Form Follows Comfort: An Evidence-based Approach to Enhancing Streetscapes

Florian Zwangsleitner

Technische Universität Berlin/Germany · f.zwangsleitner@tu-berlin.de

Abstract: In densely growing cities, an increasing competition for public open spaces can be observed. Streetscapes often present themselves as a hotchpotch of objects related to both moving and stationary traffic. Consequently, in some areas it has become difficult to move freely as a pedestrian or cyclist, and safety issues often arise. In addition, the general public is deprived of potential open spaces with high amenity quality. Furthermore, the remaining spaces are frequently occupied by cafes and restaurants, which forces people to consume and spend money in order to use them. While these locations certainly contribute to the vibrancy of a city, qualitative public spaces to dwell in without having to consume are becoming rare. This situation is contrary to the understanding that public open spaces should be democratic places that can be used by everyone.

This paper presents an approach that aims to help redefine the priorities of public open space usage by enhancing the quality of streetscapes. In the context of climate change and its increasing impact on urban open spaces, climate is an increasingly important parameter for this. Thus, the paper will illustrate which design information can be derived from climatic impacts for small-scaled streetscape interventions, such as parklets and pocket parks, through a parametric analysis approach. The approach is tested through a case study analysis in Berlin.

Keywords: Micro-climate, parametric analysis, parklets, pocket parks

1 Introduction

One strategy for reclaiming public space from car traffic is the installation of so called *Parklets* – spaces on former parking lots that can be used by the public as places to dwell. The reactions that parklets in Berlin trigger in the daily press and internet forums (e. g. taz.de: *Parklets in Berlin*, B.Z. Online: *Die Parklets, die keiner braucht, heißen jetzt "Diskussion-sorte"*; Tagesspiegel.de: "*Stonelets" statt "Parklets"*; Berliner Morgenpost: *Parklets und grüne Punkte in der Bergmannstraße kommen weg*) show that the intention to allow public road space to be used for purposes other than those related to motorized transport is a very polarizing and emotionally discussed debate. Not everybody likes the idea of losing parking lots. It can be derived that the redefinition of public road spaces it is not only a design task but asks for a comprehensible and transparent planning approach that sensibly considers the local context.

The focus of this research lies in the environmental, more precisely in the climatic impact of the local context on a site and how climatic data can be used to generate evidence-based, transparent and comprehensible design decisions in accordance with micro-climatic conditions through computational tools and methods.

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Fig. 1:
Parklet in Berlin: Located in a street that is north-south orientated, this parklet lies in the shade most of the day. The parklet is particularly exposed to the prevailing wind which increases velocity along the street profile. Further issues are noise and exhaust fumes from the busy road and raised railway tracks. Safety issues may also arise due to the adjoining bike lane (AUTHOR, 2019).

1.1 Cities for People

In his book *Cities for People*, the Danish architect and city planner Jan Gehl shows the huge impact that individual motorized vehicular traffic and the corresponding planning paradigm of the car-orientated city has on the way we experience and live in our cities. He criticizes the prioritization of motorized transport over "*the human dimension*" in modernist city planning (GEHL 2010) and states that this procedure leads to "*cities with large buildings*" and open spaces which lack details and are therefore perceived as "*impersonal, formal and cold*" (ibid. 53).

Historically developed cities, on the other hand, provide urban spatial qualities. "*In narrow streets and small spaces, we can see buildings, details and the people around us at close range*" (GEHL 2010). Facades are designed with interesting details, small shops and display windows attract attention, well designed ground level zones create a connection between indoor and outdoor space, between private and public (ibid. 75). Thus, they increase social life in the urban fabric, as unplanned, spontaneous activities and social interaction can occur (ibid. 20). This activity and the presence of other people can then attract even more actions and people in a self-reinforcing process (ibid. 65).

However, Gehl also recognizes that these qualities have been lost in many cities – not only in modernist city areas but also in historically developed ones. He describes them as places that "*continued to function as an important social meeting place in the 20th century, until the planning ideals of modernism prevailed and coincided with the car invasion*" (ibid. 25). He mentions "*limited space, obstacles, noise, pollution, risk of accident and generally disgraceful conditions*" as typical urban conditions (ibid. 3). He also describes "*deteriorated conditions for pedestrians and cyclists*" due to narrow sidewalks that are filled with obstacles (ibid. 91).

It is time for a paradigm shift in the approach to dealing with public urban spaces. It should no longer be accepted that vast parts of streetscape are occupied by cars. In this sense, Jan Gehl demands that "*People must be able to move comfortably and safely in cities on foot or by bicycle…*" (GEHL 2010) and that "*Cities must provide good conditions for people to walk, stand, sit, watch, listen and talk*" (ibid. 118).

Landscape Architects can contribute to this demand by what Jody Beck, Associate Professor at the University of Colorado Denver, calls "*presenting alternatives to the status quo*". According to him, landscape architects must use their "*skills and background to present attractive ways in which society can live more sustainably…*" (BECK 2010, 105). Following this understanding, landscape architectural proposals not only need to promote a sensitive method of dealing with the environment, a responsible use of natural resources, the use of materials with lower energy consumption, the re-use and re-cycling of materials, but also make their work "*attractive for people to reduce their ecological footprint*" (ibid.).

1.2 Parklets and Pocket Parks

One promising way to "*provide good conditions to walk, stand, sit, watch, listen and talk*" – as Jan Gehl demands or "*present attractive ways in which society can live more sustainable*" – what Jody Beck is asking for – are so called *parklets* and *pockets parks*. These instruments can be used for presenting "*alternatives to the status quo*", in which streetscapes are commonly used as parking lots and help to create a shift in the priorities of public space usages towards a "*city for people*" instead of a "*city for cars*".

What is behind these terms? Bruce defines a pocket park as "*a small-scale open space accessible to the general public*" that provides "*a place to sit, socialize, play, eat, and relax outdoors*" (BRUCE 2016, 6). He refers to areas between 12 (which is about the area that one parked car occupies) and 2044 square metres (130 – 22,000 square feet), located in urban areas (ibid.). A parklet can be described as a pocket park located on a street that was formerly used by one or several parking lots. As pocket parks, they also present a public urban space for people, providing amenities such as seating, planting, bicycle parking, and public art (GROUNDPLAY 2019).

The main question is how to ensure that these interventions become implemented successfully although in most cities parking lots, are fiercely contested and the discussion often emotionally charges.

Bruce indicates that "*the primary design principle of a pocket park is that it must be targeted to its users and provide a convenient, comfortable, and pleasant environment for visitors to enjoy time outdoors*" (BRUCE 2016, 11). Maintenance strategies and determining who is responsible for the maintenance are also very important (ibid. 14). The context needs to be considered so that the interventions are safe, pleasant, barrier-free accessible and "*designed as an integrated part of its surrounding environment*" (ibid. 15). The orientation and exposure should offer natural light, providing "*places of sun and shade"* (ibid.). Accordingly, Laue suggests to "*recognize possible overheating in summer and possible undercooling in winter as well as potentials for heat increase during transitional seasons*" for open space designs in the temperate climate zone (LAUE 2019, 98, translated by the author).

Also Jan Gehl considers the orientation and location of spatial invitations highly relevant (GEHL 2010, 25). For him, a crucial zone for improving the spatial qualities in a city are places that "*offer a feeling of organization, comfort and security*" and where "*the local climate is best* (ibid. 75). These important places – the streetscape with the sidewalks in front of buildings where private and public life connect to each other – with its cafes and shop windows and similar, too often are occupied by parked cars or traffic related infrastructure. They potentially offer high amenity qualities and a pleasant local climate – crucial factors for encouraging people to spend a longer time outdoors.

1.3 Impact of the Micro-climate

Sanda Lenzholzer, author of the book "*Weather in the City*", reports of the impact of building and streets, that cause an air temperature that is at least 1 °C higher, in nights even up to 10°C higher in cities than in the surrounding areas, with up to 10 % lower relative humidity and 30-50% lower wind speeds, while much higher wind speeds can occur at specific spots (LENZHOLZER op. 2015, 14). As these urban heat island effects negatively influence people`s comfort, health and productivity, landscape architects need to consider these factors (ibid. 15). Also Laue emphases the special importance of climatic effects in urban planning projects as the increasing thermal stress due to climate change has its greatest effect in cities (LAUE 2019, 13).

Although climatic effects are not only perceived by physical factors but also depend on individual factors such as a person's age, gender, thermal history, metabolism and activity or clothing, we can manipulate these impacts through design (LENZHOLZER op. 2015, 21). At the scale of parklets or pocket parks this can mainly be achieved by managing the amount of long- and shortwave radiation (ibid. 20). The incoming shortwave radiation can be easily controlled by identifying and providing sunny (with a high amount of shortwave radiation) and shaded areas (with smaller amounts of shortwave radiation). The longwave radiation emitted from surfaces can also be easily manipulated by considering the thermal conductivity, emissivity and the Albedo of surface materials (ibid. 32-33).

Wind is another factor that has a big influence on how climate is perceived, and which can be modified by design (LENZHOLZER op. 2015, 20). The wind in cities differs from the surrounding wind, as the wind flows change direction when they hit obstacles (ibid. 38). This generally leads to reduced wind speed (ibid. 41) but the wind velocity can also increase in areas where it is deflected and compressed (ibid. 42). Although wind patterns in cities are hard to predict and simulations or wind-channel investigation usually require more time and CPU power than is available in a conventional design process, for small scale projects, some basic principles can be derived and used for design decision making (ibid. 42-43). This includes the identification of sheltered or exposed areas and also areas with undesired effects such as *corner streams* (increased wind speeds at the sides of obstacles), *downwash* (wind that moves down along the facades of high buildings causing turbulences at ground level) or *channeling effects* (KRAUTHEIM et al. 2014, 73).

With the previously mentioned design principles of section *1.2 Parklets and Pocket Parks* in mind and in consideration of micro-climatic impacts, small-scale interventions can encourage people to go outside more often and spend a longer time outside therefore fostering a sense of community (BRUCE 2016, 11.). Even more, they can also have a positive impact on human health and the environment, including the reduction of pollution, "*improving the microclimate, providing more permeable surfaces, and offering green areas for animals and bird to make their habit*" (ibid. 2016, 10).

2 Method

Despite the complexity of the topic and the various parameters that must be considered for a successful implementation of parklets and pocket parks, this research focuses on the evaluation of climatic impact for the identification of suitable sites.

A parametric analysis approach is implemented that allows to apply environmental data to a concrete spatial situation. More precisely, this involves the climatic data of so called "*Test Reference Years*" being processed by *Ladybug Tools*, – a plug-in for *Grasshopper* design software that allows the analysis of environmental data in a spatial context, in order to derive design information from it.

The approach aims to identify preferential locations and provides further recommendations for the design task. It can also be used as a tool for the presentation of data, helping to support decision-makers in design decisions and as a mediation tool to inform various stakeholders through a transparent and comprehensible design process. The parametric approach also allows for the adaption and weighting of the input data, so it can be used as a flexible, customizable tool, e. g. for public participation processes.

2.1 Data

Test Reference Years consist of data sets of selected meteorological parameters for each hour of a year that represents the characteristic weather pattern of a complete year. Individual *Test Reference Years* for any location in Germany with a resolution of 1 km^2 are available from the *German Meteorological Service* (DWD 2017, 2). Its original intent was to provide climatological data sets for the simulation of heating and ventilation systems as well as for the thermal behavior of buildings. The *Test Reference Year* basic data, such as air temperature, relative humidity and air pressure are generated by interpolation methods. The influence of the city on the air temperature and the humidity variables are estimated based on empirically determined statistical relationships and incorporated directly into the test reference year data sets (ibid. 4).

2.2 Case Study

The case study investigates the streetscapes of a densely built central area of Berlin, close to the historical city center. The area is dominated by the classic block structure and buildings with the locally typical eaves height of 22 meters. The street spaces are mainly dominated by stationary and moving traffic, trees are almost completely missing.

In a first step, the hourly weather data of the *Test Reference Year* (TRY) – more precisely the air temperature, the relative humidity, the wind speed and the wind direction – is fed into the *Grasshopper* software application and processed by Ladybug`s *Outdoor Comfort Calculator* in order to calculate the *Universal Thermal Climate Index* (*UTCI*). The UTCI represents an international valuation standard for the thermal environmental conditions of humans (JENDRITZKY et al. 2009, 97). It is specified as "*the air temperature* [°C] *under reference conditions*" (ibid. translated by the author) and is valid in "*all climates, seasons and scales*" (ibid.).

Although some criticize that the *UTCI* overestimates the thermal stress at negative temperatures – cold stress – (DEUTSCHER WETTERDIENST 2019) and that it requires the wind speed at meteorogical height (10 meters above ground) and not at the height of the occupant (MACKEY et al. 2017, 985), it is considered to be the most suitable index for the presented investigation. This is because the *UTCI* considers the latest human bio-meteorological findings and enables the evaluation of outdoor thermal conditions (JENDRITZKY et al. 2009, 99). However, the parametric approach also allows for a flexible adaptation or a more detailed examination of the results. For example, alternative models for the consideration of the human heat balance – such as the *KMM* (Klima-Michel-Modell), *PMV* (Predicted Mean Vote), *PET* (Physiological Equivalent Temperature) – or even approaches that emphasize one factor over the other according to personal-, local-, or application related decisions could also be coded and implemented into this parametric design- and analyzation process.

The calculated *UTCI* values are then superimposed with an analysis that indicates the amount of sunlight hours within a chosen period (Fig. 2, Fig. 3).

The parametric analyzation approach with *Grasshopper* allows a flexible adaption of the input parameters like the analyzed time period. This is beneficial if the same approach would be applied to another location with different preconditions, or if the expected period of site use would vary. For the presented case study, this flexible approach is used to identify sites that provide the highest amount (> 70 % of the maximum) of direct sunlight during comfortable weather conditions (9 °C < UTCI < 26 °C) throughout the entire year (Fig. 4). It also pinpoints the sites that receive the highest amount of direct radiation (> 70 % of the maximum) at periods with expected heat stress (UTCI > 26 °C, Fig. 5), areas that mainly lie in the shade during these heat stress periods (> 50 % of hours in the shade, Fig. 6) as well as sites that receive the most hours of direct sunlight (> 70 % of the maximum) during the transition seasons from March to May and September to November (Fig. 7). The selected quantities (70 % for direct sunlight, 50 % for shade) of sunlight hours processed in the analysis are considered suitable by the author but can be easily varied through the flexible input parameters.

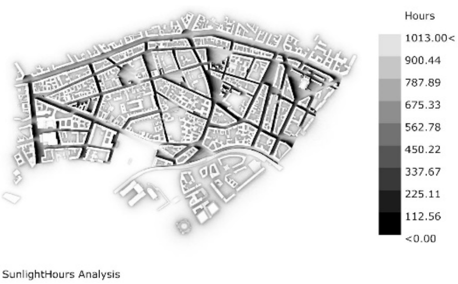

Fig. 2:
Total hours per year of direct sunlight during comfortable periods

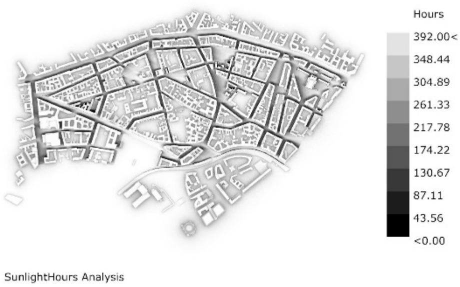

Fig. 3:
Total hours of direct sunlight during heat-stress periods

Fig. 4:
High amounts (>70 %) of sunlight hours during comfortable periods

Fig. 5:
High amounts (>70 %) of sunlight hours during heat-stress periods

Fig. 6:
High amounts (>50 %) of hours in deep shadow during heat-stress periods

Fig. 7:
High amounts (>70 %) of sunlight hours during transitional seasons

3 Discussion

The resulting information can be directly applied in design decisions. For example, the areas that provide high sunshine duration at comfortable climatic conditions (Fig. 4) may be considered as the most suitable sites for pocket parks and parklets in terms of climatic impact. This conclusion is based on the assumption that most people prefer to spend time in the sun under basically pleasant climatic conditions. Areas that provide shade on the other hand may be more suitable for temporary interventions during the hot summer months, when heat-stress conditions occur more often (Fig. 6), and the thermo-physiological perception can vary up to 15 °C between the sunny and the shaded areas of a street (LAUE 2019, 64). Of course, the climatic influence is only one parameter and design decisions must be considered holistically together with other design relevant factors such as accessibility, aesthetic qualities of the area, surrounding building facades, air quality, noise pollution, the existence of interesting views and a general sense of security. However, in the context of climate change and its increasing impact on urban open spaces, the climate is a very important parameter.

Conclusions may also concern the use of materials. For example, in areas that receive high amounts of short-wave radiation (direct sunlight) during time periods in which heat stress is expected (Fig. 5), materials with a high albedo value that do not become too hot in direct sunlight, and materials that do not emit high amounts of long-waved radiation at night could be chosen in order not to further deteriorate the micro-climatic conditions. Another outcome that may be derived from analyzing the results of Fig. 5 is in providing shade and increasing the amount of evapotranspiration (the evaporation of water over waterbodies or areas without vegetation and the release of water vapor by plants) e. g. through trees or the unsealing of paved surfaces (LAUE 2019, 32). Furthermore, ventilation through air movement should not be hindered in these areas.

Conversely, it could be beneficial to provide objects that store heat during the day and emit it at night in areas which receive high amounts of direct sunlight at comfortable hours during transition seasons (Fig.7). This includes objects from natural stone or concrete that remain warm in the evening, even if the air temperature has already dropped. Other strategies to increase the thermal comfort in these areas include offering shelter from areas of increased wind speeds and turbulences, and the conscious alignment and exposure of surfaces to the sun as sun facing surfaces which enables them to receive higher amounts of area-related energy and thus heat up more intensively (LAUE 2019, 36).

Another result of the case-study analysis shows that large areas receive high amounts of direct sunlight hours at both comfortable and heat-stress periods (comparing Fig. 4 and Fig. 5). Thus, the use of technologies that respond to the actual weather conditions such as adjustable shading elements may also be considered for enhancing climatic effects in design solutions. These elements also provide "*structural diversity*" (LAUE 2019, 98) in order to give people the choice to stay in both, sunny and shaded areas.

4 Conclusion and Outlook

The paper presents an approach that helps to identify appropriate places for small-scaled streetscape interventions and to derive comprehensible design information from contextual influences. It names some of the major benefits of small-scaled of parklets and pocket parks and illustrates how they can be implemented in accordance to micro-climatic impacts. Therefore, a parametric analysis approach has been developed that allows the flexible adaptation and manipulation of input parameters according to the specific needs of the design task. The input parameter consists of a 3D-digital site model, superimposed with environmental data – more precisely with so called *Test-Reference Years* (TRY) – Data that represents characteristic weather conditions using scientific models.

The result indicate locations where microclimatic conditions are expected to be pleasant as well as places where the negative effects of heat stress are likely to occur. The visualization and presentation of these information can help to foster acceptance through the transparency and comprehensibility of the design process. Also design information concerning orientation, shading, wind shelter, materials or the use of trees and shrubs for evapotranspiration can be derived from it. However, the design possibilities of dealing with the analysis results are diverse. The approach allows decisions to be made according to evidence-based, transparent criteria that can support decision makers and stakeholders or can be used as an information tool in participation processes.

In the summer term of 2020, the methodology will be tested in a student seminar at the TU Berlin. A mapping process through overlays of the analyzation results will help to identify preferred locations. It will further be examined if the parametric analysis of micro-climatic conditions, and the information that can be derived from it, will lead to solutions that are more precisely adapted to the prevailing microclimate and can therefore provide higher amenity values. Some of the results of the seminar will be presented at the conference.

Although this approach was developed for analyzing streetscapes it can also be assumed that the approach can be applied to other categories of open space, such as residential green spaces, parks, and plazas. If and how the methodology would need to be adapted could be the subject of future research.

Other potential fields of investigation could be the integration with GIS or the evaluation of realized projects where the presented approach was applied. Do climatically adapted, comprehensible and transparent design decisions really lead to a higher acceptance for redefining the public open space usages? Up to now, this can only be assumed.

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