

# Species-specific effects of the Urban Heat Island on tree growth across Berlin

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07 March, 2020

## Abstract

This document serves as a brief overview and outline .

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## 1 Introduction

Berlin features the most intense Urban Heat Island (UHI) in Germany due to its large extent and development intensity (Kuttler et al., 2015), with temperature increases of up to 12 *K* during day-time and 6 *K* on average for night-times (2001-2010, Fenner et al., 2014) in urban *vs.* rural areas. Consequently, urban green (infrastructure) systems are subjected to increased heat more frequently, potentially affecting their process dynamics - either positively or adversely. Their performance and health, however, is closely tied to local energy budgets (Grimmond et al., 1996 ; Hertel and Schlink, 2019), which in turn are decisive for controlling human wellbeing (e.g. Maras et al., 2016), amongst other factors. Assessing the effect of increased temperatures on green infrastructure, as part of the urban landscape, is therefore instrumental for understanding, and ultimately mitigating, the potential impact of future warming on increasingly urban societies (Norton et al., 2015).

Trees, in particular, provide shading as well as transpirative cooling in their vicinity (Endlicher et al., 2016; Gillner et al., 2015; Oke, 1982), and therefore can reduce ambient temperatures, infrastructure power-consumption and (human) thermal discomfort (e.g. Gulyás et al., 2006; Akbari et al., 2001; Hoyano, 1988; Mayer and Höppe, 1987); simultaneously, they provide numerous other environmental, cultural and psychological services and/or benefits (see Tzoulas et al., 2007 for review). Further, recent tree growth dynamics as a proxy for on-going and future warming may provide an additional line of evidence to support

the growing knowledge base on future climate-vegetation and dynamics (Zhao et al., 2016) and may aid in mitigation and adaptation efforts (Pretzsch et al., 2017).

Trees and green infrastructure in urban areas show a tendency for enhanced growth rates and/or productivity compared to rural counterparts (Jia et al., 2018; Pretzsch et al., 2017), yet feature a broad range of effect size ranges and, in some cases, directions specific to species and locality. Zhao et al. (2016) .. remote sensing.. increased growth rates with higher degree of urbanity for X Chinese cities. For Berlin, Dahlhausen et al. (2018), showed divergent patterns for intermediate and highly urbanized environments for *Tilia cordata* Mill (using growth increments), the most abundant tree of the city, with increased growth rates in the more intensely developed areas and attributed this to the UHI effect. Similarly, Moser-Reischl et al. (2019) showed positive associations between air temperature and radial growth for two species commonly selected by urban planners (*T. cordata*, *Rubinia pseudoacacia*) in Munich. By contrast, Gillner et al. (2014) highlight decreased growth for *Acer* species (*A. platanoides* and *pseudoplatanus*), *Platanus x hispanica* and *Quercus rubra* with higher summer temperatures of the preceding year, especially when compounded with drought, in another German metropolis (Dresden). Differences in growth trends may result from contrasting intrinsic inter- and intra-specific characteristics, but are indeed affected by other processes and factors, such as water availability, pollution and road-salt loading, structural impedance through infrastructure or management, etc. (Pauleit et al., 2002; Quigley, 2004; Randrup et al., 2001; Rhoades and Stipes, 1999). **In the future.. drought, both soil moisture and atmospheric drought.. potential issue for street trees .. (Brune, 2016) ??**

Conditions affecting tree growth can vary greatly within urban areas or regions, and need to be accounted for when establishing relationships with pertinent drivers, such as the UHI effect. This typically complicates the extrapolation from individual sampling sites toward predicting effect sizes across entire urban areas and tree stocks, especially for studies reliant on labour-intensive methods limited logistically by sampling effort (reduced sample size, species and spatial coverage). To complement detailed dendroecological analyses in Berlin for key species, we propose inferring growth modulation from a large data set in excess of 650000 individual trees provided by the Berlin Senate Administration (Senatsverwaltung). This data set contains information on location, species, trunk diameter (at breast height; *DBH*), and height, amongst other variables. In a space-for-time substitution, the absolute growth potential of species can be assessed across the entire urban area, and related to effects of the UHI, while accounting for other location-specific factors, such as street characteristics, development intensity, available soil volume, etc.

(Quigley, 2004) .. inferred absolute growth potential for species across demographic strata

Note (Gregg et al., 2003).. rather impeded growth adjacent to intense urban clusters; but, here focused on intra-city patterns.

## 2 Background

## 3 Proposed methods and data requirements

## 4 Preliminary results

Some results

Figure ?? shows how we can have a caption and cross-reference for a plot

## 5 Outlook

## 6 Acknowledgements

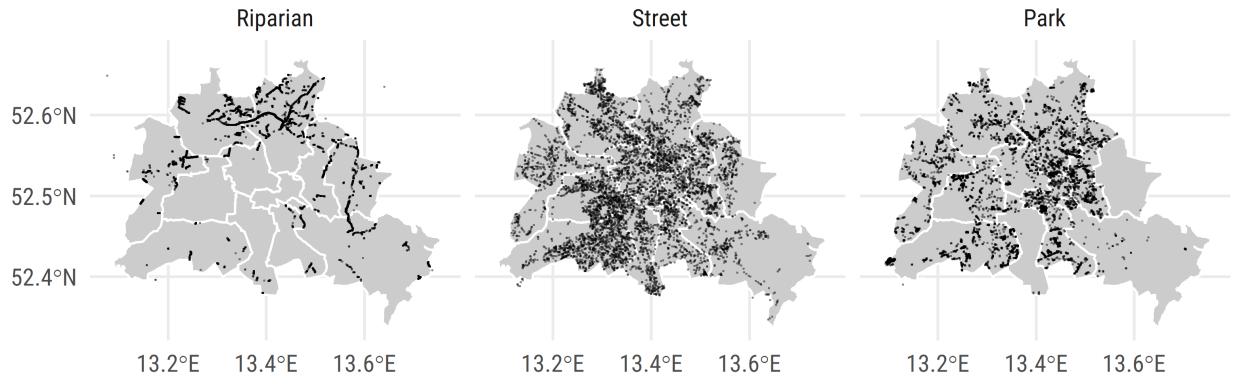


Figure 1: A plot of random numbers

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Data source: daten.berlin.de; WFS Service, accessed: 2019-12-15

Figure 2: A plot of random numbers

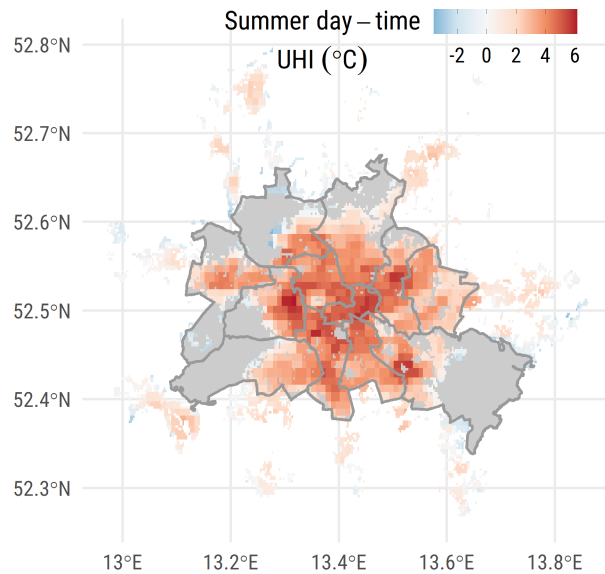


Figure 3: A plot of random numbers

Hoyano, A., 1988. Climatological uses of plants for solar control and the effects on the thermal environment of a building. *Energy and Buildings* 11, 181–199. [https://doi.org/10.1016/0378-7788\(88\)90035-7](https://doi.org/10.1016/0378-7788(88)90035-7)

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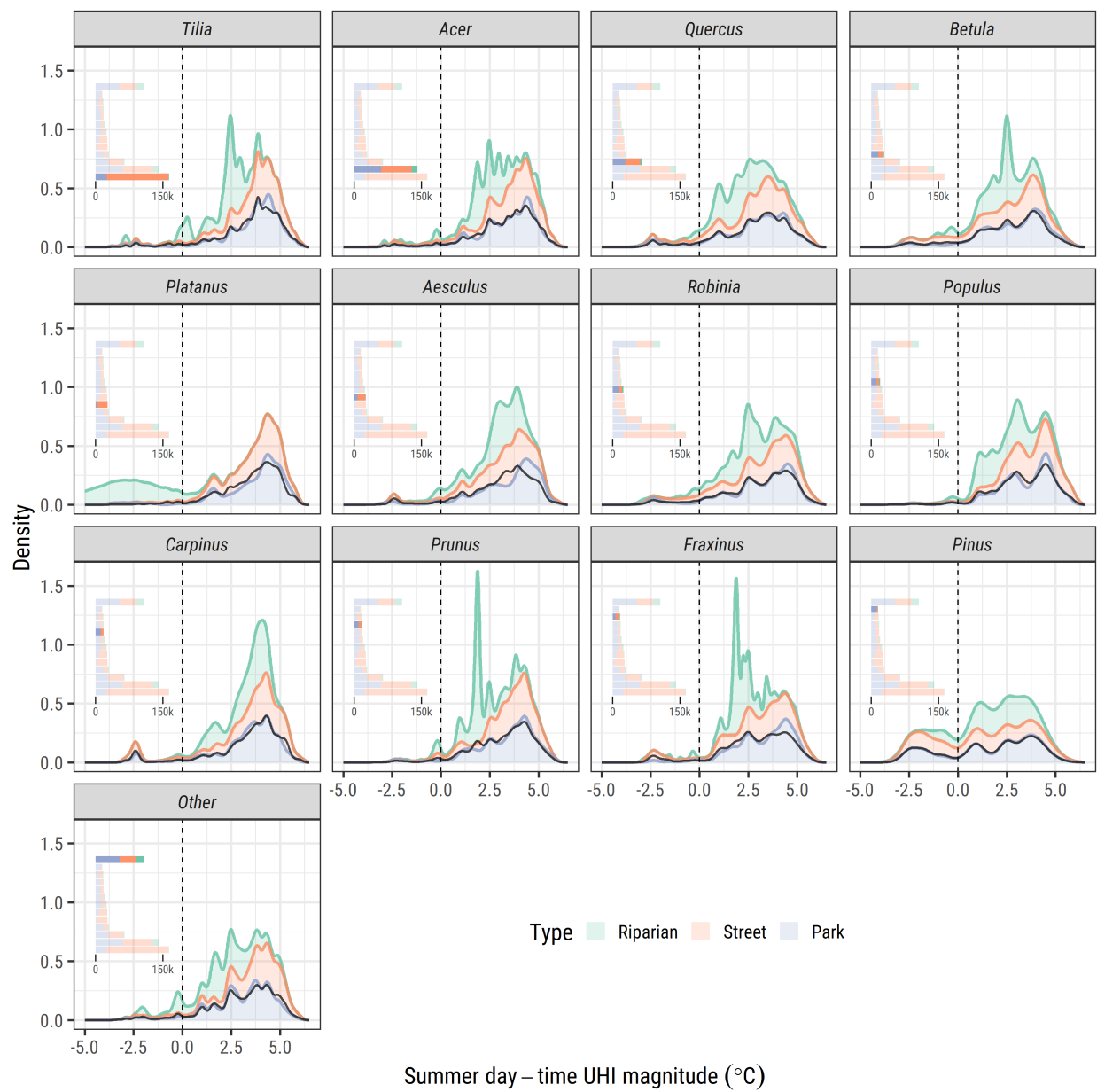


Figure 4: A plot of random numbers

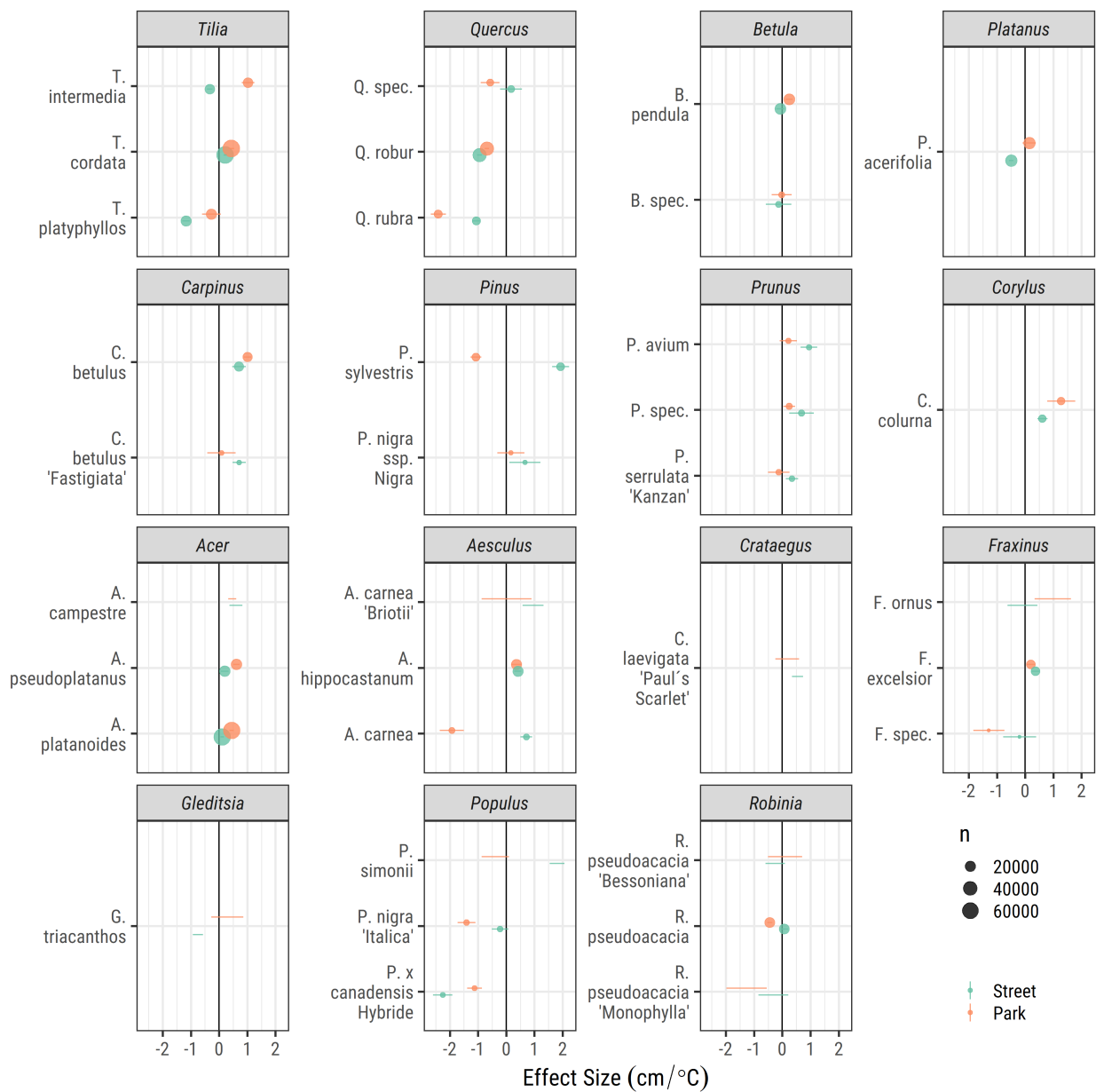


Figure 5: A plot of random numbers

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## 7.0.1 Colophon

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