Don't blame it on the sunshine! An Exploration of the Spatial Distribution of Urban Heat Injustice

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Abstract: Many global cities experience temperature differences on a micro-scale across urban areas due to Urban Heat Islands, revealing deeper climate injustice as many socially and economically marginalized communities are more likely to live in warmer neighborhoods. These areas often have less access to cooling features, like green spaces, which improve climatic conditions. Many local governments lag behind in recognizing the unequal vulnerability of certain populations or taking steps to mitigate injustices related to green space planning. We created and tested a Heat Injustice Scale model to explore how different areas of the city face spatial disparities in heat vulnerability and heat resilience as a result of green space planning. Drawing on critical urban theory and environmental justice, we seek to uncover the processes of neoliberalism and social exclusion that drive spatial heat injustices, and explore how resident perceptions of right to the city and climate resilience align with the reality of climate change. The Scale incorporates GIS data, ground-truthing surveys, and stakeholder perception-based mapping, a novel approach to measure climate resilience and mechanisms of heat injustice. Findings from a preliminary study in Antwerp, Belgium indicate an unequal distribution of green spaces according to size, proximity, and quality; but moreover, revealed the reality that local residents in all districts – particularly those with lower social capital -- are systematically disadvantaged by and dissatisfied with municipal green space planning. Through future research, we hope to provide an interactive, participatory platform for residents and city planners that will illustrate areas of heat vulnerability and

resilience in the city utilizing the Heat Injustice Scale, and incorporate resident narratives on accessibility to cooling features to highlight heat-related planning issues.

Keywords: urban heat; climate resilience; critical urban theory; heat injustice; heat vulnerability; green planning
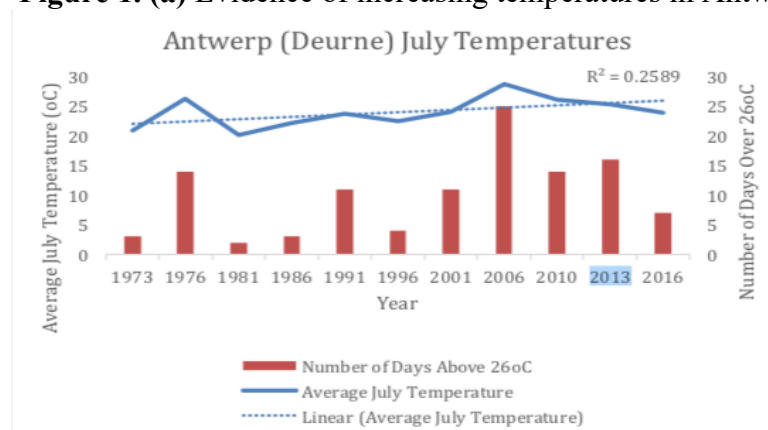
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1. The new "UHI:" Urban Heat Injustice

Europe's cities are getting hotter. Researchers have long known that vulnerability to heat is exacerbated in urban areas, as dense infrastructure and reflective surfaces can raise the air temperature within cities, a phenomenon known as Urban Heat Island effect (UHI) (IPCC 2007 and Tursilowati et al. 2012). UHI can result in cities being 4.5 - 8°C hotter than their surrounding areas, and may lead to urban spaces that are uncomfortable for everyday life (Aniello et al. 1995). As climate change is already resulting in globally rising temperatures, the risk of illness and even death due to extreme heat events is an ever-more salient threat in the world's cities.

We set out to better understand how urban planning can help to solve UHI – or serve to exacerbate it – and what this means for the everyday experiences of urban citizens who face real health risks from rising temperatures. Through a comprehensive Urban Heat Injustice Scale, we combined GIS data, ground-truthing, and perception-based mapping: a novel approach to understand how the impacts of urban heat can differ across the fabric of a single city, and how communities respond to heat injustice. This scale, as well as an innovative theoretical model for critical analysis of heat-related planning, could be an important tool for residents and local governments to improve urban design intended to reduce heat injustice, and improve community wellbeing during heat events.

2. Antwerp: An Unlikely Case Study

When considering issues of global heat injustice, Antwerp, a city of 500,000 inhabitants in Belgium, may not be the first place that comes to mind. However, despite a climatic reputation of persistent drizzle, Antwerp's population faces a future of vulnerability to extreme heat events, with forecasts of hotter summers and an increasing frequency of heat-waves (Martinez et al. 2018).

Figure 1. (a) Evidence of increasing temperatures in Antwerp
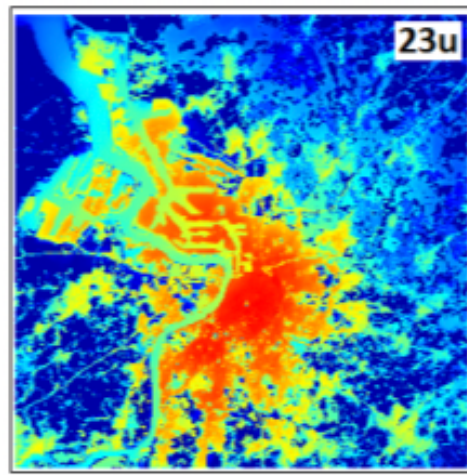

(b) Adapted from Antwerp's open data portal by Manon Burbidge   (1)

UHIs can differ across relatively small areas due to natural microclimates found within the urban environment, and, importantly, because of factors of urban design such as building density and green public spaces (Hart & Sailor 2008). Multiple studies have found that socio-economically marginalised communities are more likely to live in hotter neighbourhoods than their more affluent, often white counterparts (Sampson et al 2013). These disparities are particularly relevant with regard to public health, as heat-related deaths occur disproportionately in areas with high numbers of immigrants and substandard housing. Additionally, young children, older people, those who are chronically ill, and people living below the poverty line are also at higher risk of heat-related mortality (ORS 2003 and Sampson et al. 2013).

Figure 2. (a) Evidence of the Urban Heat Island effect experienced in Antwerp

(b) Adapted from the Urban Climate Service Center   (2)

In an ideal world, applying greening techniques to vulnerable neighbourhoods, helping to provide access to cooling features through spatial planning measures or promoting heat neutrality, and improving municipal responses to extreme heat events could reduce illness and death resulting from structural heat injustice (EEA 2016). However, many local governments lag behind in recognising the unequal vulnerability of certain populations or fail to take steps to mitigate injustices related to city planning and green spaces (Harlan et al 2006 and Sampson et al 2013).

3. The Heat Injustice Scale

With the impetus of addressing this urban climate injustice, we donned our sunglasses and wide-brimmed hats, and set out into the not-so-wilds of Antwerp to gain a better understanding of the distribution of its public cooling features: specifically, urban parks and green spaces. Our research utilised Burawoy's Extended Case Method to facilitate a connection between the micro -- the local experience of cooling features and the material reality of their distribution-- with the macro: the neoliberalisation of space, which is evident in Antwerp's urban planning policies (Burawoy 1998).

The Urban Heat Injustice Scale that we developed and deployed through this research consists of three components: spatial demographic data, observed park conditions measured through researcher-filled surveys, and resident perceptions gathered through semi-structured interviews with park occupants.

Spatial demographic data

This component of the scale consists of quantitative data-sets obtained from public platforms, including meteorological data to test whether temperatures are rising in Antwerp, and a combination of urban park shapefiles and socio-demographic data to map spatial patterns of vulnerable populations, cooling features, and heat-vulnerable areas. We used these maps and the data itself to better understand the distribution of known parks in the city, as well as to generate statistics on local populations in each district.

Observed park conditions

We sought to enhance the limited available park data with a researcher-filled survey to examine the potential of identified green spaces as cooling features. The survey primarily evaluated the conditions of the park, such as the presence of water features, type of ground cover, shade cover, and general maintenance; however, some questions related to the number and types of users at the time of our visit. It also served to ground-truth the municipally-provided parks data set, which was incomplete.

Resident perceptions

To better understand the lived experiences of the disparities we mapped and ground-truthed, we carried out a perceptions survey on-site in the public parks we catalogued. Through the survey, we interviewed residents on how they use cooling features such as parks or urban green areas, as well as the perceived proximity and quality of cooling features within their district, and in Antwerp as a whole.

4. Urban Planning Under Scrutiny: Model for Critical Analysis

In addition to piloting our Heat Injustice Scale methodology, we also created a model for critical analysis to position the results of the Scale, as well as narrative evidence from residents and from municipal planning documents, in the context of broader structures of neoliberalism and globalisation. This analysis provided key insights into how heat injustice is reinforced through institutional decisions, and elevated potential opportunities for resident reactions and reclamations of cooling features.

We examined official development visions, management policies, completed projects, and entities responsible for urban green spaces to explore their objectives, how they organise urban spaces to realise these objectives, and the likely effects they will have on the everyday life of residents (Lorquet 2012 and 2017). We used this review of official municipal perspectives on green space planning to frame residents' lived experiences and the material conditions of the unjust spatial distribution of green public spaces in Antwerp.

5. Findings: Structures of Division

Over the last decade, like many European cities, Antwerp has implemented an integrated urban development policy, initiating development and renewal projects that conceptualise the city centre as a space for sustained economic growth and entrepreneurship, while the city's periphery is presented as a tranquil urban oasis, where most large parks and green spaces are located (Lorquet 2012).

This structure of division has generated a deeper schism by separating the urban fabric into a landscape of opposition: economy vs. life, work vs. leisure, industrial vs. natural, and habitat vs. habiting (Lefebvre 2003). The unequal spatial distribution of green spaces and cooling features uncovered by our Heat Injustice Scale is the visual tip of an iceberg of inequality between areas where living, habiting, and the

natural are compromised for capitalist growth, and others where they are sequestered so that only certain populations can access them freely. These inequalities are visible not just on the macro-city level but also in the micro-context of green spaces.

As our study showed, large, city-managed parks were well maintained for use by residents and tourists, but the maintenance of small, district-managed parks and public spaces is often poor, particularly in areas with lower socio-economic and higher heat-vulnerable populations.

Residents expressed an awareness of such inequalities: just one person interviewed said that they perceived Antwerp as a green city, while 75% stated that parks were not equally distributed throughout the city.

6. Findings: Privatisation and Gentrification

Most specific green planning projects in Antwerp are conducted and managed by autonomous, private municipal companies; some additionally count on external private investors and public-private partnerships (van den Berg et. al. 2014). Local communities have been involved in some of the planning processes; however, the extent and form of participatory planning is not clear -- this is an area for fruitful future research.

Lack of community involvement is further highlighted by processes of gentrification that have begun rapidly and aggressively in the areas surrounding new city parks. This phenomenon refers to a larger trend of "ecological gentrification," a form of environmental injustice referring to planning of public green spaces that "leads to the displacement or exclusion of the most economically vulnerable human populations," in this case, away from accessible and useful cooling features and green spaces (Dooling 2009).

Green spaces in Antwerp are undoubtedly produced to improve urban liveability (Lorquet 2017). However, the promise of capital also transforms them into a commodity to increase the city's attractiveness for workers, businesses, and global investments, and the municipality still touts commercial aspects of green spaces as the vital aspects of their value and success (Mitchell 2008). Research shows that green space promotes physical activity, psychological well-being, and general public health (Wolch et al. 2014). When planning entities conceive of green spaces as a way to expand and centralise economic value, differing levels of state and private investment are provided to create and manage them in different areas of the city: a decision that replicates disparate realities of quality, accessibility, and distribution. This could explain why green space is more abundant and well maintained in rich neighbourhoods, but scarce or poorly maintained where socio-economically marginalised communities reside.

7. Findings: Unliveable Inequalities

In the network of interactions among residents, municipalities, and private interests, it is residents -- particularly those with lower social capital – who are systematically disadvantaged through the existing dynamic, as shown through the consistent lower scores of less advantaged neighbourhoods on the Heat Injustice Scale. Liveable and sustainable cities cannot be built by neglecting, marginalising, or repressing any of their residents, especially those from disadvantaged groups.

Although current policies regarding urban green space may not go so far as to stimulate social movements, the residents interviewed weren't satisfied with the status quo. They appreciate the presence of large green zones in the peripheral districts, but complain about trees being cut down for construction in the city's central districts. They explicitly do not perceive Antwerp as a green city and feel that parks in peripheral districts are better respected and less crowded than those in central districts.

8. Seeking Collective Solutions: The Community Managed Park

Heat injustice is not just about the distribution of green spaces, their quality, or accessibility. It also plays a role in defining how people cool themselves down and enjoy themselves in green spaces. Municipal planners and companies leading projects make decisions about green space planning based more on generalisations about the districts than the real life needs and experiences of local residents.

We observed great disparities in maintenance across our study area: 75% of parks in richer, peripheral areas had one or no maintenance issues, while socioeconomically disadvantaged, central areas had only 42%, and not a single park with no issues. These disparities were evident in both city-managed parks and district-managed parks. However, there was a third type of park whose maintenance and use was consistently inclusive and promising: **the community-managed park**.

These were small, and technically classified as public parks, but were maintained by residents living immediately adjacent to the parks. These spaces were primarily used for vegetable gardens, but also provided spaces of integration for a "multicultural community" and were used for self-initiated practices of cooling in summer for the residents. We found these community-managed parks to be extremely viable spaces, with great potential to resist the commodification of space and to defend, create, and strengthen accessible green urban public spaces.

These spaces, although not particularly eye-catching, represent a site of lived use and experience. Through daily life and collective activities, residents create their meanings and personal histories, finding and sharing identities, and transforming society through the reclamation of planning rights from the municipality and companies (Bhaskar 1998). These spaces could have an equal, if not more significant impact on reducing negative effects of urban heat on a district-level by providing more green spaces in absolute terms, and upon individual access to cooling features, by increasing the number of well-maintained urban green spaces in the city's most densely populated central districts.

Resident management of community parks represents the reproduction and consistent renewal of a just urban fabric, shifting heat injustice from a consequence of neoliberalism into a process of mutual creation within a more spatially equal and accessible society.

Conflict of Interest
The authors declare no conflict of interest