Urban Forestry & Urban Greening 17 (2016) 11–15

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Short communication

A murmur in the trees to note: Urban legacy effects on fruit trees in Berlin, Germany

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ARTICLE INFO

Article history:
Received 23 July 2015
Received in revised form
25 November 2015
Accepted 9 March 2016
Available online 22 March 2016

Keywords:
Urban forest
Legacy effects
Urban foraging
Berlin

ABSTRACT

This study aims to unveil historic legacy effects in the urban forest of the formerly divided city of Berlin, Germany. A tree survey based on a stratified random sampling approach across five land-use classes was analyzed in respect of fruit tree density in the former East and West. In order to consolidate the findings, data from a foraging website (*mundraub.org*) were analyzed in the same regard. Results show that more fruit trees can be found in East Berlin than in West Berlin. We attribute these findings to legacy effects of the separation of the city in the Cold War, when two different political, social and cultural systems of the 20th century led to different demands concerning fruit trees. Even though the city was reunited 25 years ago, today's ability to forage for fruit in Berlin is still influenced by legacy effects going back to the former division of the city.

1. Introduction

Urban trees are essential for delivering ecosystem services in cities. The benefits provided by trees include improving air quality (Nowak et al., 2013a; Taylor et al., 2011) and local climate (Hamada et al., 2013) as well as carbon storage (Nowak et al., 2013b). Trees also improve the psycho-physical well-being of urban dwellers (Koo et al., 2013) and the aesthetic quality of the urban environment. In addition, trees provide habitat for wildlife in cities (Shanahan et al., 2014). It is for these reasons that many cities have started ambitious tree planting programs in the past decade (see for example Lu et al., 2014 but also Pincetl et al., 2012).

Other benefits provided by urban trees are less well studied, not commonly utilized or not much is known about their utilization. This is true for timber and biofuel production (Tyrväinen et al., 2005; Zhao et al., 2014), but especially for food production (McLain et al., 2012; McLain et al., 2014; Poe et al., 2013). This does not mean that food production is not important in cities. In fact, it has been for most of history (Barthel and Isendahl, 2013) and is still essential for the livelihoods of many urban residents in the developing world (Hamilton et al., 2013). The lack of research on food provisioning by trees probably reflects the general bias of urban ecosystem service studies towards Western Europe and North America (Haase et al., 2014), where cities today depend mostly on outside sources of food (Folke et al., 1997; Morgan, 2009, 2014). But even there and in recent history, local food production played an important role during times of crisis, when every available spot was used for growing food during the Great Depression and after the World Wars (Barthel and Isendahl, 2013; Gröning, 1996; Lieske, 2010). This was also the case in Berlin, Germany (Lachmund, 2013; Maurer, 1998; Zerbe et al., 2003).

After World War II, Berlin was divided and like the two German states, the two parts of the city followed very different political and economic trajectories with far-reaching consequences for green development (Lachmund, 2013) but also food provisioning (Weinreb, 2010). While the quick economic recovery of West Germany allowed people to buy domestic and exotic fruit throughout the year and at low cost, this was not the case in the East (Lieske, 2010; Weinreb, 2010). Reflecting this, Maurer (1998) still found fruit trees planted during and after World War II in the 1990s in a housing estate located in former East Berlin. In a comparable housing estate in West Berlin, fruit trees planted after the war had been replaced by ornamentals.

Designing and conducting a tree survey in Berlin in 2013, we did not have such legacy effects of the city's Cold War past in

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http://dx.doi.org/10.1016/j.ufug.2016.03.005
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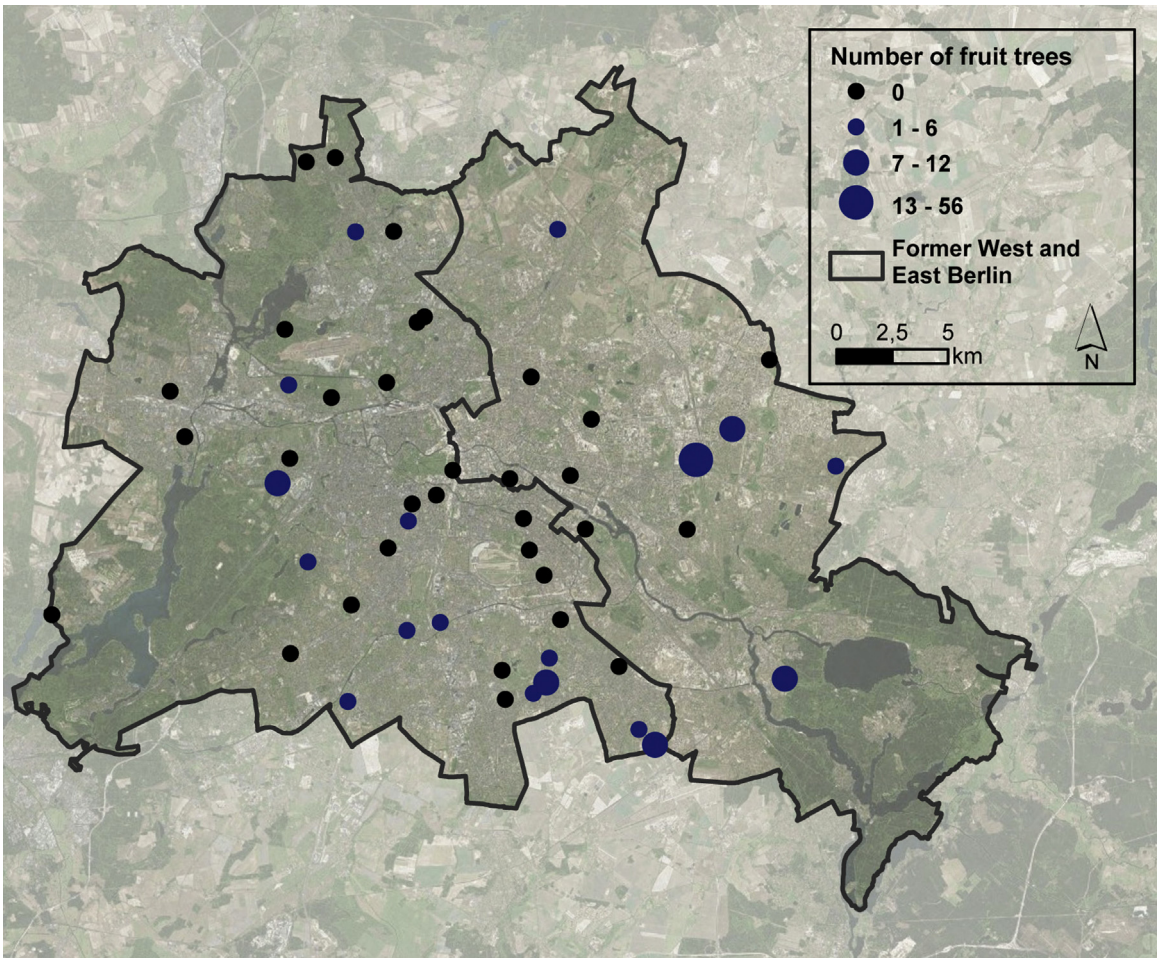

Fig. 1. Distribution of fruit trees on the 50 mapped plots; the size of the blue points indicate the number of fruit trees per plot, black points indicate plots without fruit trees. Basemap © ESRI, HERE, DeLorme, MapmyIndia, OpenStreetMap contributor and the GIS user community.

mind. Therefore, we were somewhat surprised when we found evidence of a higher number of fruit trees in East Berlin a quarter of a century after the city was re-united. We probably should not have been surprised, because legacy effects of former land use and socio-economic drivers on urban vegetation have been reported before (Clarke et al., 2013; Troy et al., 2007). In this short communication we will explore legacy effects on fruit trees within the urban forest of Berlin. We build on a tree survey conducted on sample plots across Berlin and on data from the web map portal *mundraub.org*, which allows users to located fruit trees in public spaces. The *mundraub.org* data represents a second, independent dataset on fruit trees in Berlin and it also allows us to discuss our findings in the light of contemporary foraging movements.

1.1. Study site

Berlin is the capital of Germany and its largest city with a population of about 3.5 million (Senatsverwaltung für Stadtentwicklung und Umwelt, 2012). After World War II, Berlin was divided into a British, French and American sector, which later formed West Berlin (486 km^2) and a Soviet sector which became East Berlin (405 km^2), the capital of the German Democratic Republic (GDR). West Berlin became an enclave of the Federal Republic of Germany (FRG) within the socialist GDR. After the collapse of the GDR in 1989 and the German reunification in 1990, Berlin became one city again.

1.2. Tree survey and analysis

A field study was conducted during the summers of 2013 and 2014 in Berlin on 50 plots each 1 ha in size. For stratification, five land-use classes from the Urban Atlas (European Commission, 2011)were used. They include four urban fabric classes (classification based on sealing rates ≤30%, 30–50%, 50–80% and ≥80%) and the green urban areas class. An area-weighted number of random points were placed within each of the five land-use classes. The final sample included eight plots in the ≥80% soil sealing class, 13 plots in the 50–80% soil sealing class, 11 in the 30–50% soil sealing class, six in the ≤30% soil sealing class and 12 plots in green urban areas. Five densely vegetated plots in green urban areas were mapped using a 15 m radius around the center, interpolating the results for the whole hectare. Plots were located using high resolution orthophotos. On each plot we determined the species and recorded the diameter at breast height (DBH) for all trees with a DBH above 5 cm. Of the 50 sampling plots, 12 were located in the East and 38 in the West (Fig. 1). The original goal of the study was to gather data on tree density and diversity across the Urban Atlas land-use classes for the use in ecosystem service assessments.

For statistical analysis, we first extracted data for the main fruit trees, namely apple (*Malus domestica*), cherry (*Prunus avium*), plum (*Prunus domestica*) and pear (*Pyrus communis*). The number of trees within the genera *Prunus* (plum, cherry), *Malus* (apple) and *Pyrus* (pear) is shown in Table 1. We then conducted Chi-square tests, as recommended for count data (Crawley, 2007). We explicitly looked

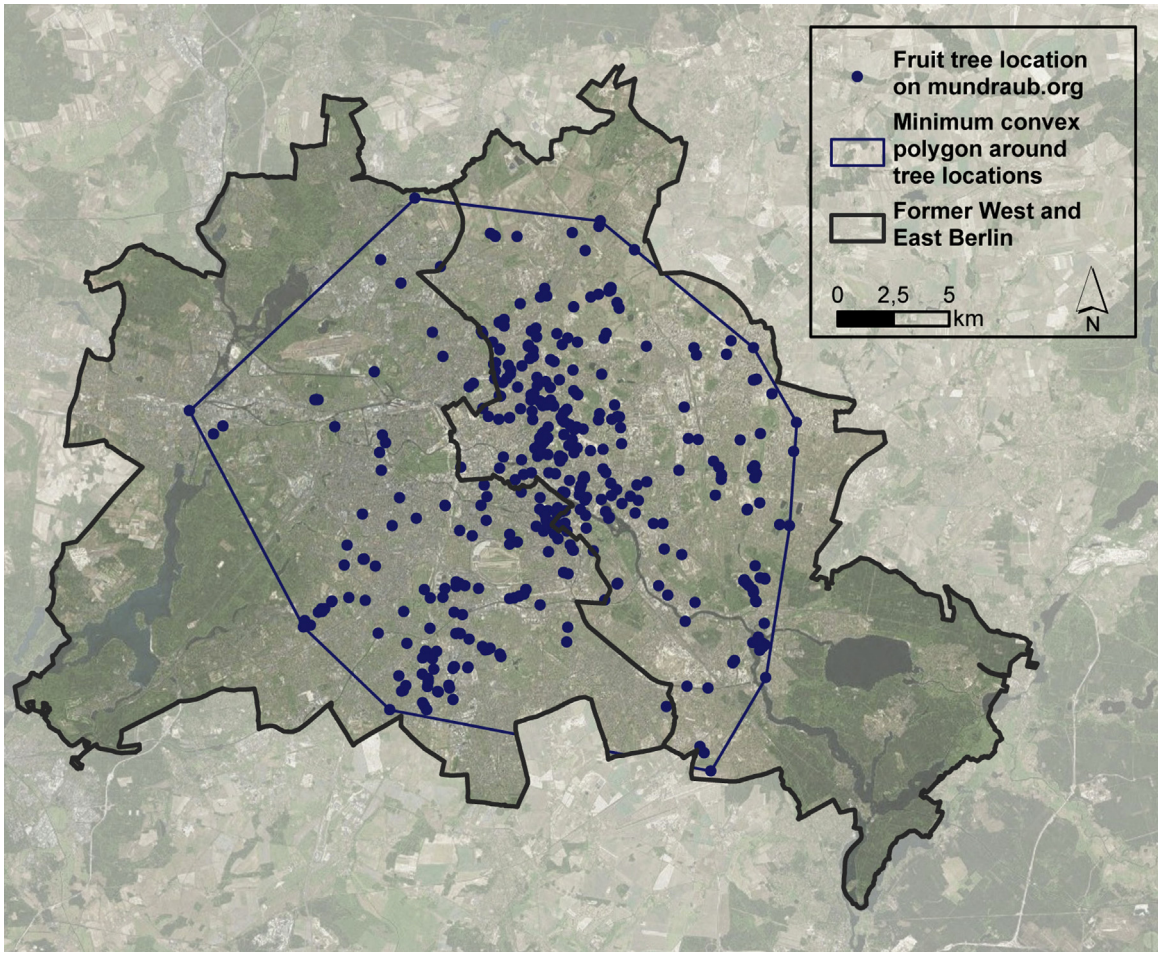

Fig. 2. Distribution of fruit trees from the *mundraub.org* data. Each point displays the location of a fruit tree. The minimum convex polygon approximates the area mapped by members of the *mundraub.org* community. Basemap © ESRI, HERE, DeLorme, MapmyIndia, OpenStreetMap contributor and the GIS user community.

Table 1
The total number of trees in East and West Berlin within the genera *Malus* (apple), *Prunus* (*cherry*, *plum*), and *Pyrus* (pear) surveyed in the field study and contained in *mundraub.org*.

	Field study		*Mundraub.org*	
	East	West	East	West
Malus	45	24	94	47
Prunus	38	27	179	94
Pyrus	5	3	24	10
Sum	88	54	297	151

at two aspects: (i) presence of fruit trees on plots in the East and the West, and (ii) total number of fruit trees on plots in the East and the West. The statistical analysis was carried out using the function chisq.test of the package stats in R (Core Team, 2014).

1.3. Mundraub.org *data and analysis*

Additional data was derived from *mundraub.org*, which is an internet platform for people interested in foraging for their own food. It includes an interactive web map, where users can map edible plants that are publicly accessible. We studied all tree-locations within Berlin as of April 13th 2015. All apple, plum, cherry and pear trees ('Apfel', 'Birne', 'Kirsche', 'Mirabelle', 'Pflaume', 'Zwetschge', 'Wildkirsche') were extracted for this analysis. The total number of trees within the genera *Prunus*, *Malus* and *Pyrus* is shown in Table 1. As an approximation of the area covered by *mundraub.org* informants, a convex hull was created around all plots and clipped to the administrative boundary of Berlin (see Fig. 2). We then summed up all locations in the former East and former West and calculated the respective areas of East and West Berlin covered by the convex hull. For statistical analysis, we again used a Chi-square test. The statistical analysis was carried out using the function chisq.test of the package stats in R (R Core Team, 2014). For the spatial processing we used the packages maptools (Bivand and Lewin-Koh, 2014), sp (Bivand et al., 2013), rgdal (Bivand et al., 2014) and rgeos (Bivand and Rundel, 2014).

2. Results

Fruit trees were found in 18 out of the 50 plots, five in the East and 13 in the West (Fig. 1). They contained a total of 142 fruit trees, 88 in the Eastern plots and 54 in the Western plots. On plot-level no significant difference was found between the observed and expected ratio of plots with fruit trees in the East and West (observed ratio: 5:13, expected ratio: 12:38, $X^2 = 0.14$, d.f. = 1, $p < 0.707$). Looking at the total number of fruit trees on these plots, a significantly higher number than expected was found in the Eastern plots (observed ratio: 88:54, expected ratio 12:38, $X^2 = 112$, d.f. = 1, $p < 0.001$). This represents an estimated tree density of 1.6 per ha in the West and 8.6 per ha in the East.

Mundraub.org contained 448 fruit tree locations in Berlin, 297 in the East and 151 in the West (Fig. 2). The area covered by the convex hull was 229 km^2 in the East and 245 km^2 in the West. There are

significantly more fruit trees in the East than expected (observed ratio: 297:151, expected ratio: 229:245, $X^2 = 64$, d.f. = 1, $p < 0.001$).

3. Discussion and conclusion

The original field study did not intend to analyze differences between East and West Berlin. This carries obvious limitations with regard to the number of plots located in both parts of the city (38 in the West vs. 12 in the East). To support our findings from the field study, we analyzed a second and independent dataset from *mundraub.org*, but this dataset has its own uncertainties concerning data quality, accuracy and uniformity of spatial coverage. Except for differences in spatial coverage, however, these issues should not systematically affect our result. To deal with differences in the spatial coverage of the Eastern and Western parts of the city, the analysis was based on the convex hull around all *mundraub.org* entries rather than the whole city area.

Our results suggest that there are legacy effects of the separation, because a higher density of fruit trees was found in the East than in the West of Berlin. In West Berlin, like elsewhere in the FRG, domestic food production decreased soon after World War II (Lieske, 2010; Weinreb, 2010). In the former GDR the supplies with fruit and vegetables were often inadequate and quality was low (Lieske, 2010; Traill and Henson, 1991). Therefore, domestic fruit production remained important for private consumption as well as retail trade (Brezinski, 1990; Lieske, 2010). Today, 25 years after the reunification, retail provision with fruit is the same across the whole city, but the estimated fruit tree density is still much higher in East (8.6 trees/ha) than in West Berlin (1.6 trees/ha). For comparison, fruit tree density in Leipzig, a city located in the former GDR and just 150 km southwest of Berlin, is 6.3 trees/ha (data from Strohbach and Haase, 2012). It would be interesting to see if the pattern holds true comparing cities across Germany, but we are not aware of available data.

Many questions remain, for example on the age of the fruit trees. If the higher number of fruit trees in East Berlin was just a legacy of the economic conditions in the past, we would expect that similar numbers of trees have been planted in the East and the West since the reunification. If, however, economic conditions of the past left a legacy on people's attitudes towards producing their own food, the number of trees planted after the reunification should still be higher in the East than in the West. It would also be interesting to know whether different varieties of fruit trees were planted in the two parts of the city. We would also expect legacy effects in the species composition for non-fruit trees. To answer these questions, a more intense sampling would be needed. A field survey with the objective of comparing trees between the Eastern and Western part of the city would either need a much higher number of plots, or a more balanced sampling between the two parts of the city (e.g., stratification by area). Equally or even more important for understanding the roots of the legacy effect described here, would be the study of people's attitudes towards fruit gathering, differences in stewardship, and the amount of fruit that is actually harvested in East and West.

The motivation for planting fruit trees is very different today than it was in the former GDR: It is not the necessity to grow fruit but more often recreation and sense of place that motivates people to garden (Lieske, 2010). Likewise, the motivation behind contemporary foraging movements in developed countries includes recreation and sense of place (Herlin and Herlin, 2015; McLain et al., 2014), but also unease about the disconnection from rural areas and the environmental impacts of modern industrial agriculture (McLain et al., 2014). It remains to be seen whether this is merely a fashion that fades away or whether urban food production will increase in importance once again. In any case, people interested in gathering fruit in East Berlin can probably build on the historic legacy of the shortage economy in the former GDR.

Acknowledgements

The first part of the title of this manuscript is from Emily Dickinson's poem 416. Special thanks to Kai Gildhorn from *mundraub.org* and the whole *mundraub.org* community and to Anna Bach for her contribution to the field survey. MWS was supported by the EU FP7 collaborative project GREEN SURGE (FP7-ENV.2013.6.2-5-603567). NL was supported by the BiodivERsA project URBES, (01LC1101A) and WAHYKLAS, German Waldklimafonds (28W-C-4-031-01).

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