Technical description - UrbanFabric a WebTool Prototype

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I determined the demand of soils and planting substrates for different urban greening scenarios in a case study. The investigated residential neighborhood of Berlin is known as the Wrangelkiez.

The neighborhood is located in the most densely build district of Berlin Friedrichshain-Kreuzberg, that has the highest degree of soil sealing with 69.7 % [4]. The map in Figure 1 illustrates the location in Berlin. It is inhabited by 11.118 [6] citizens (state of 31.12.2017) and classified to present a high bio¸climatic stress on its inhabitants due the urban heat island effect [4] and has a low accessibility to public green space. The neighborhood itself presents an average degree of soil seeing of 63 %. The Wrangelkiez is the home of the citizen initiative „Autofreier Wrangelkiez ". It is actively engaged in transforming public space from a space designed according to the needs of private individual transport to a space that ensures security for pedestrians and cyclists and provides livability for the inhabitants. The transition of mobility and the reallocation of public space is closely interrelated [9], therefore the development of urban green infrastructure in such a neighborhood is likely to be accelerated through such civic engagement.

The prototype of the RShiny App UrbanFabric can be accessed under:

`https://mowill.shinyapps.io/UrbanFabric/`.

At the current state the evaluation is limited to the neighborhood Wrangelkiez

The total area of the Wrangelkiez adds up to 526 833 km^2 of which 30.2 % are considered public space and 69.8 % of the total area account to buildings, water bodies and back yards. The public space is especially interesting as it can be subjected to greening activities initiated and directed by the district. For the district of Friedrichshain-Kreuzberg [3] summarize potentials and focus areas for greening activities.

The case study on the Wrangelkiez was realized in form of a map based interactive RShiny web application called „UrbanFabric ". The geo spatial data sets processed and synthesized for the study are summarized in Table 1.

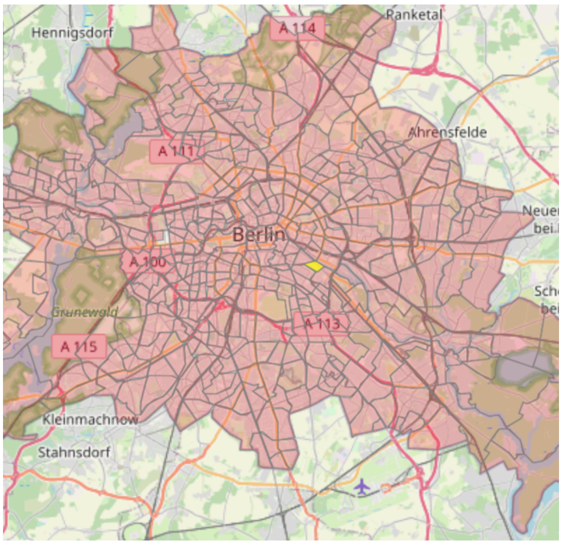

Figure 1: Location of Wrangelkiez Neigborhood in Berlin

Table 1: Data sets and their origin used in R Shiny web app urban Fabric, [4][10]

Name of data set	source
Lebensweltlich orientierte Räume (LOR)-Planungsräume	Amt für Statistik Berlin-Brandenburg
Gründächer - Gebäudeflächen	Umweltatlas
Straßenbefahrung Berlin 2014	Geoportal Berlin
Bodengesellschaften und Bodenarten 2015	Umweltatlas Berlin
Baumbestand Berlin - Straßenbäume	Geoportal Berlin
Baumbestand Berlin - Anlagenbäume	Geoportal Berlin
Adressen Berlin	Geoportal Berlin

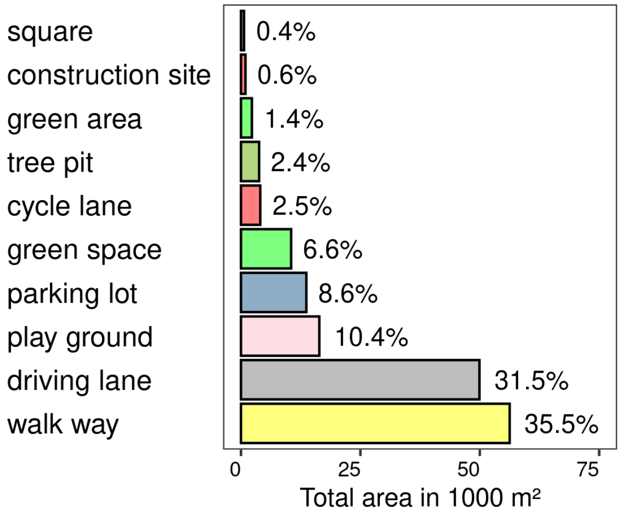

Figure 2: Inventory of surface types in public space in Berlin Wrangelkiez

Inventory of surfaces

The residential neighborhood is characterized by wide side walks that are covering the biggest share of the public space with 35.5 % percent. Following that the driving lanes are covering a similar size of the area with 31.5 %. The pavement materials sealing these surface types are variable as illustrated in figure 3 and of the walk ways here a big part is paved with less impervious materials compared to driving lanes.

In the public space unsealed soil can be encountered in tree pits, green areas and green spaces that add up to 10.4 % and partly in play grounds that make up 10.4 % as well. On play grounds and green spaces (e.g. parks) parts of the area may be paved, that are not mapped.

Soil ecosystem services, e.g. provision of habitat for plants or storm water retention can also be provided by secondary urban greening. If buildings and the green roofs on them are included in the inventory the area containing unpaved soils measures in total 11.5 %. The mapped status quo dates to 2014 in regard to the street mapping and to 2015 in regard to the greened roofs. The map in Figure illustrates the extent and location of unsealed urban soil in the investigated neighborhood.

Greening scenarios

I implemented three different greening options for the neighborhood that are currently discussed or subsidized by the Senate Department for the Environment, Urban Mobility, Consumer Protection and Climate Action of Berlin.

Tree pits Increasing the size of tree pits, discussed in the context of de-sealing potential in Berlin [5]

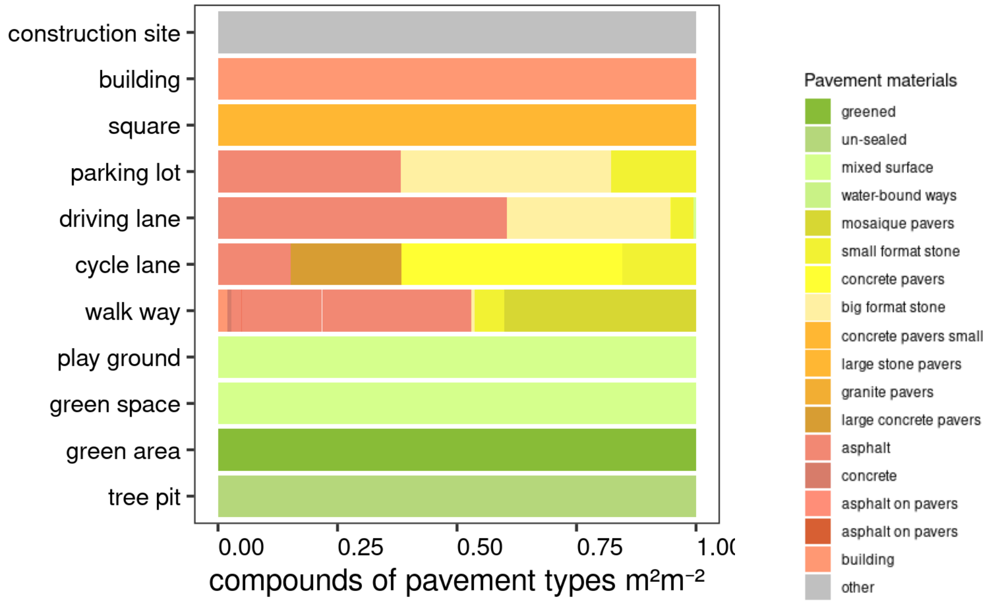

Figure 3: Pavement materials of each surface type. The color scheme reflects the soil sealing classes according to their permeability, described by [**Timm˙et˙al˙2018**]. I: green, II: yellow, III: orange, VI: red

Figure 4: Map illustrating patches of unsealed urban soils in the Wrangelkiez Neigborhood in Berlin

Table 2: Current status of UGI in the neighborhood Wrangelkiez, mapped in the RShiny App UrbanFabric

UGI	current status
Tree pits	average size $6.37\,\mathrm{m}^2$
Parklets	1
greened roofs	71

Parklets Reallocation of parking lots for small scale urban green infrastructure containing raised beds [8]

Green roofs implementation of green roofs [1]

Starting from the status quo mapped for the neighborhood summarized in Table 2 it is possible to determine the demand for soil or planting substrates when increasing the number of greened roofs, reallocating more of the 1139 parking lots or when increasing the size of all the tree pits up to the factor three.

Green roofs Of all 71 buildings mapped with green roofs, the greened roof surface covers in the average 30 % of the buildings foot print. Based on that the possible size of a green roof area on a building is limited to 30 % of its foot print size. All buildings present in the neighborhood are included in the estimation, however in reality not all buildings are suitable for the installation of a green roof. The substrate depth can be varied between 2 cm and 50 cm. Accordingly, the volume of green roof substrate is calculated from the selected substrate depth multiplied with the greenable area of the selected number of buildings. The selection of the buildings is implemented randomly.

Tree pits Increasing the size of tree pits will include the removal of the pavement and its underlying compacted substrate. Therefore the resulting depression will have to be filled up with soil or substrate that allows for infiltration and gas exchange. The volume of soil required for such a measure is calculated in the GIS based on a buffer of the size that relates to the desired increase of the tree pit and a selectable excavation depth after the pavement removal. The size of the buffer is calculated based on the equation of a circular area the by the following equation:

$$Buffer(x) = \sqrt{(x \cdot (A_{\text{treepit}} + pi * A_{\text{treepit}}/pi))/pi} - \sqrt{A_{\text{treepit}}/pi}$$

,

where x represents the selected factor by which the tree pit size is increased. Hence the size of the area that will be depaved and excavated respectively is calculated by

$$A_{\text{depave}} = A_{depave}(x - 1)$$

For the estimation of the volume of soil needed for this greening szenario a preset excavation depth of 50 cm that has to be filled with soil is assumed but can be adjusted accordingly. In a more detailed calculation, the required depth should be adapted for each type of sealing material according to the depth of materials and as well the construction beneath.

Prices for soil and planting substrates

The estimation of the price for (only) the imported soil contained by each UGI is based on the price for the product „Humusoberboden 0/15 "offered by the local distributor GaLaFa Erdenwerke Falkensee [7]. It is described as a topsoil containing 30 % compost and is sold for a price of €15 m^{-3}. Another product, especially suitable for containerized plants is sold for a price of €50 m^{-3}.

Estimation of truck loads

For the calculation of the truck loads necessary to transport the demanded amount of soil into the neighborhood the capacity of a truck is assumed to be 30 t and the density of the loose soil material (not dry) is assumed to be 800 $kg\,m^{-3}$.

$$Trucks = \frac{A_{\text{greened}} * \text{density}}{truck_{\text{capacity}}}$$

References

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