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ATG: a framework to characterize accessibility to public green in urban environments

Urban, OpenStreetMap, Sustainability, Nature, Large-scale

Extended Abstract

As the share of the worldwide population living in cities is forecasted to rise up to 68% by 2050, urban greening interventions are increasingly relied upon to improve the health outcomes and the well-being of urban communities and to mitigate the environmental footprint of cities [5]. On one side, the use of Public Green Areas (PGAs) by local communities -for physical activity, leisure, and social exchange- has been associated with healthier lifestyles and increased social cohesion [2, 6, 1]. On the other side, PGAs are effective solutions to pressing environmental challenges, providing biodiversity support and carbon storage but also acting as soil protectors and temperature regulators [4, 10, 11].

The multi-faceted benefits of urban green found definitive recognition in the United Nations (UN) Sustainable Development Goal (SDG) 11.7 that calls for the universal provision of safe, inclusive, and accessible, green and public spaces for all demographics, and in particular, for the more vulnerable. Similarly, the World Health Organization (WHO) recommends access to at least 0.5-1 ha of public green within 300m of residential areas [2]. A multi-level target has been proposed by the City Council of Berlin comprising a *short-distance* objective (access to a PGA of 0.5ha within 500m or 5 to 10 minutes walking), a *medium-distance* objective (access to a PGA of 10ha 1 to 1.5 km), and a per-person target (access to at least 6m2 of smaller and 7m2 of larger green areas per person). In a similar fashion, the recently proposed 3-30-300 paradigm addresses the need for urban green to percolate into the life of urban residents at several levels. The rule of thumb indicates three minimum green provision criteria for urban communities: 3 trees must be visible from every home, every neighborhood must have a 30 percent tree canopy cover and every home must have a PGA within 300 meters [7]. More generally, the proliferation of targets manifests a progressive shift of the urban planning paradigm towards more data-driven policy design processes, with an increasing number of urban planners and public health experts drawing attention to the importance of integrated data-driven city planning policies as a pathway towards healthier and more sustainable cities.

Our study provides a threefold contribution in this direction. First, we propose a framework and a Python package for the monitoring of several *green* targets at a high resolution. Leveraging data from OpenStreetMap (OSM) and population estimates from the Global Human Settlement (GHS) [9], the framework can be applied to all urban centers worldwide – provided the quality of OSM data is sufficient. Our sample includes more than 1000 urban centers with boundaries extracted from the GHS Urban Centre Database 2015 [3]. For each city, the quality of OSM data is assessed by comparing green features in OSM and the green coverage from the World Cover 2020 of the European Space Agency[13] using image quality assessment techniques [12]. We identify natural green areas in each urban center using relevant OSM tags and extract the walkable street network to measure walking distances using the OSM-based routing service Open Source Routing Machine (OSRM) [8]. We then define three sets of accessibility indices (minimum distance, exposure and per-person availability) for each populated cell of the population grid (Fig. 1A reports an example of the minimum distance index for the city of Paris). As a second contribution, we then study the relationship between the measured level of accessibility and the structural characteristics of the cities and unveil the role of small green areas as accessibility enhancers, particularly in densely inhabited urban centers (Fig. 1B, for the city of Paris). Thirdly, we demonstrate how the framework can be used to simulate the impact of different urban interventions, from the addition of a new public green area to infrastructural interventions to the street network, to help policymakers to shape transitions toward more sustainable and accessible urban environments (Fig. 1C, for the city of Paris). The data developed for this project are also used to build an interactive tool that represents a valuable source of information for policymakers to identify cities that are missing out and direct attention to those subareas within otherwise well-performing cities where the degree of accessibility is still insufficient.

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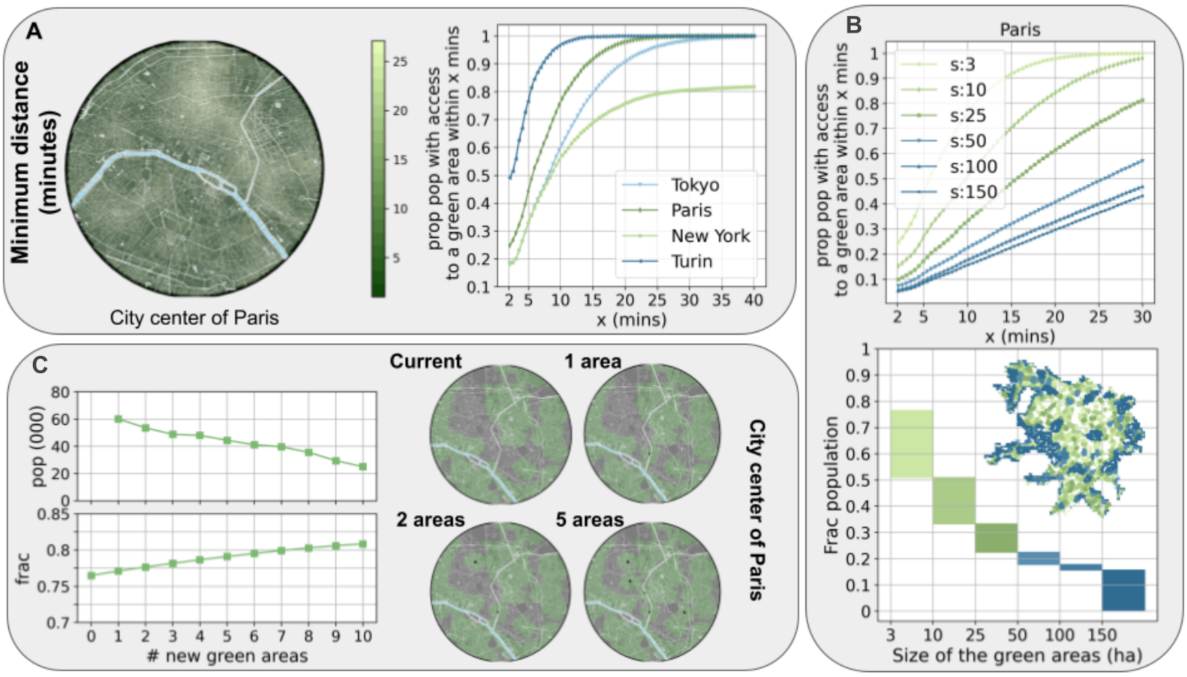

Figure 1: A: The map shows the walking distance (in minutes) to the closest public green area of at least three hectares from residential cells in the city center of Paris. The chart displays the proportion of the population with access to a green area of at least three hectares as a function of walking distance, for the cities of Tokyo, Paris, New York and Turin. B: The top chart displays the proportion of the population with access to a green area of at least three hectares as a function of walking distance, for increasing minimum park size thresholds, in Paris. The bottom chart displays the contribution of public green areas of different size to the overall fraction of the population meeting the target of having access to a public green area of at least 3 hectares within 10 minutes from their residential location. The inset displays the location of residential cells satisfying the target, coloured according to the size of the largest accessible public green area. C: The chart shows the impact of adding up to five new public green areas in the urban centers of Paris in terms of population (count and fraction) with access to a public green area of at least three hectares within 10 minutes from the residential location. The count reports the new population (in thousands) meeting the target, while the fraction is cumulative and include the entire population meeting the target for the different scenarios. The locations of the new public green areas are chosen to maximize the share of the population with access to green within the selected thresholds (10 minutes walking). The maps display in green residential cells meeting the target in the current scenario and after the implementation of the selected policy (addition of 1, 2 or 5 new public green areas).