Supplementary Material 03: Data preparation and Variable Computing

Extracting and simplifying the Open Street Map network

The pre-processing consisted of five steps and was implemented using open source software (PostGIS and QGIS with GRASS and Space Syntax Toolkit Plugins). The basis for this process was built under the recommendations in Kolovou et al. (2017)

1) The original geometries of the street network were generalised using the Douglas-Peucker algorithm to reduce the number of vertices representing each line, with the GRASS algorithms in QGIS.
2) Roundabouts and multi-lane streets represented with parallel lines were simplified by generating 20m buffers around them and deriving a centerline from the buffers to replace the original lanes using the ST_ApproximateMedialAxis function in PostGIS.

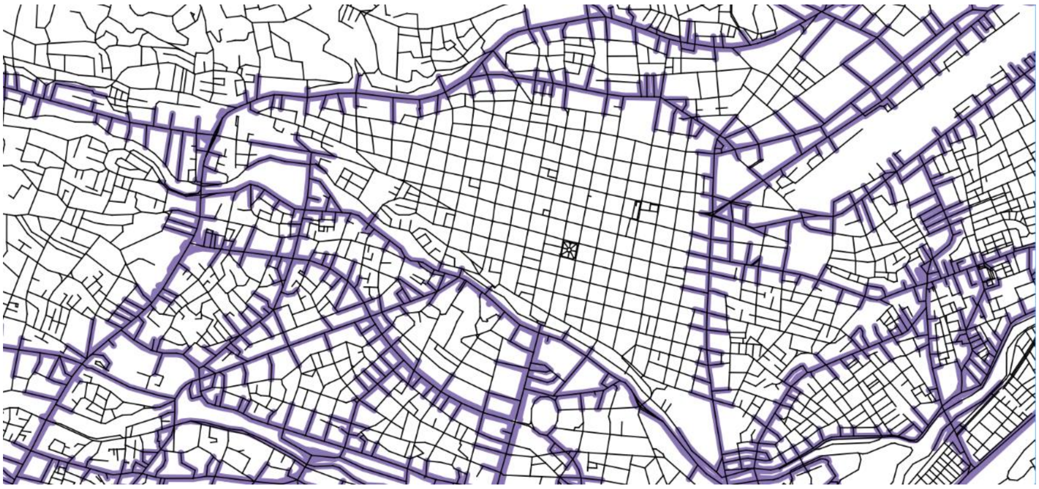

Figure 1. Main avenues with 20m buffers from which simple centrelines were derived

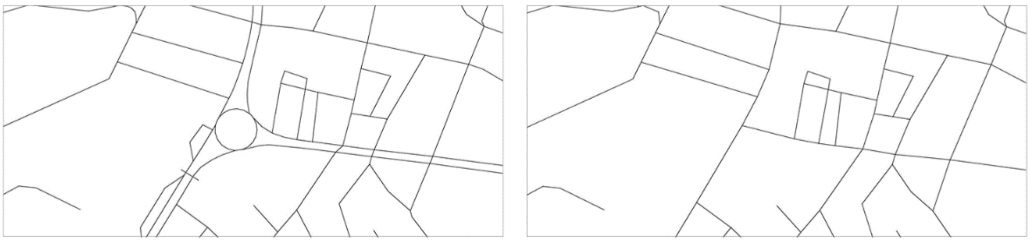

Figure 2. Original OSM network (left) Simplified streets and roundabouts (right)

3) Third, the simplified network was cleaned using segmentation and snapping algorithms in GRASS.
4) Since the street network is a planar representation, the tunnels and overpasses are not correctly represented since they appear as connected to the under- or over-passing segments. Therefore, the fourth step consisted of defining and importing these *unlinks* to the street network as points and assigning to the segments which are not connected in those intersections. This steps was conducted in QGIS using the Space Syntax Toolkit Plugin.

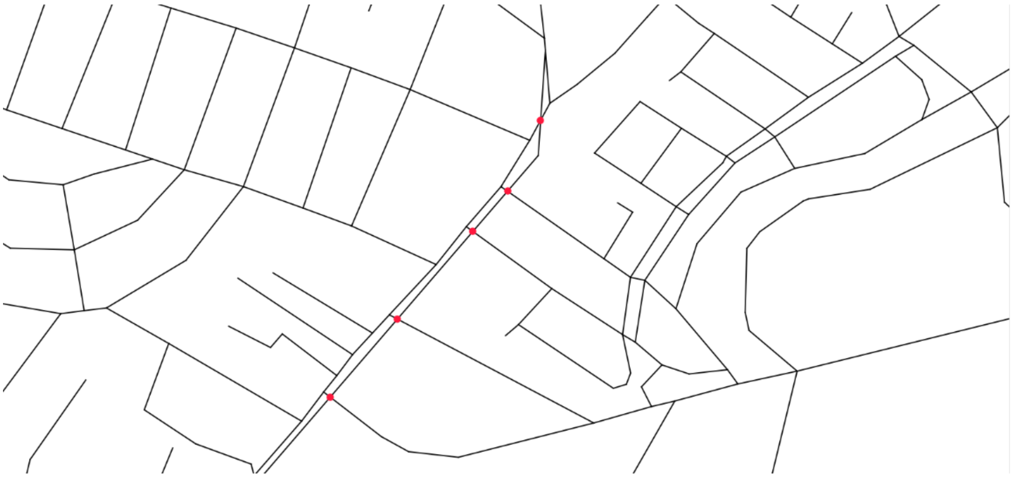

Figure 3. Points representing unlinks in an underpass where lanes don't cross in reality

5) Finally, the street network was checked and cleaned for topological and geometrical errors using the Network Cleaner tool from the Space Syntax Toolkit Plugin in QGIS. This step was conducted iteratively to fix geometries and remove invalid ones, until the tool detected no further errors. The final clean network consisted of simple fully connected centerlines and an additional layer of unlinks points.

Computing and adding variables and to the street network

1) Space syntax measures *Choice*, *Integration, NACH and NAIN* were computed for the cleaned street network using the angular segment *analysis* algorithm included in the Space Syntax Toolkit Plugin for QGIS (QGIS, 2019) and transformed to Z scores.
2) *Living Conditions Index*, *Household Density*, *Number of intersections* and *Land Use Mixture* are area-based, and were available for a regular mesh of hexagonal cells with an incircle diameter of 300m for the study area (Orellana et al., 2017). To transfer the values to the street segments, a spatial join centroid-to-polygon operation was used, where each segment received the attributes of the cell where its centroid was located. This allowed to establish a univocal area-to-segment relation and guarantee reproducibility.
3) *Slope* was derived from the altitude values of the first and last vertex of each segment and its length. Altitude values were obtained from a digital elevation model with a horizontal pixel size of 3 meter obtained from SIGTierras (MAGAP, 2012).
4) *Road Hierarchy* and *Cycleways* were already available on the original OpenStreetMap dataset and were recoded as dichotomic variables. For *road hierarchy*: 1= trunk, primary or secondary road, 0=otherwise). For *Existence of segregated bike lane:* 1= exists, 0=otherwise.
5) C*yclist counts* variables stored in the original network dataset were transferred to the cleaned street network using spatial join with tolerance values of 50m for avenues and 7m for streets. These values were selected based on the minimum distance from computed centrelines to the corresponding original lines.

References

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