Weather perception in urban public spaces:
Soho Square, London, case study

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ABSTRACT: Urban public spaces play a very important role in cities, as they fulfil our need for socialisation, play, contemplation and exercise. This paper explores the relationship between weather conditions and the use of urban public space, using Soho Square in London as a case study. Data recorded over one year from on-site measurements, interviews and observations were processed. The results show a strong correlation between microclimatic conditions and the number of people staying in that space. Specifically, air temperature was the determining factor in outdoor comfort, although interviews and observations revealed that in some cases, subjective factors were more relevant. Located in central London, Soho Square is a very active and diverse site used by different groups of people: workers, neighbours, visitors and tourists. Thus, the study investigates the different roles the square plays for these different groups and the impact of weather on their comfort.
Keywords: Outdoor comfort, public spaces, urban microclimates, field study, perception

INTRODUCTION

Cities, people and climates are intrinsically related. All three influence one another, creating multiple situations distinctive of urban life. The built environment and anthropogenic activities influence the climate by modifying energy exchanges in the atmosphere. Weather conditions and human actions create different images within a city at every moment. Moreover, people's actions and perceptions are influenced by their built and climatic environments. It is therefore consistent to say that cities are formed by these three interrelated elements. Indeed, for public life to happen, a specific social, built and climatic environment is needed. The following study aims to test the previous statement and understand how environmental conditions influence the use of urban public spaces.

DESCRIPTION OF THE STUDY

This field study was undertaken in Soho Square, London. This square is located in the heart of Soho, a designated conservation area with dozens of listed buildings. Soho Square constitutes the most important public space serving the surrounding community. People living in the area and working in the numerous offices around the square use it as a natural space for relaxation and leisure. In addition, the square attracts many tourists due to its historical and cultural values. As a result, Soho Square remains a very active cosmopolitan hub throughout the day and the year.

The study analysed and evaluated the built, climatic and social environment of the square to find linkages and correlations that could shed light on the understanding of how urban spaces work. The main body of the study was carried out as fieldwork data collection in relation to the morphology, climate and people-use of the public space for 50 days distributed over one year. Data were always collected between 11 a. m. and 12 p. m. Collection started in January 2012 and continued throughout the year until January 2013. The square's morphology, temperature, light levels, humidity and air movements, as well as observations about the use of the space represented the main parameters of the study. The use of the space was categorised by the number and length of stays for people in the square. In addition, the observational work was complemented by interviews to better understand citizens' environmental perceptions.

By connecting the morphology of the square, the environmental values and the characteristics of people that decided to stay in the square, the study aimed to understand the relationship between the environment and the use of public space.

OBJECTIVE AND SUBJECTIVE FACTORS

The study combines objective and subjective indicators to better understand the relationship connecting a built environment, climatic conditions and citizens' actions. *Objective indicators* are those that can be measured and categorised such as density, width-to-height ratios, materials, circulation, sitting areas, activities, sky view factors, solar access, wind patterns, and on-site measurements.

On the contrary, the *subjective dimension* of an environment cannot be categorised or described by a short list of key variables as the morphology or climate of a region or city might be described. As cognitive geographers [2, 6] and environmental psychologists [5] have illustrated, the environment means a lot of things to a lot of people. Buildings, landmarks, routes and meeting places have very different meanings and significance for different groups [2].

Although different people perceive the environment in different ways, it is important to take greater note of these differences. In fact, physical factors are important, but they can have no invariant or 'objective' status and can only be understood in the light of their meaning for people's lives—which in turn is determined by social and cultural values [1].

This study has analysed subjective parameters through continuous observation and interviews. These parameters were the number of people or groups that stopped and stayed in the square, the length of those stays, the specific places people chose to sit, the reasons for stopping at Soho Square, the reasons behind choosing a particular seat, and finally, the comfort level people felt in relation to the climatic conditions. By translating subjective parameters such as the decision to stay in a particular place into measurable data, it was possible to correlate both objective and subjective indicators.

THE BUILT ENVIRONMENT

Soho constitutes a high-density area of London, with narrow streets about 16 metres wide. There are few open public spaces in the neighbourhood and even fewer green areas. Soho Square is the only open-to-public green park within a 500-metre radius, with Leicester Square being the closest park.

The square is divided in two areas: one enclosed green space of approximately 5,000 m2 and a street for pedestrian and vehicular traffic that is approximately 18 metres wide (Figure 1). Both areas are divided by a metallic fence and connected by four gates located in the middle of each. The distance between the buildings facing the street is 100 metres, and their height varies between 14 and 25 metres. The resulting width-to-height ratio is between 7:1 and 4:1.

The area considered for this study is the enclosed green space of 71 by 71 metres. This area is divided into two levels. The lower level is mostly covered with grass and surrounded by benches along the borders, while the upper one is paved with concrete tiles and holds benches in its central part. The upper level is also the scenario for seasonal activities promoted by local authorities such as table tennis or piano play, which are available for free to park users.

At first sight, the greenery appears to be the most important element of the square. The square is covered with two kinds of pavement: concrete tiles and vegetation. Although vegetation completely dominates the pedestrian view, the percentage of vegetated surface is only 60%; hard pavement accounts for approximately 40%.

Figure 1. Rendering of Soho Square and the surrounding urban fabric.

The park contains some significant elements that configure its particular character. First, there is a distinctive half-timbered gardener's hut at the centre of the garden where the main paths cross. Due to its location, it dominates the view for everyone entering or passing through the park. Second, several sculptures are scattered across the square. Third, several groups of trees dominate the visual perceptions of pedestrians due to either their enormous size or their exotic origins.

THE CLIMATIC ENVIRONMENT

Located at 51.5˚ latitude, London has a temperate oceanic climate characterized by chilly to cold winters and warm, occasionally hot summers. The high variability of London's weather throughout the year makes the city a good laboratory for investigating the relationship between weather and the use of urban space.

In winter, average temperatures are between 2.7 °C and 11.6 °C. Temperatures rarely fall below -4 °C or rise above 14 °C. Snow usually occurs about four or five times a year, mostly from December to February. In terms of sunlight, January is the darkest month, with only 44.7 sunshine hours [3]. Summers are generally warm, sometimes hot, with an average maximum temperature of 23 °C. On average, there are seven days a year hotter than 30 °C. August is the sunniest month of the year, with an average of 186.1 sunlight hours [3]. Spring and autumn are mixed seasons with high variation.

Wind occurrence is greatest during the winter half of the year, especially from December to February. According to London's Met Office, wind comes predominantly from the southwest [3]. However, wind in urban areas is highly sensitive to urban morphology and local topographic effects.

As part of the fieldwork, temperature, humidity and wind speed measurements were taken at a specific point of Soho Square on a regular basis. These measurements were recorded for 50 different days between January 2012 and January 2013. Data were always recorded between 11 a. m. and 12 p. m., avoiding daily peak temperatures. Average temperature from these measurements was 11.3 °C. Out of these 50 days, 22 were sunny and 28 were cloudy. Humidity was always above 45% with an average of 70%, and wind direction was predominantly southwestern.

The climatic analysis of Soho Square was complemented by computational simulations of microclimatic conditions using Ecotect and Envi-met software.

According to these simulations, the square's north corner receives the most sunlight, with an average of around 5.5 hours per day. The sky view factor at Soho Square varies between 0.00 below the trees to 0.61.

Wind speed and flow through the square was simulated using Envi-met software. Maximum wind speed was 5.50 m/s and found at the southwest and northeast entrances to the square. According to computational simulations, wind speed through the park flows calmly with an average speed of about 2 m/s. Wind direction analysis showed some turbulence points on the south and southeast corners formed by the buildings and on the street entries along the southwest-northeast axis. Over the observation period for the square, no wind turbulence areas were detected.

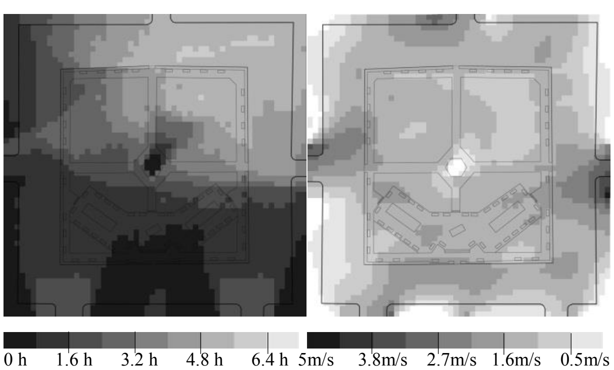

Figure 2: Annual average daily number of sun-hours (left) and wind speed (right) patterns using a grey scale. Dark areas represent fewer sun hours in the first diagram and higher wind speed in the second.

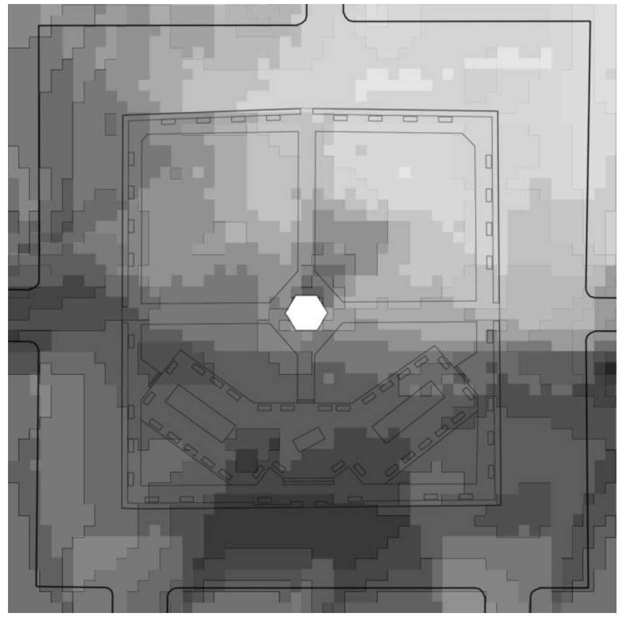

Figure 3: Annual combination of sun and wind patterns in a grey scale.

According to existing literature, solar access and wind speed represent the most important factors determining outdoor comfort. Considering London's climate, sunlit areas with calm air flow will propitiate the most comfortable spots in the square. The methodology used in this study is based on the simplified analysis and representation technique developed by André Potvin for assessing the microclimatic impacts within existing urban fabrics [4]. Thus, a combination of solar access mapping and wind flow patterns was generated to identify the most climatically comfortable areas in the square. Figure 2 shows those sun hours and the wind speed mapping being converted into the same grey scale. In both diagrams, dark colours correspond to uncomfortable spaces, while light spots identify the most comfortable ones. The combination of both graphs generated the graphical annual microclimate rating. Figure 3 shows the nine-tone grey scale rendering of the annual microclimatic performance of the square.

THE SOCIAL ENVIRONMENT

During the fieldwork, people's movements and actions in the square were observed and documented. Observation became a fundamental tool for understanding and evaluating the functions of the square. It not only complemented the analytical studies but also translated them into the social realm that cities are.

Observational data gathering occurred between 11 a. m. and 12 p. m. to keep other influencing factors on people's use of the space derived from the time of the day constant. Specifically, the study recorded (a) the number of people who stayed in the square during the data gathering time; (b) the amount of time each person or group of people spent at Soho Square; and (c) the spaces people occupied while staying in the square.

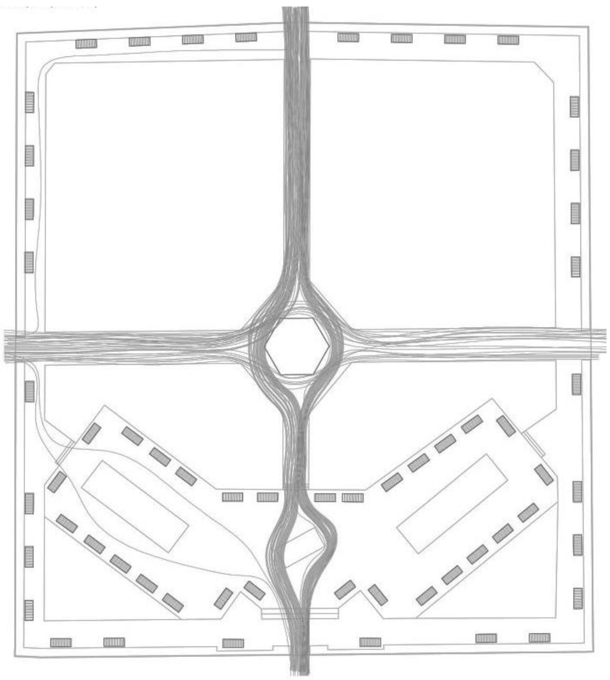

Figure 4: Diagram of pedestrian circulation. Each line represents a trip through the square. Grey rectangles indicate benches locations.

Pedestrian circulation through Soho Square was very high. Figure 4 shows the flow of people through the square between 10:35 a. m. and 10:45 a. m. on Nov. 23, 2012. Each line represents the trip of one person or group through the square, for a total of 81 people or groups of people circulating through it in 10 minutes. The main path followed was the north-south axis connecting Oxford Street and Soho. Seventy-eight out of these 81 people crossed the square through the middle point. This pattern of circulation allows plenty of space for green and sitting areas and, at the same time, increases the safety feeling for people staying in the square, as it does not leave any part of the square out of the sight of pedestrians.

Through continuous observation, different areas within the square have been identified based on the frequency with which people stop and remain there (Figure 5). Thus, the benches located closer to the north-south path were the most-used sitting areas. These places are the first to be occupied; additionally, it has been observed that people on those benches remain in the square longer. In the same way, the vegetated area along the western border of this path is the first spot to be occupied on sunny and warm days.

On 1st of December 2012, a total of 55 interviews with people sitting in the square were carried out for this study. Climatic condition during interviews were clear skies with temperatures between 7 ˚C and 9˚C and west-southwest winds of 13 km/h. Questionnaires focused on two different issues: use patterns and motivations, and thermal comfort perceptions. When asked about motivations, more than half of the interviewees said that sunlight was their main reason for selecting a bench. Quiet, relaxing spots and convenience were the next-preferred answers, followed by enjoying the greenery and views.

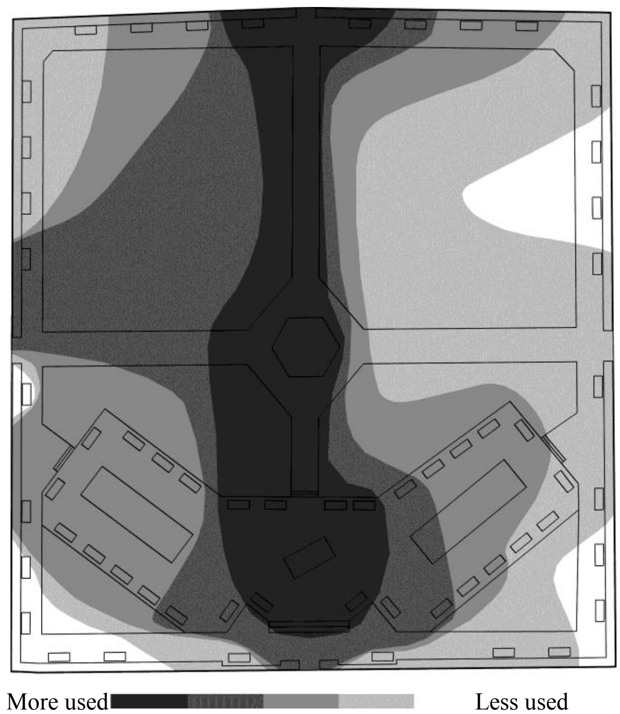

Figure 5: Diagram of the use of sitting areas.

In order to assess comfort levels, people were asked to assign a value to their thermal comfort perceptions. A seven-point scale was used in these questionnaires, -3 being very cold and 3 very warm. This methodology allowed for translating these feelings into quantitative values and comparing the answers with the climatic conditions on the day and time the interviews were carried out. The mean values were -0.92 for thermal comfort, 0.42 for comfort in terms of wind and 0.33 for light comfort. On average, then, people felt comfortable under existing climatic conditions.

Fanger's *predicted mean vote* (PMV) and *physiological equivalent temperature* (PET) values for those conditions and a clothing level of 3clo were PMV = -1.7 and PET = 11.8 °C. According to these values, environmental conditions on the square should have been uncomfortable. It is assumed, then, that other factors were influencing comfort feelings of the interviewees. Considering all of the physical and physiological parameters in the calculation of PMV and PET values, the difference in real comfort values should have been influenced by psychological factors derived from perceptions of the built and climatic environments.

RESULTS AND FINDINGS

Climatic conditions and the use of the space:

The study showed that there is a strong correlation between climatic conditions and the use of space by citizens. Figure 6 shows the correlation between on-site climatic measurements and observations of people's movements through the square taken on the same day and time—the x-axis characterizes the temperature measured at the beginning of the observation period and the y-axis signifies the number of people or groups that stayed in the square longer than five minutes. The chart differentiates between sunny and cloudy days.

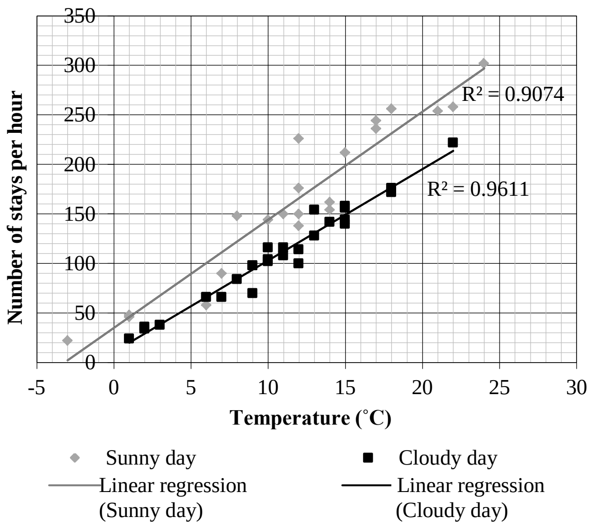

Figure 6: Correlations among temperature, cloudiness and number of stays.

The results show that as temperature rises, the number of stays in the square rises proportionally. Stays on sunny days are predominantly higher than those on cloudy days. The number of stays was also compared to other climatic parameters such as wind and humidity. Although the study showed that there are some linkages between the number of stays and wind speed and humidity levels, temperature surfaced as the most influencing parameter.

Additionally, the average time spent in the square by all visitors each day was compared to the corresponding temperatures and cloudiness (Figure 7). It can be seen that this correlation is poor and that time spent in the square is not related to climatic conditions. For example, the average time spent by visitors on one day at 1˚C was equal to that spent on another day at 22˚C.

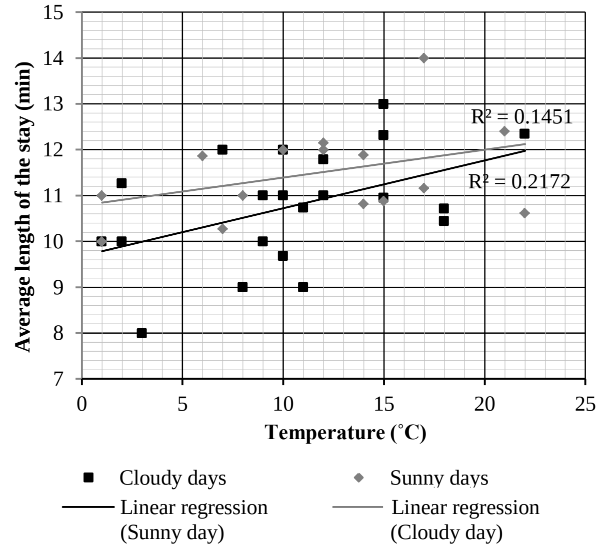

Figure 7: Correlations among temperature, cloudiness and average length of stay.

Designing for the climate:

The climatic analysis exposed the different areas of the square in relation to sun exposure and wind speed. In London's mild climate of cold winters and temperate summers, sunlit leeward areas corresponded to the most comfortable spots. The analysis identified these areas on the north corner of the square, where very few benches and sitting opportunities were found. However, the main sitting zone, where most benches were located, corresponded to the darkest and windiest area of the square.

Climatic analysis integrated into design processes can inform and improve design results by identifying the most comfortable areas for different activities. This methodology can assess the disposition of sitting areas, play areas or seasonal activities in a way that enhances the use of the space.

Perceptions of the environment:

Interviews and observations revealed that people sitting in Soho Square felt more comfortable thermally than expected from the mathematical models. Also, interviews showed that people's perceived comfort was related not only to the climatic environment but also to the built environment. The words *greenery, quiet space, trees, sunlit spot* or *enclosed area* were the most repeated expressions when talking about comfort with the square's occupants.

These results prove that different factors of the climatic, built and social environments influence individuals' thermal comfort. As a cognitive process, perception is understood as the way in which a person relates to the surrounding environment, the way in which he or she interprets the information gathered. Thus, thermal perception cannot be isolated from other perceptual processes that occur simultaneously.

CONCLUSIONS

This study showed the important role that weather and climate play in cities. Climatic conditions represent a pervasive aspect of people's routines and daily decisions (Figure 8). Accordingly, the use of public spaces is highly determined by climatic conditions and resulting comfort levels. An open space designed with the climate in mind provides more comfortable spaces and attracts more people to them.

The study revealed too that the combination of comfortable and pleasant weather with a space that allows its enjoyment acts as a catalyst for urban life. People attracted by sunlight and a comfortable thermal environment help generate a lively urban area. This activity draws yet more people into it.

Figure 8: Soho Square at 11 a. m. on a summer day (top) and at 11 a. m. on a winter day (bottom), respectively.

It has been observed though, that there is not a universal rule that relates a specific climate with a specific use of space. Many factors influence this relationship, causing a unique link between each person and his or her surrounding environment. Nevertheless, the study has identified different groups of people—workers, residents, homeless individuals, tourists—that follow similar use patterns. Thus, public spaces can be improved by analysing and understanding the daily routines and lifestyles of the people using these spaces.

Climatic conditions have great influence on the way the environment is perceived. Any change in the weather, time of day, point of view or viewer's mood influences understanding and perception. The same scenario can be completely different depending on the atmospheric conditions. Even a seemingly solid object like a building may look different depending on the moment in which we look at it. Therefore, people's relationship with their environment is totally dependent on weather conditions.

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