Assessing the Completeness of Urban Green Spaces in OpenStreetMap

Christina Ludwig[1,*], Robert Hecht[2], Sven Lautenbach[3], Martin Schorcht[2] and Alexander Zipf[1]

[1] GIScience Research Group, Heidelberg University, Heidelberg, Germany; christina.ludwig@uni-heidelberg.de, zipf@uni-heidelberg.de
[2] Leibniz Institute of Ecological Urban and Regional Development, Dresden, Germany; r.hecht@ioer.de, m.schorcht@ioer.de
[3] HeiGIT (Heidelberg Institute for Geoinformation Technology), Heidelberg University, Heidelberg, Germany; sven.lautenbach@uni-heidelberg.de

* Author to whom correspondence should be addressed.
This abstract was accepted to the Academic Track of the State of the Map 2019 Conference in Heidelberg after peer-review.

Urban green spaces provide a variety of important ecosystem services such as micro-climate regulation, increase of biodiversity and the provision of recreational and cultural services for citizens. Thus, they are an important factor for the quality of life in cities [1]. However, in order to take advantage of these services citizens need to have sufficient information about the location and qualities of urban green spaces. Within the project “meinGrün” (funded by the German Federal Ministry of Transport and Digital Infrastructure, BMVI) we are addressing this issue by developing a web-based recommendation service which helps citizens find nearby green spaces that satisfy their personal needs.

OpenStreetMap (OSM) plays an important role in this project, since it provides a lot of valuable information about urban green spaces and the amenities they provide (playgrounds, benches, etc.). However, the spatially heterogeneous data quality of OSM, especially in regard to the level of completeness, provides challenges for its usage in a recommendation system. Therefore, the integration of OSM data for our purposes requires a prior assessment of the completeness of urban green spaces. The level of completeness of certain geographic objects is one of the main fields of investigation in regard to OSM data quality. In recent years several studies investigated the completeness of OSM data with respect to the road network [2], buildings [3] or land use features [4]. Urban green spaces, on the other hand, were rarely the focus of completeness studies. Ali et al. [5] developed a method to quantify the plausibility of vegetation-related tags being assigned to specific OSM features and Lopes et al. [6] evaluated the potential of OSM for extracting information about natural local climate zones. Since both of these studies do not explicitly address the completeness of urban green spaces, we developed a new methodology for this purpose.

In contrast to buildings and highways this poses unique challenges due to the variety of vegetation-related OSM tags and the many different forms of urban vegetation ranging from large parks over private gardens to roadside greenery. OSM tags that describe natural objects are numerous and sometimes conceptually overlapping e.g. some features could be tagged as *leisure=park* or *leisure=garden*. This leads to different representations of urban

Ludwig et al. (2019). Assessing the Completeness of Urban Green Spaces in OpenStreetMap
In: Minghini, M., Grinberger, A.Y., Juhász, L., Yeboah, G., Mooney, P. (Eds.). Proceedings of the Academic Track at the State of the Map 2019, 21-22. Heidelberg, Germany, September 21-23, 2019. Available at https://zenodo.org/communities/sotm-2019
DOI: 10.5281/zenodo.3387701

green spaces in OSM across different geographical regions. Defining just one set of relevant OSM tags to measure the completeness of urban green spaces that can be applied everywhere is therefore not possible. Furthermore, the high degree of uncertainty that comes with this vagueness needs to be taken into account when using the data.

We developed a method to intrinsically measure the completeness of public urban green spaces based on the Dempster-Shafer Theory of Evidence (DST). First, a joint analysis of OSM data and the Normalized Difference Vegetation Index (NDVI) derived from Sentinel-2 imagery was used to quantify the relationship between a certain OSM tag and probability for the presence of vegetation. Urban green spaces marked with tags that were associated with high NDVI values were considered as explicitly mapped in OSM. In order to quantify the completeness of these data, additional indicators for the presence of public urban green spaces were derived based on the following geographic context variables: the density of foot paths, the presence of a POI (playground) and high NDVI values. These indicators were combined using DST to get a second estimate for the presence of public urban green spaces. Comparing this evidence to the map of explicitly tagged public green spaces in OSM yielded an intrinsic measure for completeness along with an estimate of its uncertainty. As a basis for this comparison the study area was divided into patches of homogenous land use based on natural and human-made barriers such as the road network, rivers or objects that mark changes in land use (fences, walls, etc.).

Results for the City of Dresden show that most public green spaces (e.g. municipal parks) are mapped with a high degree of completeness. However, publicly accessible, but privately owned green spaces within residential areas (e.g. courtyard of an apartment building with a playground) are only sometimes explicitly mapped as green spaces using tags such as *landuse=grass*. By comparing explicitly tagged public green spaces to the ones only indicated by geographic context (high density of foot paths, presence of a playground and high NDVI values) it was possible to successfully identify building blocks that contain public green spaces not explicitly mapped in OSM. In addition, these results were also compared to official data from the City of Dresden.

References

[1] Bolund, P., & Hunhammar, S. (1999). Ecosystem services in urban areas. *Ecological economics*, *29*(2), 293-301.

[2] Barrington-Leigh, C., & Millard-Ball, A. (2017). The world's user-generated road map is more than 80% complete. *PloS one*, *12*(8), e0180698.

[3] Hecht, R., Kunze, C., & Hahmann, S. (2013). Measuring completeness of building footprints in OpenStreetMap over space and time. *ISPRS International Journal of Geo-Information*, *2*(4), 1066-1091.

[4] Jokar Arsanjani, J., Mooney, P., Zipf, A., & Schauss, A. (2015). Quality assessment of the contributed land use information from OpenStreetMap versus authoritative datasets. In *OpenStreetMap in GIScience*, 37-58. Cham: Springer.

[5] Ali, A., Sirilertworakul, N., Zipf, A., & Mobasheri, A. (2016). Guided classification system for conceptual overlapping classes in OpenStreetMap. *ISPRS International Journal of Geo-Information*, *5*(6), 87.

[6] Lopes, P., Fonte, C., See, L., & Bechtel, B. (2017). Using OpenStreetMap data to assist in the creation of LCZ maps. In: *2017 Joint Urban Remote Sensing Event (JURSE)*, 1-4.