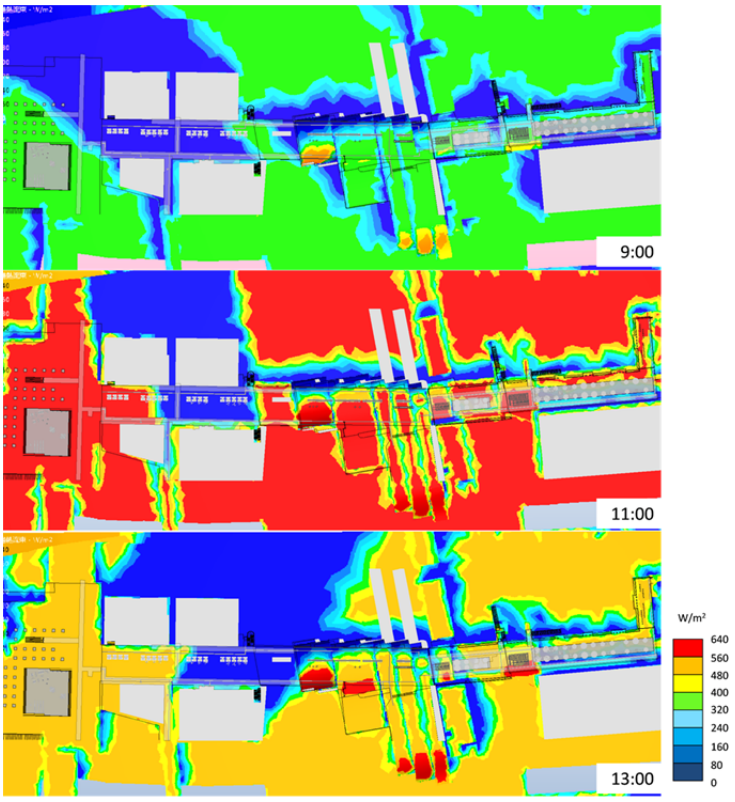

Figure 12. Simulation results of the amount of solar radiation (Source: Authors)

Second, according to the amount of solar radiation results, the amount of solar radiation was highest at around 11:00. It can be observed that the location of the shadow caused by the building changes with the movement of the sun. In this target area there were two types of spaces: those with roof and those without roof. The areas with roofs were located on the "PUBLIC LIFE DECK", partly on the "SHADE DECK" and the northern or southern side of the pedestrian deck. Moreover, there was shade created by a tree on the "RELAX DECK". As for areas without roof, the amount of solar radiation on the "NOMADO DECK" differed. Specifically, in the morning, the eastern side on the "NOMADO DECK" area, which was also included in the "PLAY DECK", was in located in the shade. In the afternoon the western side of the "NOMADO DECK" area was located in the shade. Overall, the shadows created are a result of the high-rise buildings close to the "NOMADO DECK" area. Also, the amount of solar radiation on "GARDEN DECK" differed. It can be observed that the amount of solar radiation at the northern side of the pedestrian deck was greater than that on the south side.
The next section presents an analysis between the numerical simulation results and the distribution of stationary people for a better understanding of the area in which human activity is generated from the perspective of climatic characteristics.

6. Relationship analysis and climate zoning

6.1. Relationship analysis

In this section, the data of stationary people other than "PUBLIC LIFE DECK" is used as

the number of stationary people staying at this deck is greatly influenced by the station which has a slightly different characteristic compared to the other decks. First, Figure 13 shows the number of stationary people by each wind speed class on weekdays and holidays using the activity survey results and wind simulation results. In this study, the wind speed class interval was set to 0.5m/s. The results for the weekdays revealed that the number of stationary people was relatively low in the area where winds were relatively high. On holidays, when the wind speed is 3m/s or less, the number of stationary people increases as the wind speed increases. When the wind speed is 3m/s or more, the number of stationary people decreases as the wind speed increases.

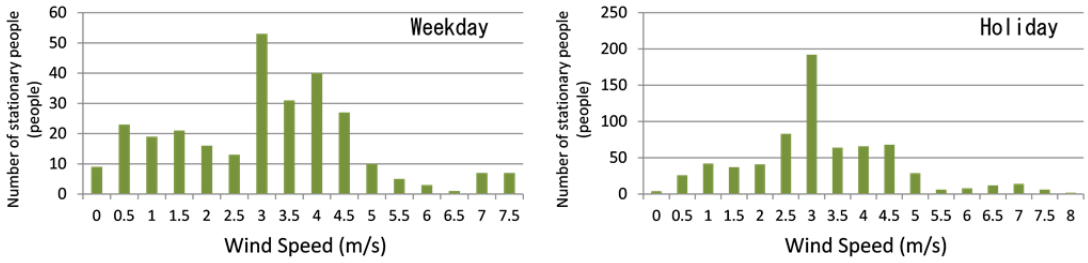

Figure 13. Number of stationary people by each wind speed class on weekday and holiday (Source: Authors)

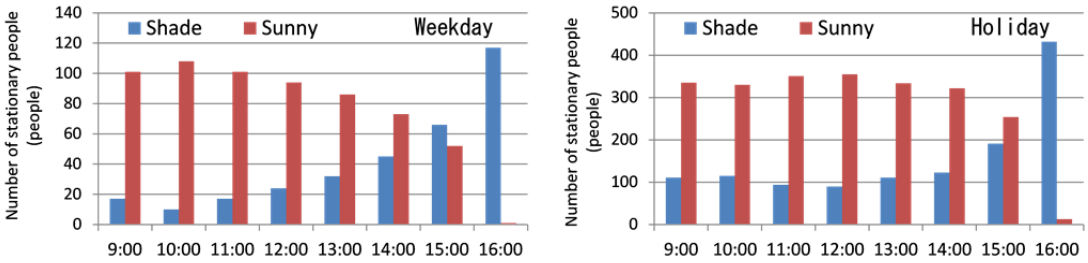

Figure 14. Number of stationary people in the shade and sunny place on weekday and holiday (Source: Authors)

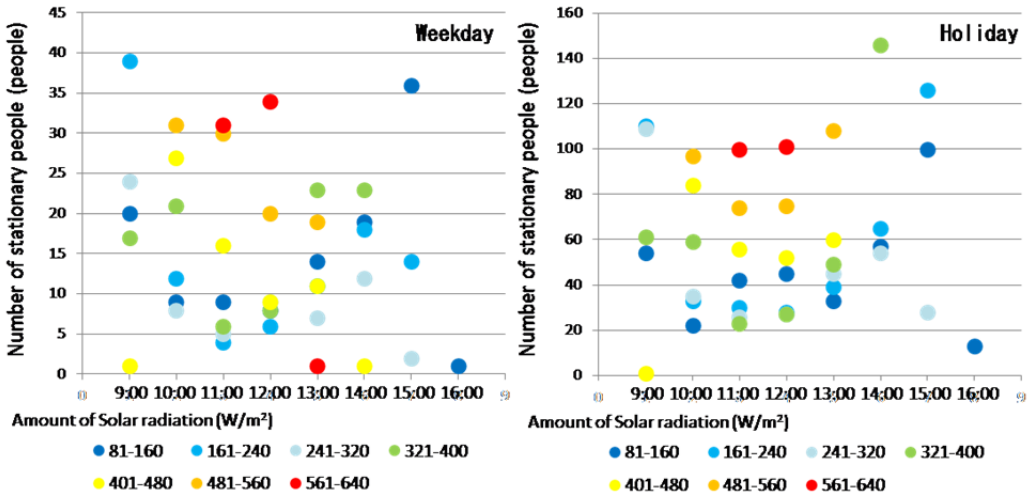

Figure 15. Number of stationary people by each amount of solar radiation wind speed class on weekday and holiday (Source: Authors)

The same trend was observed on holidays and on weekdays. Thus, the area in which the wind speed range was between 0.0m/s to 3.0m/s people easily stayed outside during this season. Second, Figure 14 shows the number of stationary people in the shade and on sunny places during weekdays and holidays using the activity survey results and the amount of solar radiation simulation results. In this study, shady areas were available under the roofs or street trees with less than 80W/m^2. The results highlight that the number of stationary people in the sunny place was higher than that in the shady areas during evening hours. Furthermore, during the evening the opposite trend was observed as most of the target area was fully shaded. Thus, the sunny area or solar radiation environment was considered to be the area of choice where people easily stay outside during daytime as part of this season. In addition, the number of stationary people and the amount of solar radiation class on weekdays as well as holidays is shown in Figure 15. From this figure, it shall be concluded that the greater the amount of solar radiation during this season, the greater the number of visitors, especially on holidays.

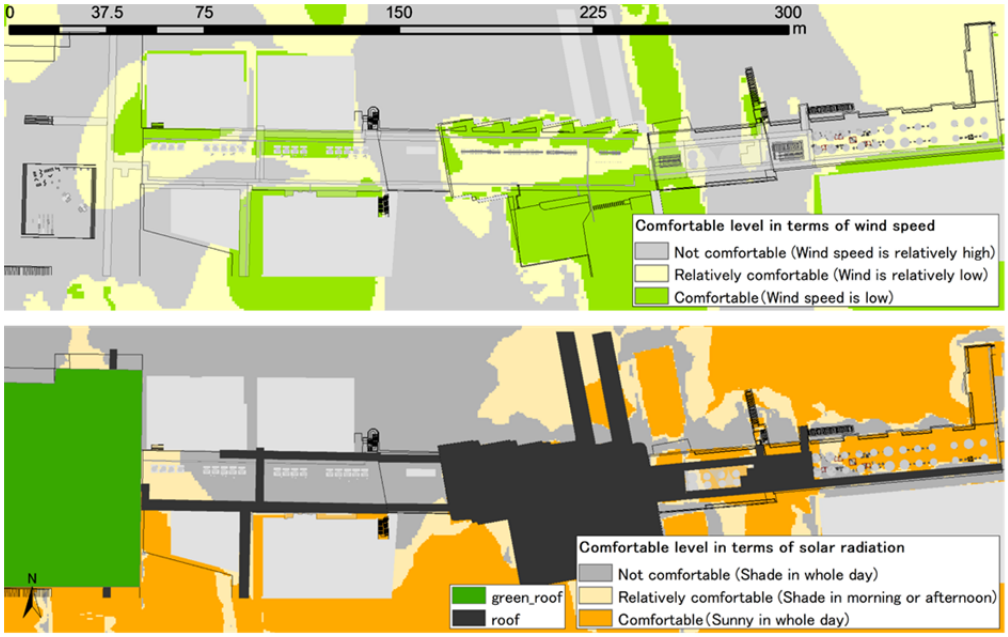

Figure 16. Climate zoning and street environmental climate map (Source: Authors)

6.2. Climate zoning related to wind speed and solar radiation

First, climate zoning related to wind speed and solar radiation is discussed based on the results of the relationship analysis (Figure 16). Zoning was first performed using the threshold of the wind speed, 3.0m/s, the relationship between the number of stationary people and wind speed, and then based on the difference in shade and sunny places at each time. The area where the wind speed is less than 3.0m/s was divided in two parts and the sunny place is divided into a sunny area during morning hours and another sunny area in the afternoon. Based on these zoning and in terms of wind environment there are many comfortable areas for stationary behavior in the northern or southern side of the "PUBLIC LIFE DECK" and "NOMADO DECK" and the southern side of the "GARDEN DECK". Moreover, there were many uncomfortable areas for stationary behavior on the "SHADE DECK" and "PLAY DECK". In terms of the solar radiation

environment, there were many comfortable areas for stationary behavior on the "SHADE DECK" and "GARDEN DECK". In addition, there are many uncomfortable areas for stationary behavior on "PLAY DECK" and "NOMADO DECK". Second, the street environmental climate map was created by using the climate zoning; the areas where people easily stay outside during this season. Each zone is shown in Figure 16. The map in terms of wind environment shows three different zonings: the comfortable zone, relatively comfortable zone and not comfortable zone. A comfortable area is an area where the wind speed is 0.0m/s or higher, and up to 1.5m/s. The relatively comfortable zone is an area where the wind speed is 1.5m/s or higher, and up to 3.0m/s, and the not comfortable area is an area with a wind speed of 3.0m/s or more in this study. The map of solar radiation environments shows three zonings: the comfortable zone, relatively comfortable zone and not comfortable zone. The comfortable zone is an area that is sunny throughout the whole day. The relatively comfortable zone is an area that is sunny in the morning or afternoon, and the not comfortable area is covered in shade throughout the whole day.

7. Conclusion

This study aimed to better understand the relationship between numerical simulation results and investigation results of the actual user behavior and develops a street environmental climate map for stationary people to design and plan for more comfortable public spaces by considering climatic characteristics in the SNUC area. The results were as follows:

1) Investigation of the actual users' behavior revealed that there are many pedestrian and stationary people in front of stations and the number of stationary people in the eastern area was higher than that in the western area.
2) Meteorological observations indicated that the climatic characteristics and factors influence the actual user behavior and differed according to places in the street area.
3) The relationship analysis elucidated that during autumn season which average temperature is around 20°C, people tend to stay outside in sunny areas as well as in areas where the wind speed ranged from 0m/s to 3m/s.

The study limitations and prospects for future research are as follows:

1) This study was conducted in autumn when the maximum and minimum temperatures are about 22 °C and 15 °C, respectively. However, the area where people easily stay outside differs during each season. Therefore, it is necessary to further consider other seasons for better design and plan more comfortable public open spaces with the use of pilot projects.
2) This study highlights that environmental factors affect the number of stationary people. In the future, it might be necessary to analyze the relationship between other factors and environmental simulation results. For example, those are stationary times or stationary behavior types.
3) Although the wind environment map and the solar radiation environment map of this study were made separately, it is necessary to overlay them from now on and to determine an environmentally appropriate place when conducting social space experiments.

Acknowledgements

This study was supported by Grant-in-Aid for Japan Society for the Promotion of Science Fellows (17J07605). The authors thank Urban and Architectural Planning Laboratory in Department of Architecture, Graduate School of Engineering, Hiroshima University, especially Ryosuke Okada and Shuhei Ota on the CFD simulation. Also, the Public Life Fes Saitama Shintoshin Center 2018 and its investigation are being carried out in cooperation with Saitama City, the Public Life Fes Saitama Shintoshin Center Executive Committee, Saitama Shintoshin Center Development Council, UDCO Urban Design Center OMIYA, and Sotonova.

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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

Public open space initiatives for healthier cities in Rwanda

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Abstract
With a population of close to 13 million, and an annual growth rate of 2.86 percent, Rwanda plans to position itself as a climate resilient, low carbon, low unemployment, reduced poverty country, with a strong services sector by 2050. Its projected increase in its urbanization rate from a current value of 18.4 percent to 35 percent by 2024 is driven by strong political will, significant investments in infrastructure, service provision, and human capital development. Rwanda's secondary cities, identified as economic nodes of growth, are currently undergoing revision of their masterplans in consideration of climate change realities and the pressure on infrastructure and services due to rapid urbanization. Currently, cities in Rwanda do not yet have a system of public open spaces. Where available, such spaces are usually hardly accessible and need upgrading. To address this, the Ministry of Infrastructure, Rwanda Housing Authority, City of Kigali and six secondary cities have committed to deliver on public open space related activities and targets under the yearly performance contract 'Imihigo'. The outcomes of their commitments support the climate-responsive revision of masterplans of the City of Kigali and six secondary cities. This paper presents public open space initiatives in Kigali and the results of the technical assessment of public open spaces and participatory planning and design workshop in Nyagatare, secondary city in Rwanda's. It also discusses ongoing policy changes and initiatives that aim to promote public open spaces as crucial for urban public health.

Keywords: public open space, resilience, masterplan, secondary city, Kigali, Nyagatare, Rwanda

To cite this article:
Gubic, I., Baloi, O. (2020). Public open space initiatives for healthier cities in Rwanda. *The Journal of Public Space*, 5(2), 129-146, DOI 10.32891/jps.v5i2.1287

This article has been double blind peer reviewed and accepted for publication in *The Journal of Public Space*.

1. Introduction

Rwanda has one of the highest annual urban growth rates – an estimated 4.5 percent – in East Africa. Estimates indicate the country's urbanization rate will increase from around 18.4 percent currently to 35 percent by 2024 (Ministry of Infrastructure, 2019). Rwanda's *Economic Development and Poverty Reduction Strategy* (2013-2018) identified six secondary cities as potential poles of urban growth to reduce migration to the capital city and develop opportunities in Rwanda's mostly border cities: Huye, Muhanga, Musanze, Nyagatare, Rubavu and Rusizi. These secondary cities' populations account for a quarter of the country's urban population (Ministry of Infrastructure and Global Green Growth Institute, 2016) and contribute 13 percent to its GDP (World Bank, 2017). Rural-urban migration is driven by limited land surface and rural poverty. Despite policies favouring green cities and buildings in Rwanda, rapid urbanization is driving further greenhouse gas (GHG) emission sources such as transportation, construction and industries. In areas along main roads, vehicle emissions are the largest contributor to poor air quality, while domestic stoves are the largest contributor in rural areas (Rwanda Environment Management Authority, 2018). Air pollution in urban and rural settings is comprised of a mix of chemicals, particulate matter and biological materials that may contribute to breathing problems, chronic diseases and premature mortality (International Association for Medical Assistance to Travelers, 2020). In previous years, more than two thousand deaths per year have been attributed to ambient air pollution, a major risk factor in Rwanda for respiratory diseases (Rwanda Environment Management Authority, 2018).

Against this backdrop of rapid urban growth and increased GHG emissions, public open spaces are a key element in ensuring social cohesion (Peters, Elands, & Buijs, 2010) and wellbeing with wide-ranging benefits to public health (Cicea & Pirlogea, 2011; Hoffimann, Barros, & Ribeiro, 2017) and the environment (Rakhshandehroo, Tahir, Yusof, & Yunos, 2017). Research on public open spaces in rapidly urbanizing Rwanda's cities is limited. That could be explained by the general interest of research institutions and development partners in issues related mainly to the provision of basic urban services such as electricity, water supply, waste management, while public open spaces are still regarded more as a commodity (Gubic & Baloi, 2019).

To contribute to the prevention of air pollution and to the overall health of its urban residents, the Ministry of Infrastructure, Rwanda Housing Authority, the Global Green Growth Institute and other stakeholders including local governments, are leading public open spaces planning, design and implementation in the City of Kigali and six secondary cities. This article addresses some of the findings of the initiative that are in line with national policies and also with recommendations from Sustainable Development Goals (SDGs) and the New Urban Agenda (NUA).

2. Development Agenda's Recommendations: Health Benefits of Public Open Spaces

Health-based urban planning promotes opportunities for increased physical activity and social capital, reduced crime, obesity reduction, diabetes reduction, reduced hypertension, depression and improved access to healthy food (Grant, 2015; Mogo, Lerno, Abdeta, & Olufemi, 2019). Political support is needed to ensure adequate allocation of resources for better integration of health, environmental, social and

economic concerns in land-use planning, transport, housing and economic development policies (Barton, Grant, Mitcham, Tsourou, 2009). In addition to accessible health facilities, urban planning must reduce environmental risks and provide more public open spaces that can create conditions for healthy, active lifestyles (London Healthy Urban Development Unit, 2014). The adoption by the UN Member States of Agenda 2030 in September 2015 was a major milestone: for the first time there was clear recognition from the international community of the need to focus on sustainable urbanization, with SDG 11, "make cities and human settlements inclusive, safe, resilient and sustainable", dedicated to this aim. This included a specific provision on public spaces (SDG 11.7): "By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities" (UN General Assembly, 2017). SDG 11 also pledges to achieve sustainable development through "making cities inclusive, safe, resilient and sustainable" by reducing the number of deaths and the number of people affected by disasters, including water-related disasters; reducing the environmental impact of cities by paying special attention to air quality, and provision of universal access to safe, inclusive and accessible, green and public spaces (UN General Assembly, 2017).

In 2016, countries across the world adopted the New Urban Agenda (NUA) during the UN Conference on Housing and Sustainable Urban Development (Habitat III) in Quito, Ecuador. The NUA was the culmination of three years of preparation involving a wide range of governments, observers, and stakeholders, with public spaces identified as one of the main priority areas (Habitat III Secretariat, 2016). The Issue Paper on public spaces, prepared during the Habitat III preparatory process, suggests that interaction with nature, through green public space, has been associated with general and mental health. It also suggests that urban ecosystem services like air pollution reduction and urban cooling have multiple long-term health benefits (Habitat III Secretariat, 2017). During the preparatory process, Barcelona's local authority hosted a thematic meeting on public spaces: this resulted in the Barcelona Declaration, calling on governments to include public spaces in the NUA (UN General Assembly, 2016). The Barcelona Declaration also highlights the social and political dimension of public open spaces. It especially mentions recreation and health, insisting that public spaces should provide equal opportunities for enjoying indoor/outdoor spaces and promote healthy practices and sustainable consumption and production patterns in harmony with nature (UN General Assembly, 2016).

There was a great deal of collaboration between local authorities, civil society groups and other stakeholders in shaping inputs on public spaces for the NUA. These initiatives helped shape the final text of the NUA, with its emphasis on promoting safe, inclusive, accessible, green and quality public spaces (Gubic & Baloi, 2019). The NUA (United Nations, 2016) mentions public spaces in paragraphs 36, 97, 99, and 109 through the lens of urban sustainability and as standalone commitments in paragraphs 13, 37, 53, 67, and 100. After the adoption of the NUA in October 2016, the Government of Rwanda undertook a review of its existing laws and policies against the NUA as part of the Rwanda State of the Environmental Outlook, prepared by the Rwanda Environment Management Authority (REMA) with support from the Ministry of Infrastructure and other stakeholders (Rwanda Environment Management Authority, 2017), though so far, no policies have actually been revised to localise the NUA (Gubic & Baloi, 2019).

Nevertheless, the Government of Rwanda has taken a positive step towards localizing and implementing the NUA through the organization by the Ministry of Infrastructure of the National Urban Forum (NUF), a multi-stakeholder platform to support sustainable urban development by creating awareness and promoting participation, coordination, engagement, and discussion in this area. For the NUF's "Implementing the New Urban Agenda", a number of stakeholders including the World Bank, the Global Green Growth Institute, the International Growth Centre (IGC), and UN-Habitat, led by the Ministry of Infrastructure, prepared a background paper on the Government of Rwanda's work to date on various urbanisation issues, including public open spaces, with projects in Rubavu public beach and *Mount Rubavu* highlighted as notable achievements in this area. The report also mentioned an assessment of public spaces in Nyagatare, Huye, and Rubavu (Ministry of Infrastructure, 2019) that will be presented as a case study in this article. Other initiatives, also held as parallel events to the NUF, included Urban Walk (Global Green Growth Institute, 2019a) and Inclusive Cities Talk (Global Green Growth Institute, 2019b), organized by the Global Green Growth Institute, all linked to the importance of public spaces and the inclusion of residents in their planning, design and implementation, as suggested in paragraph 97 of the NUA (United Nations, 2016). The two-day forum had facilitated intensive discussions on various topics around four main themes, with 17 recommendations emerging. One of the key recommendations is to protect and enhance wetlands and green public open spaces (Ministry of Infrastructure, 2020). Key actions were assigned to relevant institutions to implement the forum's recommendations.

3. Research Question and Methods

This article, drawing on research on public spaces in Rwanda's capital and Nyagatare, a secondary city[1] in Rwanda, examines whether current initiatives are embedded in a collaborative planning framework that meaningfully incorporates interaction among different stakeholders. Furthermore, it discusses health as a main benefit of green and public open spaces. It explores the following questions:

1) How does Rwanda's current approach to urban development reflect public health concerns, and does it align with global development agendas? This is answered by examining the process guiding the masterplan revisions for Kigali and Nyagatare.
2) To what extent do government decision-makers and Rwanda's development partners prioritize public open space initiatives for improved health? This is answered by examining the current government's initiatives addressing public open spaces and presenting outcomes of a thematic working group on public open

[1] Rwanda is approximately 18% urbanized, which is the lowest in Africa. However, the current average growth rate of the urban population is 4.5%, which is well above the world average of 1.8%. Moreover, this growth is largely concentrated in the capital city, Kigali, which has an annual population growth rate of 9%. In order to better distribute economic growth across the country and accomplish the national urbanization target of 35% by 2020, the Government of Rwanda has identified six secondary cities to serve as growth poles: Huye, Muhanga, Nyagatare, Rubavu, Musanze and Rusizi. However, these cities currently face challenges in the management and provision of basic infrastructure services to their growing population sizes, which, in turn, affect the ability of the cities to develop their economic prosperity (Republic of Rwanda, National Roadmap for Green Secondary City Development, 2015. Available at: https://gggi.org/site/assets/uploads/2017/12/National-Roadmap-for-Green-Secondary-City-Development.pdf).

spaces chaired by the Ministry of Infrastructure and co-chaired by the Global Green Growth Institute.

In the first section, a literature review and analysis of Rwanda's planning documents helps to explain the general context of urban development and the extent to which the existing national legislation addresses public spaces for health benefits of its citizens. Secondly, data from field visits to Kigali, and the secondary city of Nyagatare present an in-depth understanding of the current trends in public open spaces in Rwanda. Thirdly, the authors draw on the results of quantitative surveys with 100 citizens of Kigali and Nyagatare, as well as more than 10 semi-structured qualitative interviews with government officials and professionals working in Rwanda.

4. Public Space for Public Health in Rwanda's Planning Documents

The main legislation regulating urbanization is the Law Governing Urban Planning and Building in Rwanda of 2012 (Rwanda, 2012) and its implementing orders of 2015. Masterplans are guided by the National Land Use and Development Masterplan of 2010 which provides the general directives and principles for land use development including densification, mixed land use, mixed housing, green design, and participation. In Rwanda's National Land Use Planning Guidelines public spaces are all places publicly owned or of public use, accessible and enjoyable by all for free and without profit motive (Ministry of Natural Resources, 2017). Rwanda's Building Code does not define public space uses specifically but refers to 'recreational land use' (Ministry of Infrastructure, 2015a). In that document, recreational land use includes public open space, greenways and green areas, recreation and sports facilities. It can be distinguished between spaces for passive recreation and spaces for active recreation (Ministry of Infrastructure, 2015a). The National Land Policy stated that green spaces, as well as valleys, would be protected, and suggests that the creation of parks and protection of existing green areas in urban zones could eventually be transformed into accessible open public spaces (Ministry of Lands, Environment, Forests, Water and Mines, 2004). The policy also presents a general framework for the future urban development of Rwanda, with reference to public space (Ministry of Infrastructure, 2015b). The Rwanda National Land Use Planning Guidelines have also set guidelines for the promotion, protection, and creation of public, open, and green spaces in Rwanda (Ministry of Natural Resources, 2017). The Guidelines stipulate that open spaces, natural beauty, and environmentally sensitive areas should be maintained and developed for financial value (Ministry of Natural Resources, 2017). Financial value of public spaces is discussed in paragraph 53 of the NUA (United Nations, 2016) as a commitment to: promote safe, inclusive, accessible, green, and quality public spaces as drivers of social and economic development, in order to sustainably leverage their potential to generate increased social and economic value, including property value, and to facilitate business and public and private investments and livelihood opportunities for all. The document, in conformity with the Urban Planning Code (UPC), states that small neighbourhood parks should provide access to basic public space functions. For instance, it recommends that at least 5% of urban residential areas should be allocated to public spaces and facilities and provides recommended standards on the widths of sidewalks when designing intra-urban roads (Ministry of Infrastructure, 2015c). In the upgrading and renewal of urban informal settlement, the guidelines stipulate that in conformity with Ministerial Order

no. 04/Cab.M/015 of 18/05/2015 determining urban planning and building regulations and the Rwanda UPC, trees, green spaces should be preserved and restored. Furthermore, article 46 of the Organic Law no. 04/2005 of 08/04/2005 (Rwanda, 2005), determining the modalities of protection, conservation, and promotion of the environment in Rwanda, calls for the government and citizens to "establish, maintain, and manage parklands and green spaces".

Another planning document is the Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development (Government of Rwanda, 2011). Designed to support Rwanda's development into a climate-resilient, low-carbon economy by 2050, the strategy suggests favouring the creation of high-density, walkable cities to avoid excessive sprawl and long commuting times. The strategy also recommends corridors for pedestrians and cyclists, and green public spaces to improve the population's quality of life (Government of Rwanda, 2011). Such wording aligns with paragraph 118 of the NUA (United Nations, 2016), calling for the provision of adequate pedestrian and cycling infrastructure. The national strategy also calls for urban areas that are attractive with trees, parks, and public spaces to promote low-carbon transport, improve quality of life, and reduce the risk of flooding (Government of Rwanda, 2011). The experiences of other countries regarding flood prevention measures, where investments can be four times more cost-effective than post-disaster reconstruction (Lochhead, 2017; Silva & Costa, 2018), highlight the importance of public spaces and resilient development in Rwanda, given the climate-induced challenges already evident in the country, particularly droughts and floods.

The Ministry of Infrastructure, with the Global Green Growth Institute, developed the National Roadmap for Green Secondary City Development (NRGSCD; Ministry of Infrastructure & Global Green Growth Institute, 2016). Since the six cities are experiencing similar urban problems to those observed in Kigali, the Government of Rwanda deems that planning for the growth of those cities in a sustainable framework will increase benefits and avoid negative consequences such as urban sprawl, traffic congestion, the growth of informal settlements, and inadequate public services. To support green urban development in the six secondary cities, the authors of the NRGSCD recommend that they increase financial resources and local revenues to support investment in improved public spaces: these would, in turn, generate more public income.

In the absence of a clear definition of 'public spaces' in the Rwandan context, different terms with different meanings are used interchangeably in different governmental publications to mean 'public spaces'. To overcome the lack of clarity, the Ministry of Infrastructure, the Rwanda Housing Authority, Global Green Growth Institute, and the University of Rwanda are working on a review of existing laws and policies to support the development of a common and localised understanding of public space.

In terms of policy frameworks, the government of Rwanda has launched the Green Growth and Climate Resilience: National Strategy for Climate Change and Low Carbon Development (October 2011); Urban Planning and Building Code (May 2015), National Roadmap for Green Secondary Cities Development (December 2015), Green City Toolkit for Rwanda (November 2016) and National Land Use Development Masterplans. Through good governance, urban planning is aimed at job provision and ensuring quality of life for urban dwellers through the following pillars of urbanization: enhancing the building and construction sectors, energy, urban mobility and transport,

water management and waste management. The above-mentioned planning documents underline District Development Plans and Strategies, strategic investment plans and annual investments plans developed and implemented by the sectorial ministries, districts and city authorities. Kigali and the six secondary cities mentioned above are undergoing the process of masterplan revision. As part of the green city development actions, the government has enabled critical progress through the ban on plastic bag use, development of National Land Use Development Masterplan and other connected masterplans with great consideration of Green Urbanization, adoption of 'Made in Rwanda' policy, promotion of Rwanda Cities 'Car Free Day' event, availability of 'Environmental protection unit' in the Rwanda National Police and the proposed ban of single use plastic bottles currently in process. Despite the government's active efforts for green and environmentally sound cities, there are challenges in increasing the number of private investors in waste management and recycling but also weaknesses due to the difficult topography that makes the adoption of non-motorized transport less feasible.

4.1. District Development Strategies (DDS) Recognizing Public Spaces as Development Priorities

District Development Strategies (DDS) 2018–2024 are a guide for Rwanda's 30 districts to achieve their development vision and objectives, Vision 2020 and Vision 2050, emphasising strategic interventions to implement the current NST 1. DDSs were the result of a year-long consultation process reviewing what remained from the 2013–2018 District Development Plan and developing new strategic interventions. While for 24 Rwandan districts the Ministry of Local Government (MINALOC) hired consultants to facilitate discussions and draft strategies, in Rwanda's six secondary cities, Global Green Growth Institute seconded its technical district assistants to facilitate discussions. During the facilitation process with stakeholders, public spaces were identified as one of a number of important socio-economic public assets. To support the implementation of strategies, the Ministry of Infrastructure and the Rwanda Housing Authority have included public spaces as part of the yearly performance contract. The government-led mainstreaming of public spaces in the six secondary cities and districts is part of efforts to improve the response of cities to challenges induced by rapid urbanisation and implement the country's transformational strategy.

4.2. Master Plan Revision

The Global Green Growth Institute has worked in collaboration with the Government of Rwanda to develop the Green Climate Fund (GCF) Readiness Proposal for the Republic of Rwanda to access global funding for climate action. This readiness programme ended in December 2019 and strengthened the National Determined Authority's coordination capacity to align on-going climate finance efforts with green city and sustainable infrastructure development, through stakeholder engagement. The project provided a detailed physical plan of Nyagatare and other secondary cities, incorporating low emission and sustainable development strategies in line with national policies (Global Green Growth Institute, 2018c). Public space is one component of these much-needed resilience frameworks, contributing not only to climate change adaptation and disaster risk prevention but also yielding socio-economic, physical and other health benefits to urban residents. Given the geographical limitations, the

masterplan revision is promising development of defined environmental protection zones such as protected forests, wetlands, heritage zones, and steep slopes will enable accessible green open spaces for leisure, sports and other health-promoting activities. It promotes projects such as an eco-resort area, community centres, wetland parks, forest parks and neighbourhood parks defined by the detailed zoning.

4.3. Sector Working Group

The government-led Sector Working Groups aim to improve the coordination of programme development and delivery across multiple government institutions and organisations (Gubic & Baloi, 2019). The Sector Working Group on urbanisation and rural settlements is led by the urbanisation division of the Ministry of Infrastructure and World Bank. Members of the Sector Working Group are other line ministries, government agencies and stakeholders such as UN-Habitat, Global Green Growth Institute, RWN, and the University of Rwanda. One of four thematic sub-sector working groups is focusing on urbanization and public space, chaired by the Ministry of Infrastructure and co-chaired by the Global Green Growth Institute. The first meeting of the thematic sub-sector working group was held in October 2018 to ensure the programmes of actions were aligned to national priorities, as well as the identified priority areas for urban development (Ministry of Infrastructure, 2018). The second meeting was organized in July 2019 where stakeholders presented designs for planned and/or ongoing public open space related projects (Global Green Growth Institute, 2019c).

5. Case Study: Kigali, initiatives for non-motorized transportation

The updated masterplan for Kigali 2050, to be adopted in 2020, will provide corrective measures and updated direction to the urban growth of Kigali considering current trends including climate science and research. The rapid urban growth has resulted in unplanned development, increased numbers of motorized vehicles, and an increase in consumption of biomass for energy purposes. The development of Kigali as a sustainable city implies protecting sensitive ecological areas from unplanned urban growth, restoring damaged natural elements like water bodies, adopting natural resource management systems, green building initiatives, steep slope protection strategies, and the development of parks and green connectors.

Hills with prominent ridges define Kigali's topography. Unplanned developments can be found in the valleys around and within wetlands. The tops of the ridges have an average elevation of 1600 meters, while the valleys are around 1300 meters. Encroachment in wetlands is also a threat that affects both the ecosystem and human health as most of the encroachments are polluting industries. To this end, the masterplan revision recommends conserving wetlands and rehabilitating, as well as exploring nature areas for sustainable and strategic economic gains and green jobs. Rwanda Environment Management Authority and the Ministry of Environment (MoE) are conducting urban wetland mapping, restoration and design of urban wetlands as green public spaces to be used for recreation and leisure, contributing to the overall public health of city residents (Figure 1).

Global Green Growth Institute (GGGI) supported the Rwanda Environment and Management Authority (REMA) to design a project proposal to strengthen climate

resilience of the City of Kigali (1 million EUR from the Government of Italy) specifically on urban wetland rehabilitation: The project focuses on restoring the degraded urban wetland in the city of Kigali called "Nyandungu". A 130ha urban wetland will conserve wetlands and habitat for wildlife and provide walking/cycling trails, fishponds, and botanical gardens for residents and tourists. The project seeks to increase biodiversity, reduce flood risk, raise awareness on wetland conservation, create green jobs and promote tourism. The project will not only increase the resilience of the city but also have long-term benefits for Kigali citizens because it is a public asset designed to address the need for recreational public space and provide jobs. This project is under implementation.

Figure 1. Restored Urban Wetland in Kigali, Rwanda, further work is being done to transform the wetland into public open space for recreation and leisure, 2019 (Source: Oana Baloi)

In Kigali, urban development initiatives such as car free zones, expansion of roads for bus rapid transit, relocation of Industrial Parks, protection of wetlands and development of public open spaces are under implementation. The government is working on continued awareness and capacity development for urban resilience and potential projects for public and private investment. With public participation via expert discussions with communities during umuganda, for example, being a priority. Umuganda is a practice of community self-help and cooperation, reinforcing socio-economic development.

Kigali is conducting monthly car-free days promoting physical activities such as fitness, jogging and outdoor games on urban roads temporary closed for vehicles (Figure 2). The car-free days reduce 24-hour GHG concentrations in the city, which are typically five times the limits stipulated by the WHO guidelines (Kalisa, et al., 2017). The City of Kigali has designated a "car-free zone" in the city centre to reduce greenhouse gas

emission levels and encourage greater use of public space. The City of Kigali is also promoting car-free zones in other neighbourhoods in a bi-monthly event, inviting urban dwellers to spend time outside for events such as sports activities, exhibitions, and performances.

Urban Walks, an initiative piloted by Global Green Growth Institute, is organized in Kigali and Rwanda's six secondary cities with the intention of highlighting pressing urban issues to residents (Global Green Growth Institute, 2018a). Access to public open space is important to increase recreational walking: while this is commonly referenced in high-income countries, there is little mention of this in middle-income and less developed countries (Florindo, et al., 2017), hence the value of engaging citizens through this form of activity.

Figure 2. Rwandans at the Car Free Day in Kigali, a regular monthly initiative promoting recreation for public health, 2018 (Source: Ilija Gubic)

6. Case Study: Nyagatare

Nyagatare District is spread over an area of 1,741 square kilometers making it the largest district of the country by area. Although Nyagatare has recorded high internal migration toward the Eastern Province absorbing significant investment in recent years (World Bank, 2016), the city has the lowest number of companies and job creation among the six secondary cities (World Bank, 2017).

In Nyagatare, the masterplan was developed in May 2015, and conceptually covered10% of the planned developed area. The city of Nyagatare was a sparse human settlement in 1999, which has been expanding spatially at an average annual rate of 25 percent (World Bank, 2017). The unsustainable urban sprawl causes loss of high value agricultural land and natural habitat/biodiversity creating risks to urban food security (World Bank, 2017), while the growth of urban unplanned settlements constrains the

urban water supply, leading to limited sanitation and public health threats, diminishing urban livelihood opportunities, growing youth unemployment, inequality, social discontent and conflict. In Nyagatare, only 62 percent of households had access to clean water in 2017, achieved through the construction of a water treatment plant. There is a documented shortage of water and prolonged drought in five sectors of the district.

6.1. Nyagatare Masterplan Revision

The Nyagatare Masterplan revision process is aligned with the National Transformation Strategy and the District Development Strategy 2018-2024, as well as other government-led guiding documents such as National Roadmap for Green Secondary City Development (Global Green growth Institute, 2015) developed jointly by the Ministry of Infrastructure and Global Green Growth Institute.

The Global Green Growth Institute, the Ministry of Infrastructure, Rwanda Housing Authority, local authorities, and other stakeholders collaborated on the assessment of public spaces in Rwanda's secondary cities. The report titled "Mapping of Public Spaces to Inform Master Plan Review for Secondary Cities in Rwanda," (Rwanda Housing Authority & Global Green Growth Institute, 2019) was developed after assessing 36 public spaces in six secondary cities in Rwanda, through citywide surveys that informed the revision of the masterplans.

Due to recent rapid urbanization in Rwanda, public spaces could play a vital role in determining the quality of life (Gubic & Baloi, 2019). Moreover, the assessment provides information on the necessary aspects for the design and implementation of public spaces, including street lighting, increased access for people living with disability (handrails, ramps, signs), and public toilets. The assessment also underlines the urgency of including public spaces in the green city and national planning agenda.

The revision of the Masterplan aims at the development of Nyagatare as a Green City. Nyagatare is facing climate impact that is worsened by water scarcity and prolonged droughts, deforestation, but also seasonal flooding. Water management, waste management construction and transport development are key in ensuring low emissions. The masterplan promotes green mobility encouraging compact growth, transit-oriented development, and a walkable city where public space design and implementation is imperative to allow socioeconomic and resilient neighbourhood development. Population projections for Nyagatare city by 2050 place it at approximately 450,000 (Nyagatare District Development Strategy, 2018). This will require double the amount of housing and facilities, calling for an approach of densification, contrary to the current sparse development trend. In order to prevent sprawl and plan for liveable neighbourhoods with mixed typology housing options, adequate amenities, and facilities, the masterplan is introducing flexible zoning regulations that allow for incremental development. Information shared by the District during the consultation meetings suggests that the detailed masterplan provides adequate urban green space aimed at 15 square kilometres capital urban green space by 2050, urban parks within walking distance (400m) and promotes a participatory approach to planning (Global Green Growth Institute, 2019e).The masterplan also guides access to basic infrastructure to 100 percent of the population, including the promotion of recreation corridors along rivers and streams; the establishment of a hierarchy of open space systems, the rehabilitation of flood-prone areas and the development of drought hazard management. At the neighbourhood level, public space

planning can improve urban quality, social cohesion and inclusion, and encourage activities fostering public health. Participatory planning, involving communities in managing urban commons contributes to improved spatial integration, human security and resilience, local democracy and social accountability (UN-Habitat, 2015).

6.2. Implementing the Masterplan of Nyagatare

The Ministry of Infrastructure (MININFRA), the Rwanda Housing Authority (RHA), and the Global Green Growth Institute (GGGI) undertook a city-wide public space survey in Rwanda's secondary city of Nyagatare to understand the needs of citizens. Authors of this paper were representing Global Green Growth Institute in the process. The survey findings indicate that residents need safe, inclusive, and accessible green and public spaces and are willing to walk and ride bicycles to and from public spaces, and to maintain their cleanliness (Rwanda Housing Authority & Global Green Growth Institute, 2019). The city of Nyagatare hosted a two-day public space participatory design workshop organized by MININFRA, RHA, and GGGI (Figure 3 and 4). Authors of this paper facilitated the workshop. Citizens from diverse backgrounds engaged in the design process, with each group listing the main elements to be incorporated in the public space to increase resilience, support the absorption of greenhouse gas emissions, and foster public health. This approach promotes greater gender equality and socio-economic inclusion through safe, accessible public spaces for all.

Figures 3 and 4. Final design of green and public space in Nyagatare, 2019 (Source: Ilija Gubic).

The Masterplan revision of Nyagatare has benefited from a valuable contribution from the Green Climate Fund (GCF) established at United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties for accelerating access to finance for low emission and resilient development. The GCF objective in Nyagatare enables planning for urban green growth through participatory and well-designed resilient and low emission development strategies as part of the urban development plan guiding

both public and private investment. Due to the need to green the spatial development guidance frameworks in Rwandan cities, GGGI, which is the delivery partner of REMA in implementing GCF projects, has been invited to contribute to the revision of the master plan for all six secondary cities. This shows that the Rwandan government acknowledges the need for green urban development, but also exposes the reliance Rwanda currently has on external funding for these innovations (Global Green Growth Institute, 2018c).

The Ministry of Infrastructure, Rwanda Housing Authority and the Global Green Growth Institute in partnership with the Rwanda Women's Network undertook citywide public open space survey in Nyagatare (and other secondary cities in Rwanda) to better understand the needs of citizens for public open spaces as well as what facilities and utilities these spaces should include (Rwanda Housing Authority & Global Green Growth Institute, 2019). Most of the surveys were conducted close to the market, school, and border crossing with the Democratic Republic of Congo in Rubavu, all of which are known for their vibrant social scene. The distribution of responses across the city is largely uniform.

The surveys were conducted between August and November 2018. The survey was accompanied by a short training session by Global Green Growth Institute staff to surveyors with background information about the project and the types of questions that surveyors might receive. All respondents were asked if they consented to the survey before being asked the first question. The face-to-face surveys were designed to cover more than one theme and included 20 multiple choice and open-ended questions (Global Green Growth Institute, 2018b). Following these processes, the city of Nyagatare hosted a two-day public space participatory design workshop organised by the Ministry of Infrastructure, the Rwanda Housing Authority, and Global Green Growth Institute (Global Green Growth Institute, 2019d). Local authorities assisted with site identification by analysis of land ownership and masterplan and defined the boundaries of the public space: the selected areas belong to the central government and are surrounded by public buildings and commercial areas that would benefit from well-maintained public space. These surveys followed stakeholder consultations facilitated by Global Green Growth Institute in preparations for the Huye, Nyagatare, and Rubavu DDSs 2018–2024, where public spaces were identified as one of the priorities to support sustainable urbanisation. The initial survey results indicated that Huye, Nyagatare, and Rubavu residents were in favour of safe, inclusive, and accessible green and public spaces and would prefer spaces with child-friendly playground.

The main climate change impacts in Rwanda are drought and floods. In drought-prone areas similar to Nyagatare, studies show that despite the fact that properties close to well-maintained green public open spaces are valued 10% higher, in times of drought irrigation of green public space is subject to restrictions (Fam et al., 2008). In Nyagatare, the area assigned for the city's public space is part of the water management system, containing drains. These facilities can integrate multi-layered approaches to urban systems, combining public space design with urban water management. For example, through the creation of retention ponds, the water runoff from slopes is reduced while the presence of water can be used for design purposes and for irrigation. In the context of Rwanda, where rapid urbanisation is resulting in densification, thus reducing the residential garden size, there should be public gardens and open areas for both water management and public space. A study comparing 'business as usual' with an innovative

irrigation system showed that the use of locally sourced, untreated water was more efficient for irrigating community gardens, public parks, and recreational landscaping if the neighbourhood was designed in a water-efficient way (Dhakal, Syme, Andre, & Sabato, 2015). In implementing Rwanda's urban agenda to enable green public spaces to add economic value to the neighbourhood, multi-institutional cooperation is required as well as water-efficient neighbourhood design.

The public space design workshop in Nyagatare mobilised citizens from different backgrounds to engage in the participatory design process, with each group listing the main elements that should be incorporated in the public space to ensure they do not affect the functioning of the existing ecosystems. The participatory design included a 'live' advisory session where all participants reached a consensus on where the public space design elements should be located within the site (Global Green Growth Institute, 2019d).

In Nyagatare, although the DDS refers to resilience in terms of agricultural production, in an urban context, the masterplan revision process defines resilience in terms of actions at the household level (such as rainwater harvesting systems), in construction and building (through the promotion of green building codes), water management systems and public open spaces that can be used for improving climate resilience. For example, in Nyagatare, public open space, coupled with agroforestry and water management, can support water retention for longer periods and its use for community gardens and public space maintenance, important in particular during the prolonged drought periods (Dhakal et al., 2015). The allocated site for public space is part of the proposed city-wide resilience infrastructure that could include a series of open spaces (Parker & Simpson, 2018), water and infrastructure works, and a green network linking the peri-urban ecosystems with urban green areas. While supporting increased resilience, the public spaces will also support the absorption of greenhouse gas emissions (Andriono, Hanafi, & Yanuwiadi, 2013) and so reduce the heat island effect, improving microclimate and regulating temperatures in particular in the dry season. At the same time, this approach promotes gender equality and socio-economic inclusion through safe, accessible public spaces for all.

7. Conclusion

The Rwandan government works on implementing initiatives to tackle environment-related public health risks. With increasing urbanization, the reduction of GHG emissions remains essential. Government entities are working to implement electric mobility, Bus Rapid Transit, restoration and design of wetlands as green public open spaces, and the revision of the masterplan for Kigali and six secondary cities to respond to climate change realities. Masterplanning provides entry into urban spatial and transport planning, development, and landscape design, including city extensions and renewal across neighbourhood, city wide, metropolitan and district scales. The masterplan revision also creates momentum for improving health. A healthy urban planning practice requires: codes and regulations in the construction sector, which Rwanda is proactive in developing; planning standards which are defined by the masterplan revision as a guiding framework for Kigali and secondary cities; periodic public open space activities organized by communities and city leaders; and public space participatory design which the Global Green Growth Institute promotes. Design

guidance and regulatory frameworks are yet to be incorporated in the urban landscape of Kigali and secondary cities, while the efforts of different agencies to protect and enhance public health are not being well documented in relation to urban planning.

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The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

VIEWPOINT

Falling through Space. The gap between public art /new infrastructure and the displaced natural environments

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Figure 1. *Ponds Dreaming*. Art work by Jill Chism (Sydney, 2011-2014).

As an artist, whose involvement with creating art in public spaces now spans 19 years, one of the key issues I have is with how to link public art (mostly incorporated in new public infrastructures) with the natural environments and prior histories that the artwork and infrastructure have displaced. My aim is always to address the importance of the balance between nature and culture. The way in which our relationship to nature and the prior histories of a 'site' are translated, depends foremost on the nature of the commission and its location. Variables related to the commissioned artwork may include the following:

- It is tacked on to an already built structure

- It is allocated to a specific site within an existing architectural plan
- The artwork and infrastructure are created in collaboration between artist and architect
- In rare cases the public work is impermanent (e.g. the case of Great Walks – Art and Environment 2006).
- The artist is given full control either by a self-created event – as with 'Call of the Running Tide' – Environmental sculpture and multimedia event in the Douglas Shire in September 2019, or through a rarely received creative fellowship such as 'Waters Edge – Creating Environments' 2007 -2010

I will now elaborate each one of these variables. Starting with the situation where the commissioned artwork is *tacked on to an already built structure.* An example of this is my commission for an entrance sculpture for the new Marlin Coast Neighbourhood centre, 'Sharing' (Figures 2 and 3). An essential aspect of this work was that it created a space where visitors could gather and converse. However, the central theme of this work is the question of ecological imbalance created by the making of the new suburb of Trinity Park. One of the fallouts of development was the large amount of cleared land. In this work I researched the types of trees that were being replaced and using reflections text and images of fallen leaves, I reminded viewers of our relationship to the natural environment, the histories of the site and the nature/culture conflict that is inevitable with development.

Figure 2. *Sharing* at the Marlin Coast Neighbourhood Centre, Digital Art Glass Reflective Stainless-steel panels wood and polished stainless steel, 2011 (Source: Jill Chism).

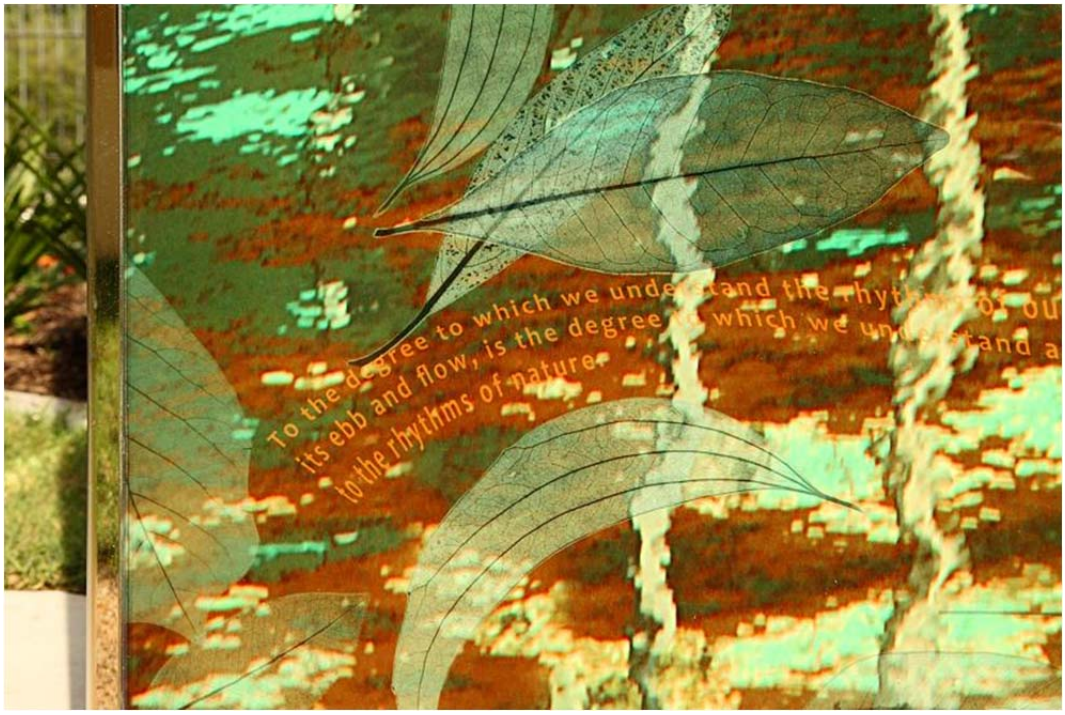

Figure 3. Detail of *Sharing* at the Marlin Coast Neighbourhood Centre, Digital Art Glass Reflective Stainless-steel panels wood and polished stainless steel 2011 (Source: Jill Chism).

The next variable refers to the artwork being allocated to a *specific site within an existing architectural plan*. A new visitors' centre was required for the Cairns Botanic Gardens and Tanks Art Centre in 2011(Figures 4 and 5). At this point there was significant concern and public debate about what the building complex *should* be. The new precinct was mooted at the crossroads of an approach to architecture in Cairns. Many strong community voices vied for a traditional approach derived from existing local architecture, specifically 'The Queenslander'. Another set of voices felt that any set of buildings in a natural environment would create unnecessary disruption to nature. I was already using digital art glass in my public artworks and working with transparencies, reflections and texts as a way of both reminding us of the surrounding natural environments and posing questions for the viewer about their relationship to nature. To solve the question of the centre's intrusion into the surrounding environment, the architect opted for a fully reflective building, which complemented my current use of materials. However, greater use of reflective materials formed another departure point for me as I then went on to create numerous works where the sculptures were dissolving, reflecting the sky and surrounding natural environment, or where natural elements from the site were deliberately incorporated through large layered photographs. Examples of this are 'Ponds Dreaming' at the centre of the Ponds community in Western Sydney, 'Sharing' at the Marlin Coast Neighbourhood centre in the Northern Beaches of Cairns, and 'Reflections on a Blue River' in Mackay for the hospital entrance ceilings. The latter work is based on images of the Pioneer River, which runs from the sea through the city to the hospital.

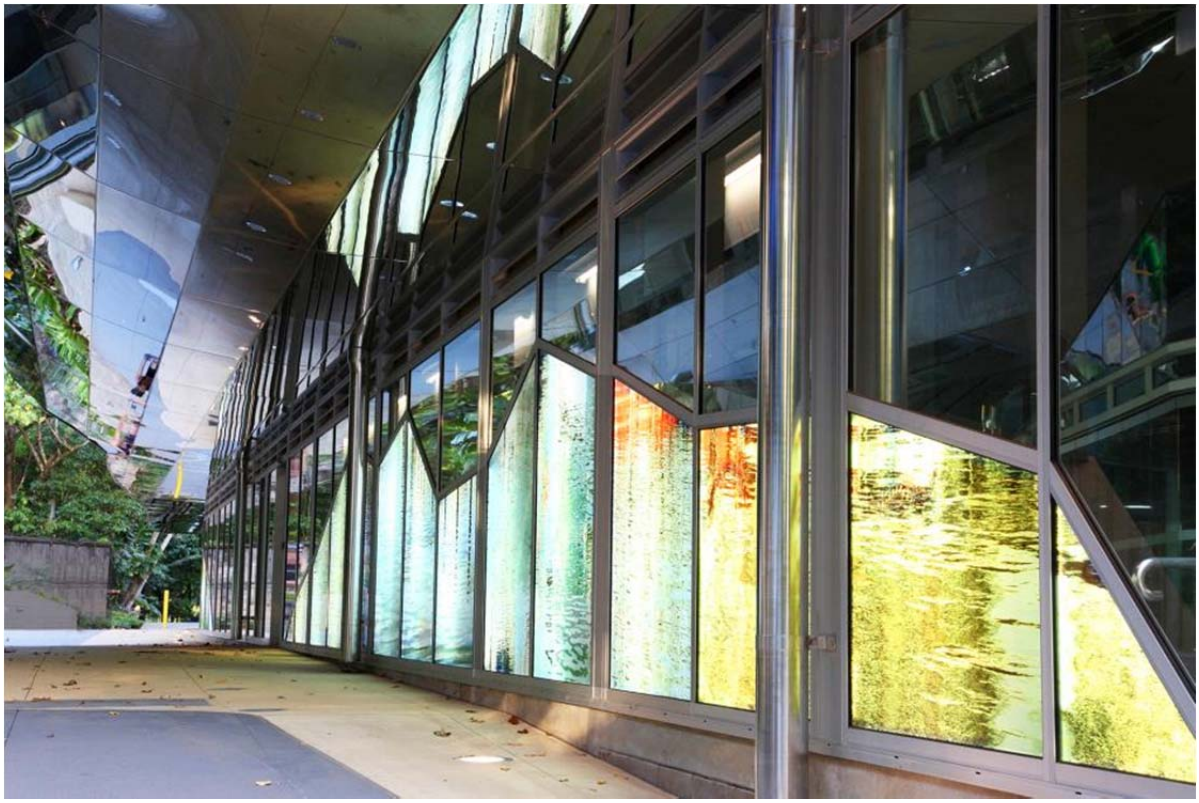

Figure 4. *Reflections from the Tanks* Cairns Botanic Gardens Visitors Centre. Digital Art glass and LED panel lighting (2012). (Source: Jill Chism)

Figure 5. Detail of *Reflections from the Tanks* Cairns Botanic Gardens Visitors Centre. Digital Art glass and LED panel lighting (2012). (Source: Jill Chism)

The *artwork and infrastructure can also be created in collaboration between artist and architect.* From 2016 to 2018 I created a collaborative work in Darwin with Liquid Blue, Architects and in particular with Daniel Hahn. As the commission involved the reconstruction of the Parap Pool, the theme 'Under the surface' (Figures 6 and 7) was the bodies interaction with water[1]. The final entrance sculpture and 70 linear meter facade melded art with architecture.

[1] See https://www.jillchism.com.au

In addition to adopting the use of 'Pic Perf' or perforated aluminium, I also used reflective materials and glass while merging the zig zag formation of the façade with the motion of an ocean wave to create the entrance sculpture. The finished artwork and building are particularly striking because both artist and architect were committed to the best possible outcome.

Figure 6. *Under the Surface* Parap Pool Darwin, Digital Art Glass, Pic Perf, Dibond reflective panel (2018). (Source: Jill Chism).

Fugure 7. *Under the Surface* Parap Pool Darwin, Digital Art Glass, Pic Perf, Dibond reflective panel (2018). (Source: Jill Chism).

There are also some rare cases where *the public work is impermanent*. In 2006 the Environmental Protection Agency EPA in league with Queensland Parks and Wildlife decided to open up a number of 'Great Walks' along the Queensland Coast. I was the artist nominated for the 'Wet Tropics – Great South Walk' from Wallaman Falls to Henrietta Gate 56.8km, known as the 'Jagany' (goanna) walk. A unique public art experience, this commission was called 'Marking Time' (Figure 8), and opened the possibility for me to create ephemeral work and create poetry from the experience of undertaking the walk. The final work integrated the parks and wildlife map with topographical maps of the area, photographs of the experience and poetry created during the walk.

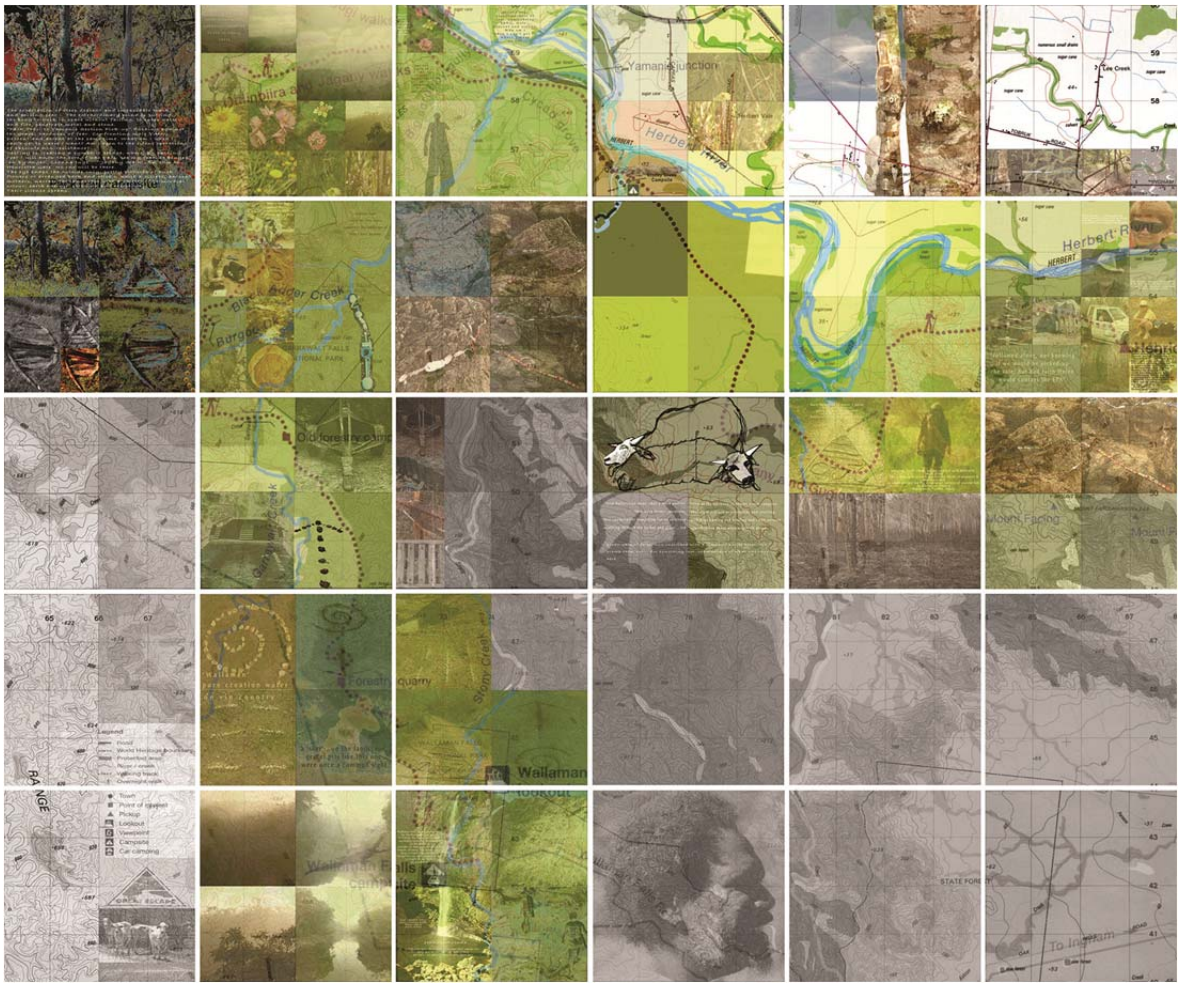

Figure 8. Detail from *Marking Time* currently in the Powerlink collection in Brisbane, Australia. Digital Art, Photographs and drawing on paper 2.4m x 2m (2006) (Source: Jill Chism).

From the poem 'Walking in space without falling' – accompanying final exhibition at Queensland Arts Council, and toured regional galleries in Queensland (Queensland Parks and Wildlife Service, 2006) – I have included an excerpt, which elucidates how foreign we actually are to a more primal connection with the natural environments around us, as experienced by the Warrgamay, the traditional owners of the area:

> *'Walking through the unfamiliar with openness to the moment, not absorbed by the mundane/(everyday), offers a way through the mysterious pass.*
> *Sorry thoughts of separation (…) the Warrgamaygan's separation from their people taken to Palm Island. My separation is from the rawness, bluntness of the bush: roars and screeches of feral bulls/clean-skins, the possibility of crocs, while here with the breathing earth, swaying trees and silences.*
> *My incarceration is the built structures cluttered by daily habits and chores: calling my life. It is the insulated environment, leather couches and concrete walls, career and expectations dividing my space from this unenclosed one with which I am unfamiliar.'*

My approach to the *Great Walk* as a metaphor for our life's journey was 'informed by the Eastern meditative practice of using mindful walking as a tool to still the mind and develop awareness. The idea of the environment as a historical narrative offered the possibility of potent insights from the past including the stories of the Warrgamaygan people (Queensland Parks and Wildlife Service, 2006).
The last possibility is that *the artist is given full control* either by a self-created event or through the rarely received creative fellowship. Recently, in 2017, I created *Call of the Running Tide*, an Environmental Sculpture and Multimedia event which culminated in a 10-day festival in the Douglas Shire in September 2019. The event involved four venues, 28 artists and over 150 performers. As a lauded event in a region that encompasses world heritage listed rainforest and close access to the Great Barrier Reef it evidenced public recognition of the need for art events that highlight current local and global environmental issues. This event has set the precedent for a biennial 'Call of the Running Tide' festival, with the next festival in September 2021. Figure 9 below shows my piece.

Figure 9. *New Wave* 7m x 2.8m x 3.6m Marine Debris on armature (2019).
The work both indicates a wave and the skeletons of large marine animals. (Source: Jill Chism).

This event builds on the experiences of 'Waters Edge – Creating Environments' (2007-2010), an interregional event I created as a result of a creative Fellowship from Arts Queensland[2].
Both events abovementioned were and are highly satisfying in that they involved responding to various sites in the natural environment, while drawing attention to local environmental issues. Here art and environment are directly entwined. In these public art events, the artists and participants have '(taken) only photographs and (left) only footprints' (Queensland Parks and Wildlife Service, 2006).
In conclusion, there are projects, such as 'Great Walks - Habitus Habitat' and the self-created festival above – 'Call of the Running Tide' – where art and artist directly respond to natural environments. In these cases it is the artists' role to draw attention to our connection as organic beings while communicating the impact of human habitation. There is an expectation that public artworks are long lasting (10 years has been mooted by various employees of Arts Queensland). However, due to the poor quality and material constituents of discarded and recycled materials along with the expectations of the various clients, my solution has been to predominantly use poetic sayings and illusory material that reflect the surrounding landscape environments and the changing skies back to the viewer. There is a sense that the sculptures are partially dissolved drawing our minds back to what is important: that primary connection we have to earths' ecosystems and natural environments.

Reference

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To cite this article:
Chism, J. (2020). Falling through Space. The gap between public art /new infrastructure and the displaced natural environments, *The Journal of Public Space*, 5(2), 147-154, DOI 10.32891/jps.v5i2.1289

This article has been reviewed and accepted for publication in *The Journal of Public Space*.

[2] 'Waters Edge…' catalogue available for download at https://envart.jillchism.com.au

The Journal of Public Space
ISSN 2206-9658
2020 | Vol. 5 n. 2
https://www.journalpublicspace.org

VIEWPOINT

LEARNING the City: Beyond the Urban Diary

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Figure 1. Personal and unique experiences of public spaces (Photo: Charles R. Wolfe).

My viewpoint towards understanding cities is ecumenical and immersive. We all experience urban life, and have associated expectations, however simple or complex. In democracies, informed representatives are said to advance the needs of their constituents. Basic human needs are similar, but how they are expressed and sorted in a chosen location are not, so places will vary based on blends and mixtures of expression. To understand the particulars of a city, we must understand associated and customized needs, as well as opportunities to provide them.

Achieving public health, safety and happiness will vary. Solutions may be similar, but not the same, and we need to understand—to see and feel—what these solutions, or 'context keys', look like from place to place. When considering customized 'context keys' for cities

today, we must understand how each city or urban place varies from broad stereotypes. We should avoid one-size-fits-all solutions without community input.

Although not conclusive in themselves, the initial stages of *looking* and *exploring* are particularly important, which I addressed many times through articles and my first two books on the importance of urban observation, *Urbanism Without Effort* (Wolfe, 2019) (UWE) and *Seeing the Better City* (Wolfe, 2017) (SBC). These stages jump-start discussions in a meaningful way, and they are necessary stepping-stones to further discussion and solution.

UWE set out the universal, naturally-occurring fundamental and historical relationships between people and cities and argued that these relationships should be better understood before undertaking planning and development. UWE introduced the "urban diary tool" as one approach to document these relationships. SBC expanded the urban diary tool and advanced the related "LENS Method" for urban observation and data-gathering (**L**ook, **E**xplore, **N**arrate, and **S**ummarize). SBC further advocated a more significant visual dialogue to supplement existing municipal land use and historic preservation processes.

In June, 2018, I joined an initiative to apply my thinking to a public health and climate-based Fulbright Specialist residency in Far North Queensland, Australia. There, a team based at James Cook University's Cairns campus convened a two-session UN-Habitat's World Urban Campaign "Urban Thinkers Campus"[1] in Cairns and Townsville (Figure 2). The Campus was—to my delight—designed around the LENS Method (Look, Explore, Narrate and Summarize) and urban diary tool set forth in my initial books (2017, 2019), and stressed not only the contextual distinction of Cairns and Townsville from the settings of other Australian, European, and American cities, but also how planning and design to address public health issues must also vary within the tropical climate zone.

Figure 2. James Cook University 'Urban Thinkers Campus' in Cairns, Australia (Photo: Charles R. Wolfe).

[1] https://www.worldurbancampaign.org/urban-thinkers-campus-city-we-need

The Role of the Urban Diary

Between 2011 and 2018, I found the LENS Method and urban diary tool an easy sell, and it became a *de facto* testing ground for approaches to co-creation and alternatives to conventional public hearings and participation methods. I often touted the urban diary as a means to empower and allow many previously disaffected urban inhabitants to overcome the prescriptions of consultants and indiscriminately borrowed quick-fixes to perceived urban ills. It noted that many were already creating urban diaries through Instagram and Facebook postings, recording what they see, and what they like or dislike, about the cities they inhabit. I argued that we should take these postings a step further.

I suggested how urban diary information could be applied in a flexible fashion, to become more mindful about urban surroundings and better approaches to urban redevelopment. In setting the stage for the Cairns and Townsville campus sessions, I argued the urban diary as an inclusive alternative to abstract, top-down prescriptions by enabling diverse contributions to urban decision-making. I quoted Vancouver planner Yuri Artibise, who kindly argued the urban diary could "reintroduce the human experience into urban planning." If applied in more than a single-instance session, I still believe in this sentiment, however, as discussed below, I have determined that this jump-start tool needs elaboration to be effective and is not always understood by those who could most benefit by its application.

What Happened in North Queensland

Our Urban Thinkers Campus team promoted the urban diary tool to enhance personal observation, increase individual awareness, and create positive urban change, which provided the fundamental basis for understanding the context of Cairns and Townsville through a local lens. Campus sessions enabled a broad range of local participants to first identify current behaviours, reflect on how planning and design impact public health in their cities, and to suggest locally relevant planning and design improvements through the urban diary tool, premised on the importance of local history, values, and knowledge.

Before the Urban Thinkers Campus took place, organizers provided written guidance and sought input through urban diary photography (and short narrative) from citizen, professional, governmental, and academic participants. Participants were asked to submit imagery that showed successful methods for offsetting the effects of heat and humidity in the urban environment. The provided guidance advised that participants take and caption photographs of their surroundings, noting how the urban environment in which they reside impacts public health and liveability in both a positive and negative sense. Many actively contributed and described their photographs to designated Facebook groups and email addresses.

The organizers were clear through promotional materials and post-event summaries to offset any stereotypical imagery or assumptions of tropical "paradise" settings, as the goal was not to brand or serve as touristic assumptions, but to focus on relevant public health solutions. While advance participation was not uniform among participants, many urban diary submittals were successful in showing relevant examples to be emulated, including shade trees, attention to canopied commercial frontage, walking paths shielded from the sun, and outdoor playground lighting and equipment that encouraged park use at night. These solutions suggested that urban diary photographs provided locally-sourced inspiration applicable to the affected culture and character of Cairns and Townsville. In

general, the urban diary tool helped participants frame context with photographs and short narrative, noting how urban design in Cairns and Townsville affects the health of residents within these tropical cities. Participants had the opportunity to experience the value of local and specific visual feedback about health impacts to urban planners, even among those who seemed more intent on presenting from their own professional perspectives.
Another positive development came from parallel efforts that worked in tandem with the qualitative results from the Campus. In one example, consultants and James Cook University faculty monitored temperatures in various Cairns locations in search of heat islands. These areas were often coextensive with urban diary photographs showing an excess of pavement. They became candidates for urban greening, contextual application of new shade trees to offset the effects of high temperatures. Cities around the world, such as Paris, are adopting similar approaches aimed at reducing urban carbon footprints.
However, local government representatives, consultants and interest groups sometimes confused what was a highly contextual climate and health-based agenda with more conventional statements of issues of equity, generic urbanism (e.g. nonspecific walkability and bicycle use), civic branding exercises, and professional promotion. Certain presentations by public health professionals and council staff seemed more motivated towards sharing their own data and initiatives without integrating them with the observation component that was intended to jump-start the Urban Thinkers Campus.
Despite the framing effort around visual examples from each city, some participants seemed to ignore local context in favour of a one-size-fits-all, "feel good" urbanism. One generic presentation did not account for local climate conditions and emphasized walkability and bicycle transportation modes as universal solutions. While the presentation was inspirational, it was arguably inconsistent with the focus of the Campus: to find place-based solutions for the local tropical conditions of extreme heat and humidity
How might the urban diary tool have fulfilled a more complete role, consistent with my earlier writing and advocacy? Future applications of the urban diary tool might also consider even more detailed suggestions for each contributor to think about the visual aspect of current urban life and governance as they relate to more focused topics at hand, e.g., walkability principles relevant to even more hyperlocal locations and situations, such as particular street, park and block level definitions. Also, a more resounding acknowledgment may have resulted from a longer-term integrated approach less focused on one-day events, featuring the more patient immersion and sustained listening coupled with the use of the urban diary documentation as part of ongoing initiatives undertaken by Councils, staff and/or developers.
This revelation motivated me to develop the more expansive LEARN approach as a complement to the LENS Method. Stakeholders must **L**ook, **E**ngage, **A**ssess, **R**eview and **N**egotiate (LEARN), an immersive process that is the subject of my third book, *Sustaining a City's Culture and Character* (Wolfe, *forthcoming*). The LEARN process involves a coordinated inquiry beyond the physical observation emphasized in *Seeing the Better City.* LEARN frames the pending book's substantive chapters, which recommend first isolating the multifaceted look and feel of local context, understanding the differences between global and local forces that impact urban areas today, and only then developing customized approaches to sustaining the culture and character of a particular city or urban place.
Each step in the LEARN process invites creative observation and listening, exchange, and respect. The process underscores the importance of compilation and analysis before

outcomes can be meaningfully "negotiated." The elements of LEARN are as follows (see also Figure 3):

STEP 1—Look: Watch, see, view, roam, stroll, capture
STEP 2—Engage: Immerse, involve, participate, undertake
STEP 3— Assess: Amass, assemble, compile, gather, examine, consider, investigate
STEP 4—Review: Reflect, dissect, appraise, evaluate
STEP 5—Negotiate: Discuss, debate, decide, determine

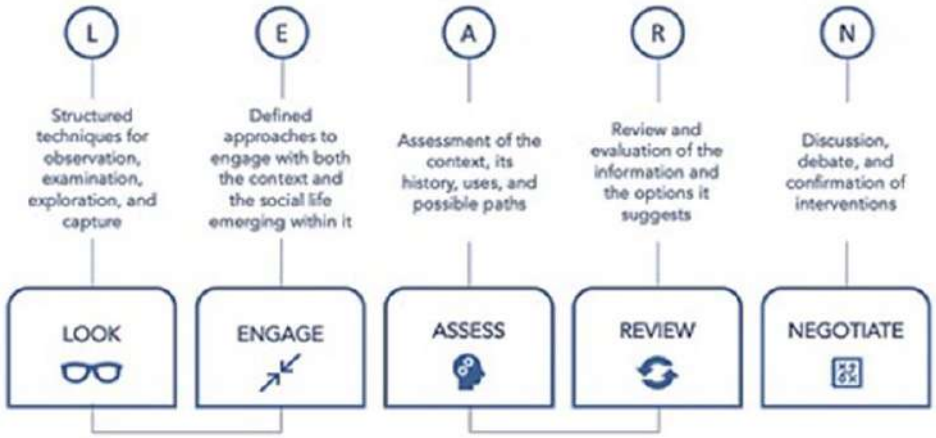

Figure 3. The LEARN process (Source: Charles R. Wolfe).

Undeterred by critics of a holistic view, LEARN offers an overarching approach to understanding urban culture and character, to highlight ways to figure out, explain, settle, decipher, decode, interpret, unravel, determine, clarify and/or define.

Perspective

In a tropical urban environment, liveability challenges are already considerable, and climate change drives concern with the most basic elements of habitation. The most basic issue for governments may be how to sustain the foundational element of liveability, to provide survivable conditions for those who live there. Neither living entirely underground or in conditions completely dependent on air-conditioned environments will prove sustainable, and the urban diary approach suggests that residents' simple observation of a range of solutions may be the most foundational and helpful.

While urban diaries are a good starting point, as explained previously, they are not ends in themselves, and although the Urban Thinkers Campus in Cairns and Townsville may have shown their initial utility to envision, solutions, the Campus did not entirely integrate what I now term the "look and engage" stages with the "assess, review and negotiate" elements that are also necessary under LEARN to advance the context of a place (in this case two Australian tropical cities) to the next level of sustainable identity.

To do so will require a more well-considered identification of actors and constituents over time, in a more integrated way. Even though the Campus was a good start, a truly co-

created approach cannot be achieved by single-meeting input sessions. Input from those with a range of local life experiences must be balanced against professional motivation. In any process seeking to blend so many perspectives, there are words and concepts that matter. Words like "special," "adaptable," and "appropriate" suggest contextual thinking and analysis that must follow from initial urban diary observations. Words alone are not enough, but neither are urban diary photographs. They must be combined to result in specific plans and programs that achieve articulated goals.

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To cite this article:
Wolfe, C. R. (2020). LEARNING the City: Beyond the Urban Diary, *The Journal of Public Space*, 5(2), 155-160, DOI 10.32891/jps.v5i2.1288

This article has been reviewed and accepted for publication in *The Journal of Public Space*.

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The Journal of Public Space
ISSN 2206-9658
Editor in Chief Luisa Bravo
City Space Architecture
Italy

https://www.journalpublicspace.org

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UN HABITAT
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