An open source approach for the intrinsic assessment of the temporal accuracy, up-to-dateness and lineage of OpenStreetMap

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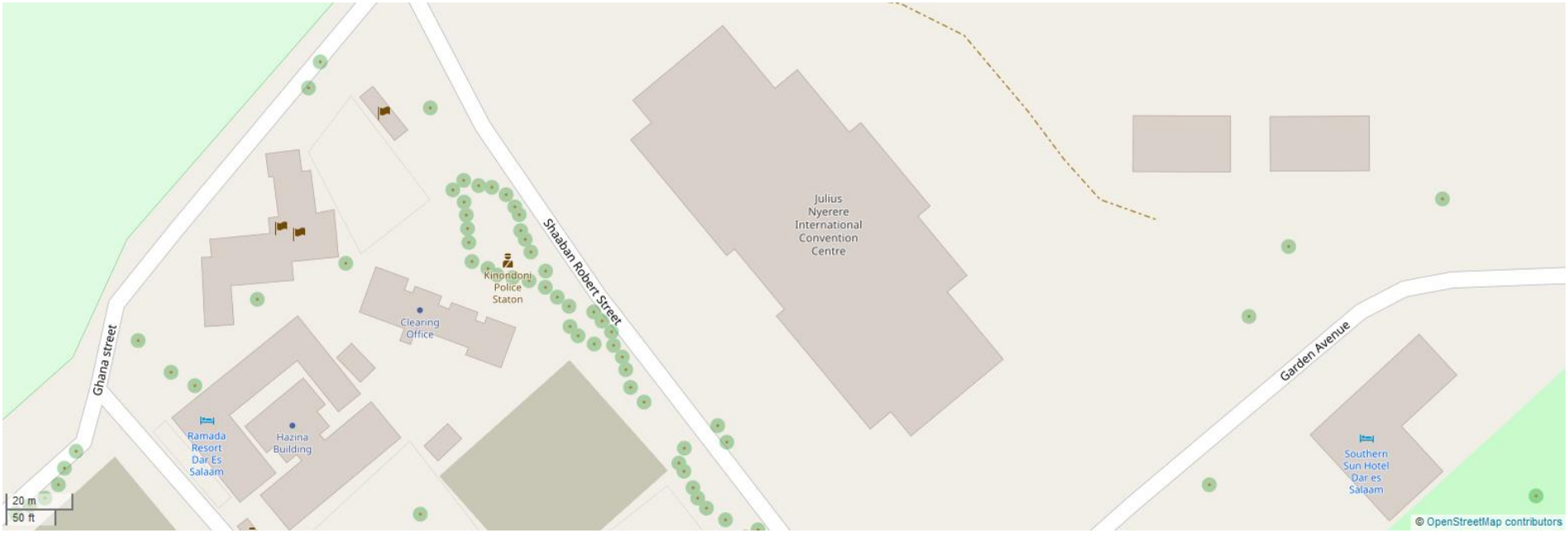
Julius Nyerere International Convention Center, Dar es Salaam | August 31, 2018

OpenStreetMap (OSM)

- The most popular Volunteered Geographic Information (VGI) project:
  - started in 2004, currently featuring 4.8 million contributors
  - largest, most detailed, complete & up-to-date global spatial database
  - available under the Open Database License (ODbL)
  - used by many actors/applications & studied by researchers



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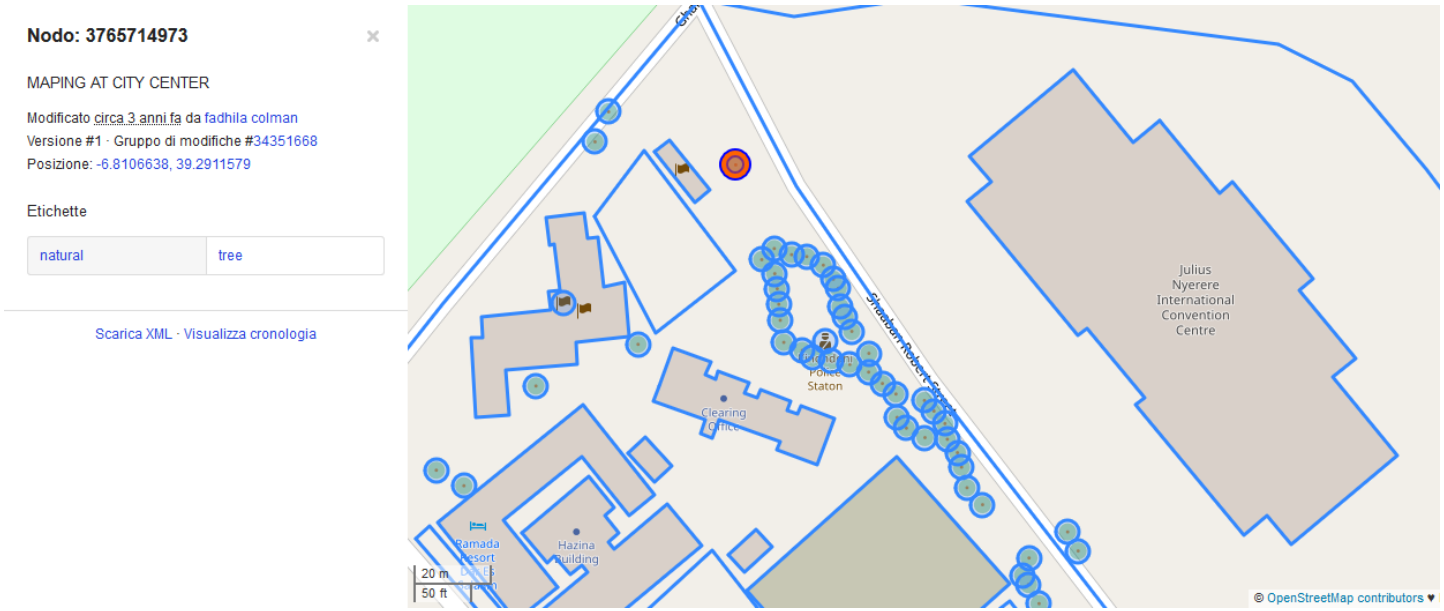

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Percorso: Shaaban Robert Street (25929218)

Align ways to imagery.

Modificato oltre un anno fa da master_raster
Versione #8 · Gruppo di modifiche #46260174

Etichette

highway	residential
name	Shaaban Robert Street
smoothness	good
surface	asphalt
width	4

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Percorso: Julius Nyerere International Convention Centre (192773202)

added the POI information

Modificato 6 mesi fa da Wonderworld
Versione #6 · Gruppo di modifiche #56530976

Etichette

addr:city	Dar es Salaam
addr:country	TZ
addr:street	Shaaban Robert Street
building	public
building:levels	1
building:material	cement_block
name	Julius Nyerere International Convention Centre
wheelchair	yes

OpenStreetMap quality

- The main concern which still limits the widespread use of OSM
- Quality can be assessed through several parameters:
  - positional accuracy
  - completeness
  - logical consistency
  - semantic accuracy
  - thematic accuracy
  - temporal accuracy
  - up-to-dateness
  - lineage
  - fitness-for-use & fitness-for-purpose
  - …

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- OSM quality assessment approaches are:
  - extrinsic, when OSM is compared to a reference dataset
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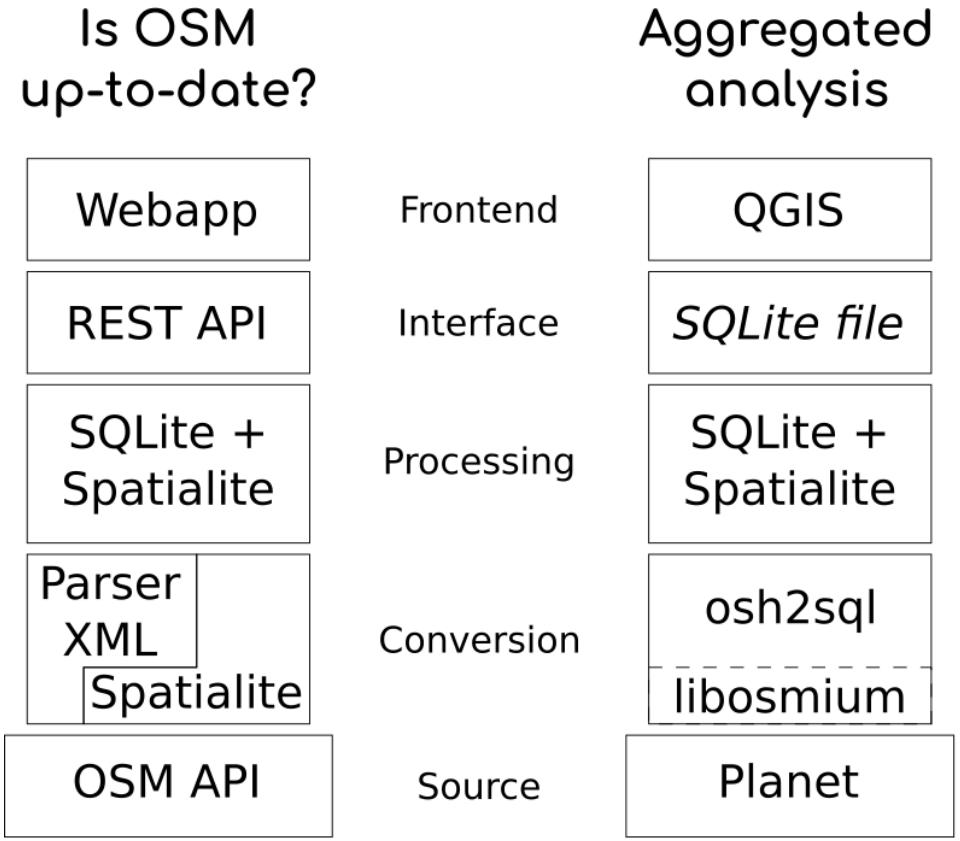
Methodology – Architecture & application

- 2 open source software stacks:
  - web application to return real-time results for single OSM nodes/ways
  - aggregated analysis on a predefined area

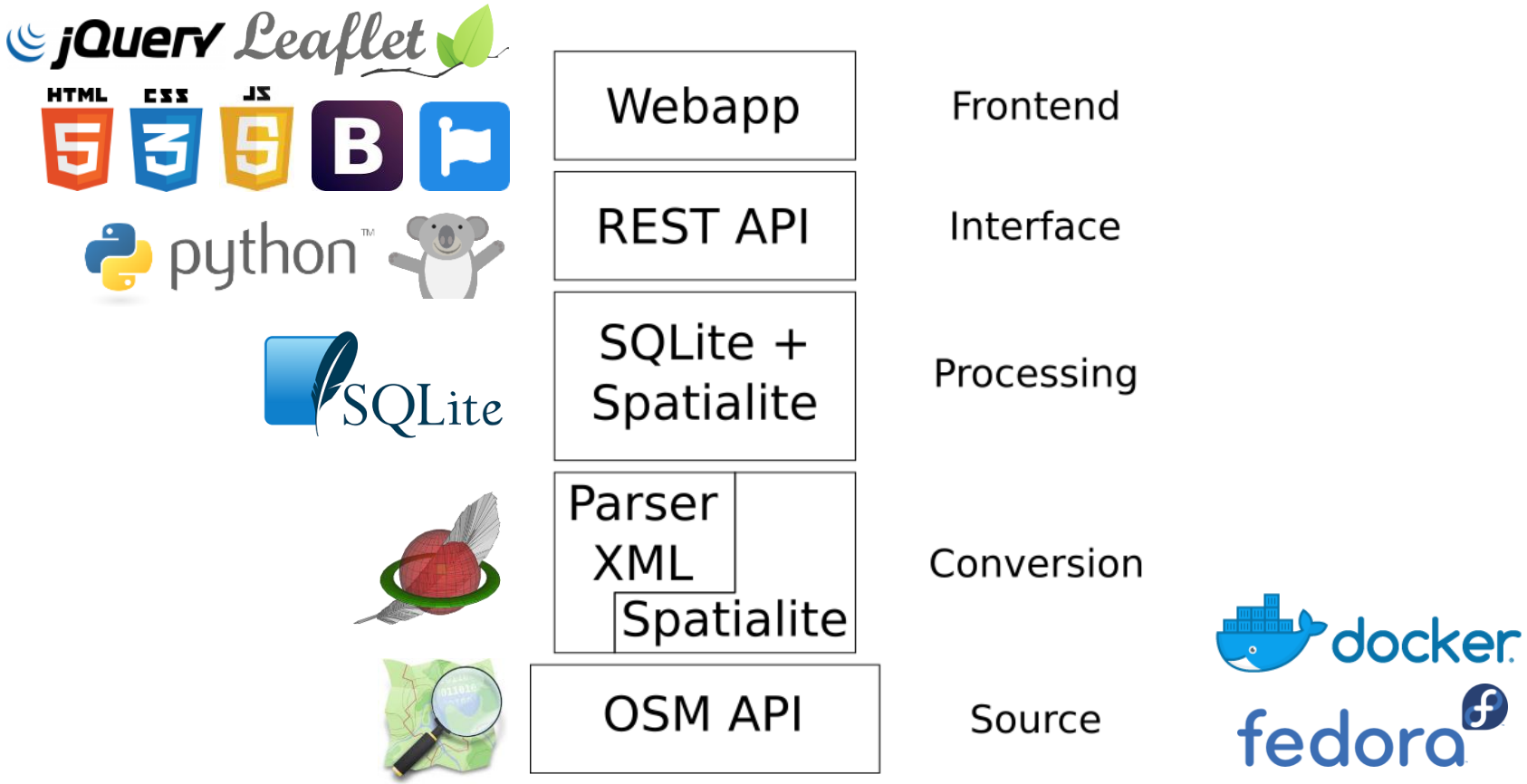


Methodology – Study area & hypotheses

- Study area: Dar es Salaam, Tanzania
  - densely mapped in OSM, mainly thanks to the Dar Ramani Huria project
- Analysis on nodes (POIs) and ways:
  - nodes/ways deleted not considered
  - edits considered are only those with changes in tags
  - changes made in a single changeset count as one single new version
- For the aggregated analysis, data downloaded on May 3, 2018:
  - 129572 nodes and 1156948 ways
  - edits by 1959 different contributors
  - 150716 and 1592221 versions for nodes and ways, respectively

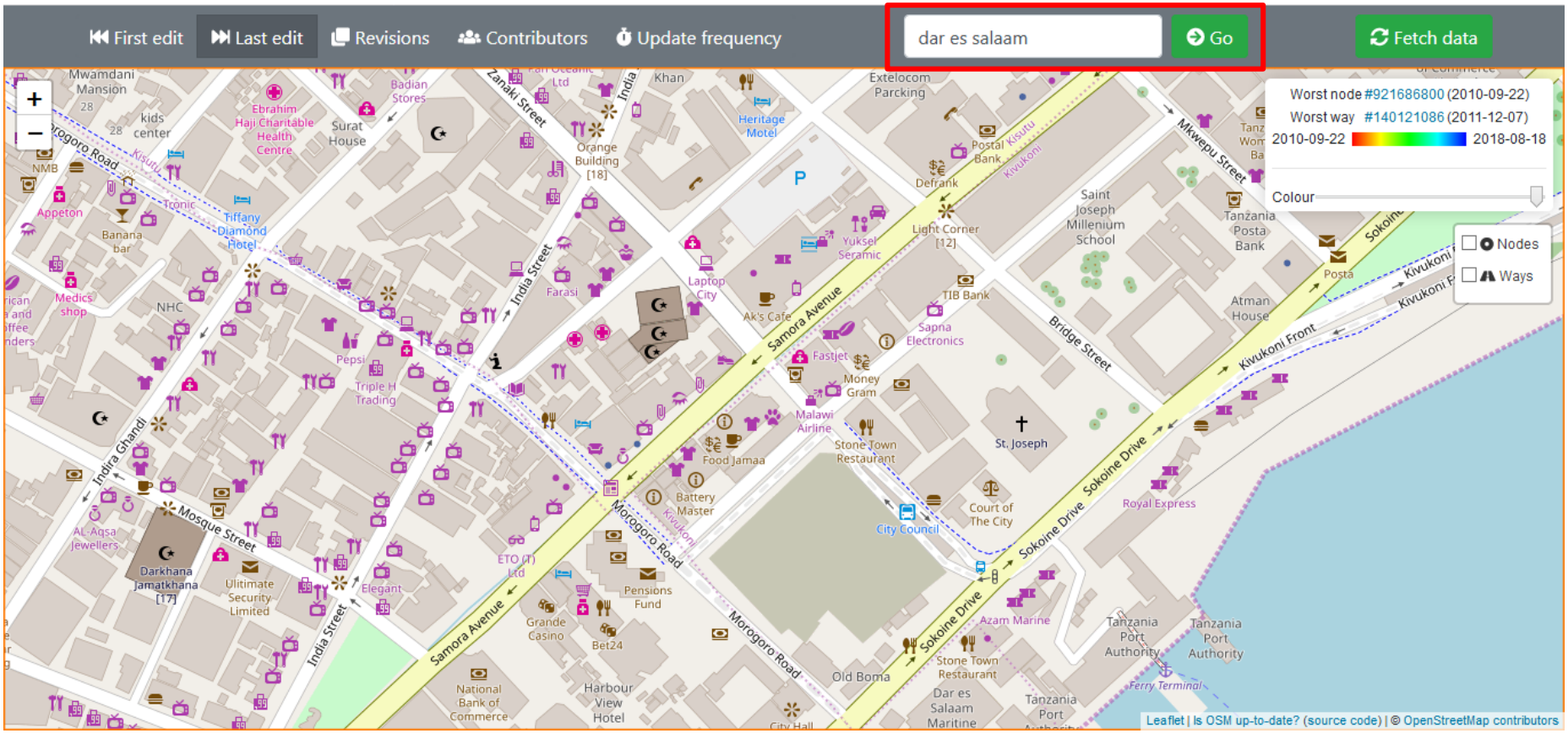
Methodology – Web application

- “Is OSM up-to-date?”: https://is-osm-uptodate.frafra.eu
  - source code (AGPL v3): https://github.com/frafra/is-osm-uptodate
  - description: https://wiki.openstreetmap.org/wiki/Is_OSM_up-to-date



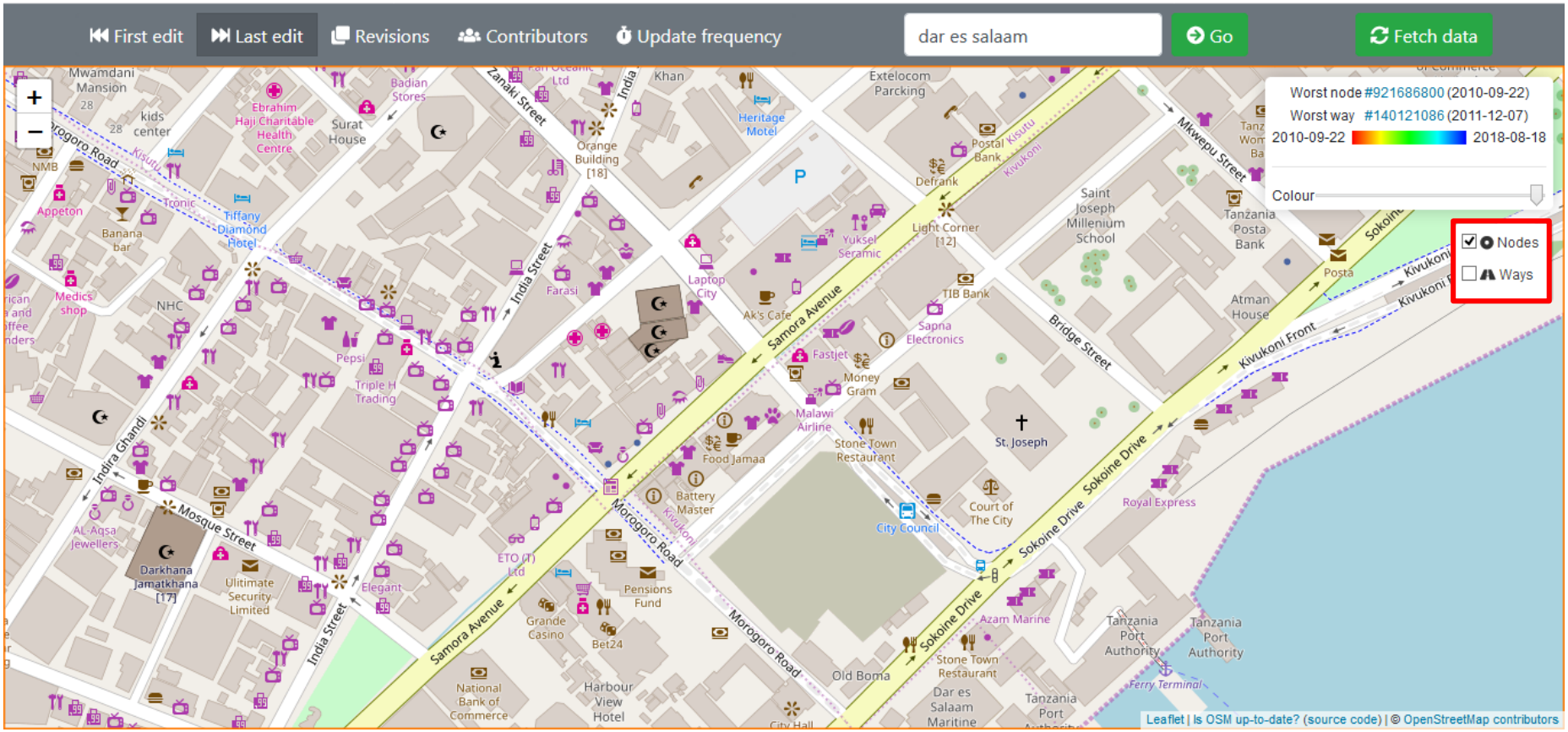
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - search & zoom the map on a specific location



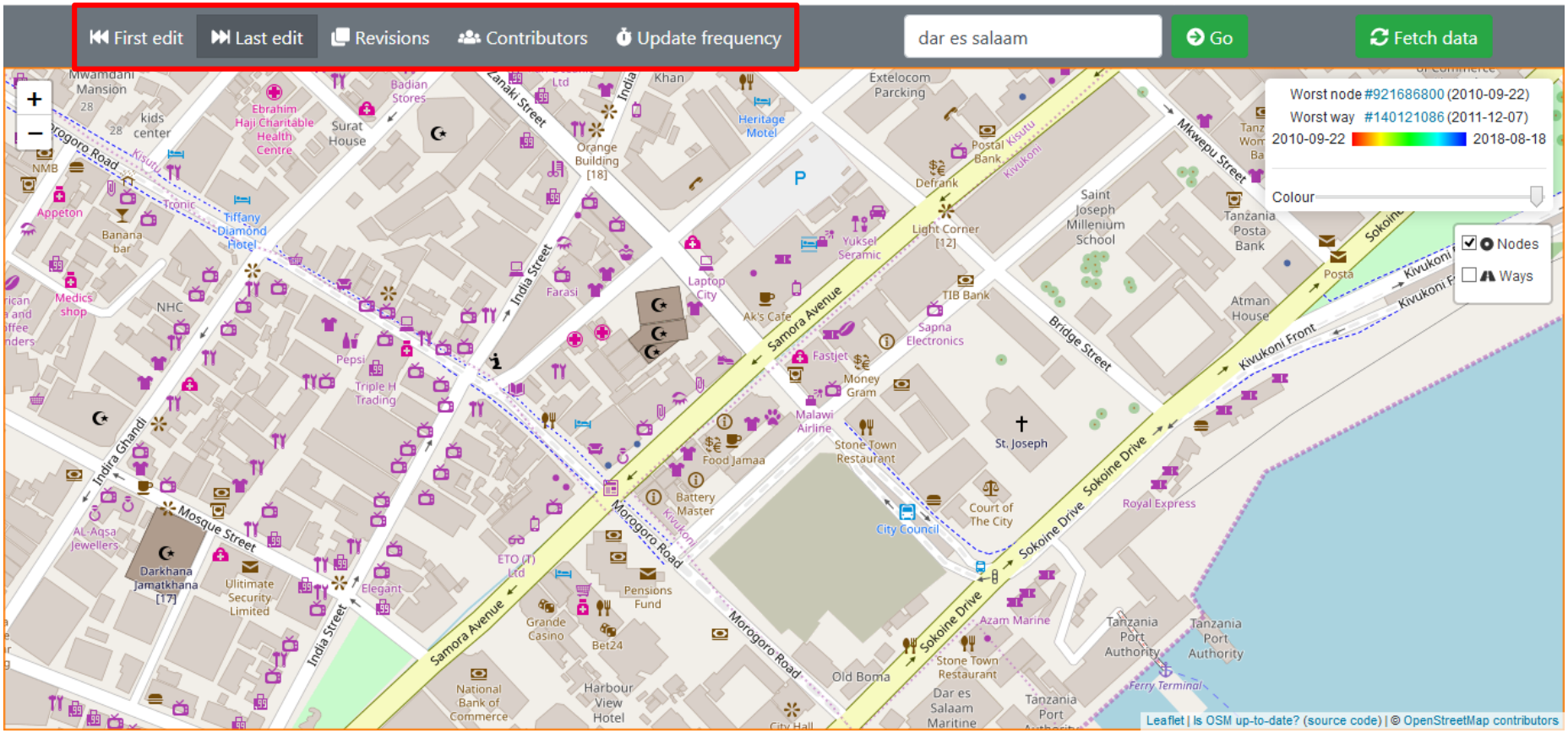
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - choose whether to analyze OSM nodes, ways, or both



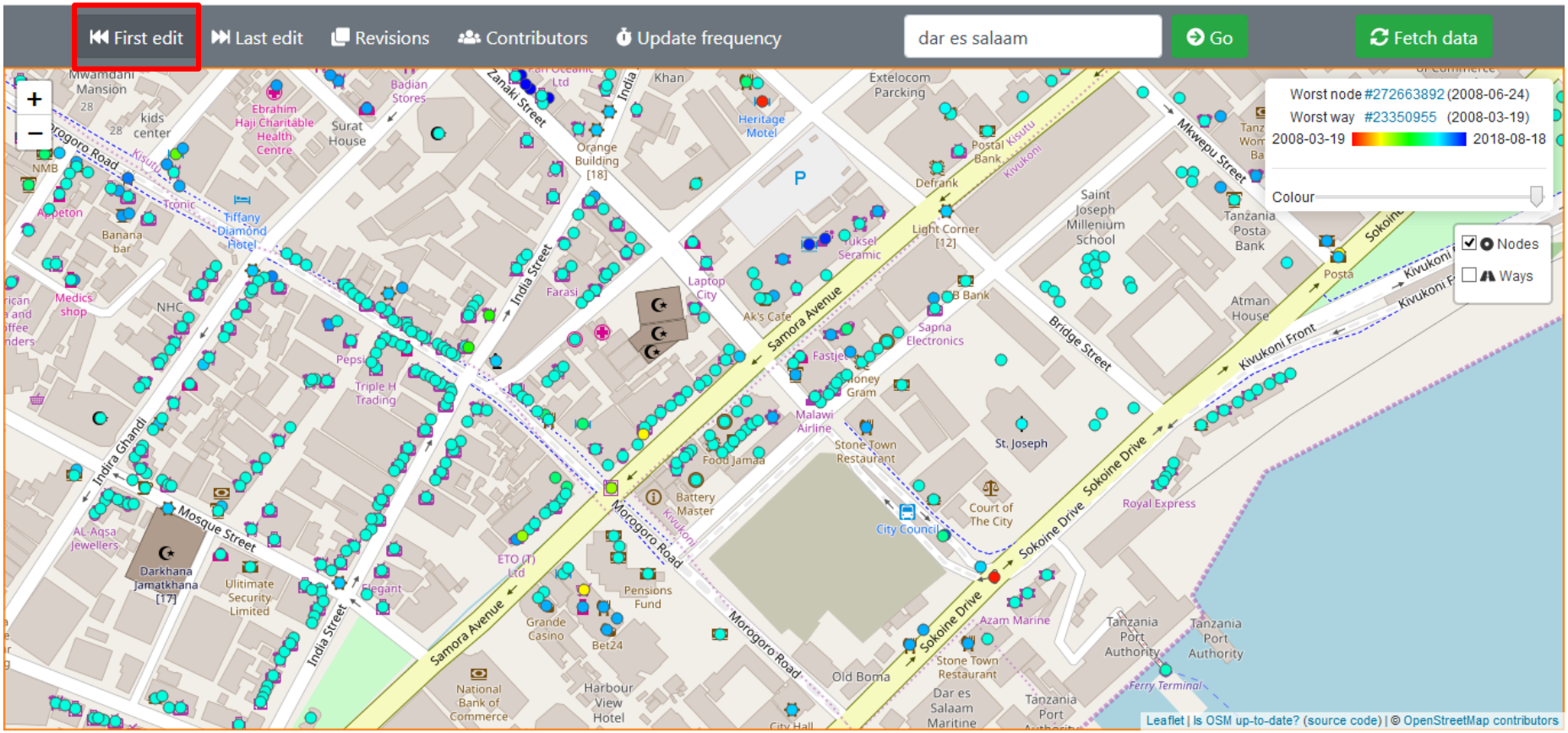
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - choose the attribute to analyze: date of creation, date of last edit, number of versions, number of different contributors, update frequency



Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - visualize color classifications of OSM nodes/ways based on the attribute
    - date of first edit (i.e. creation) of nodes/ways



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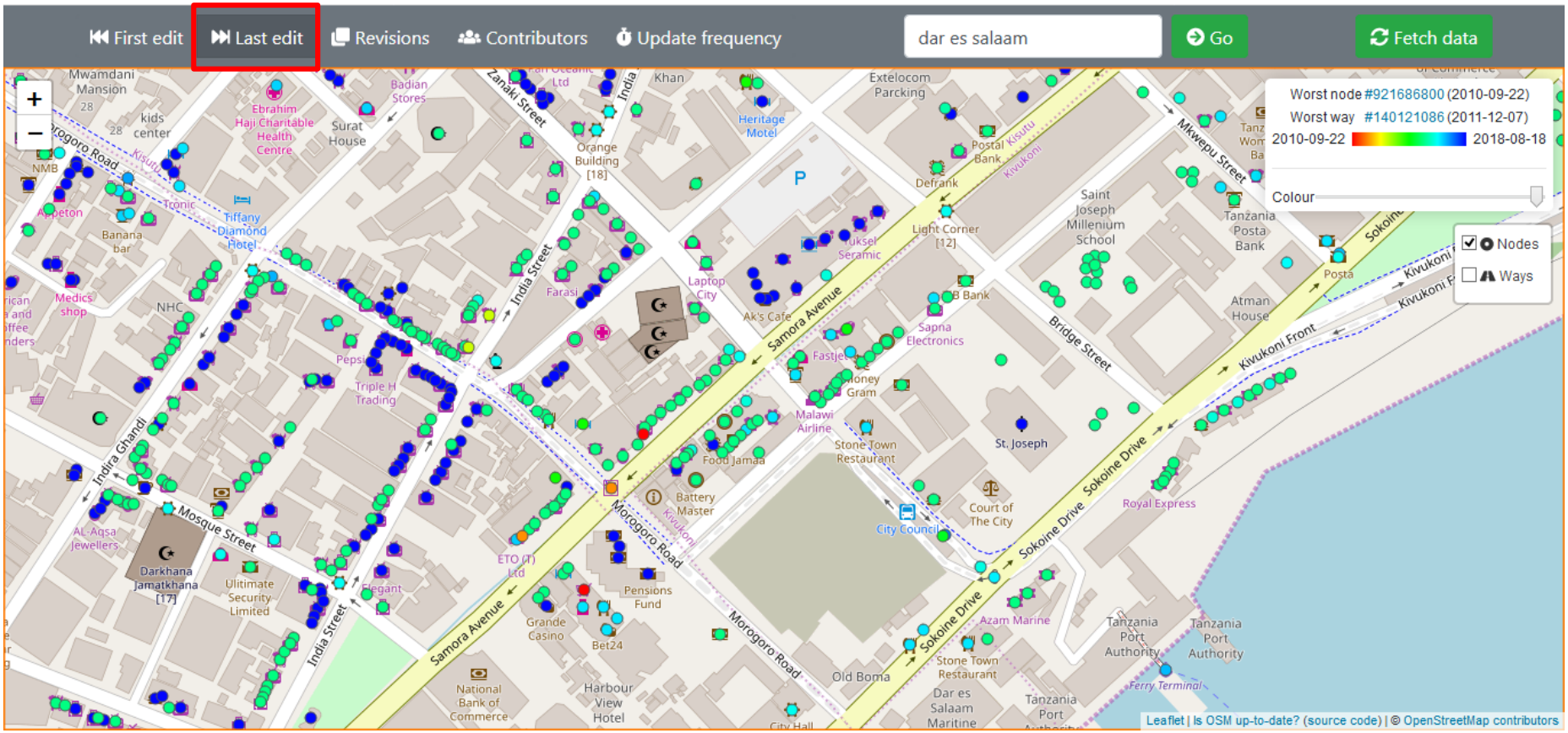

Methodology - Web application

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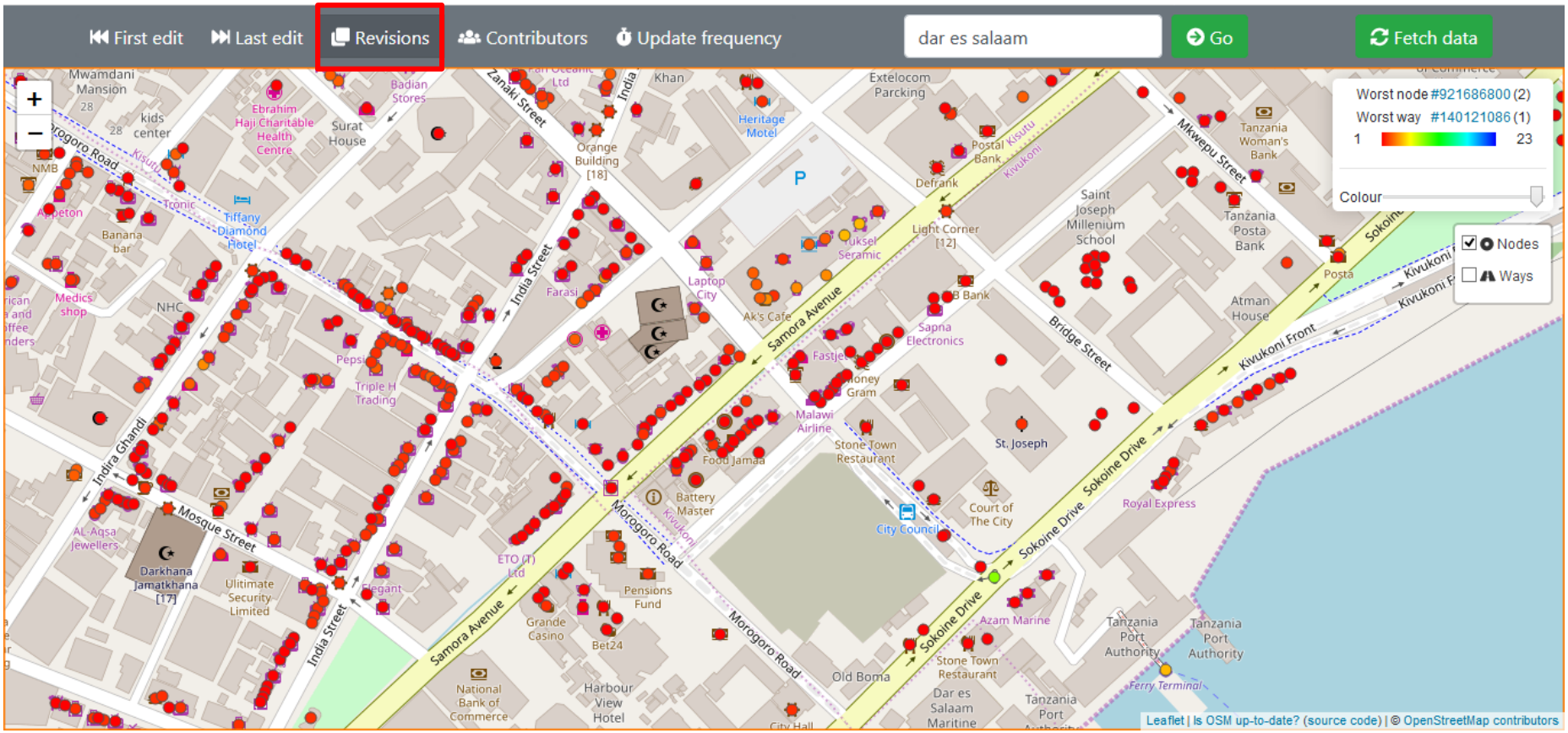
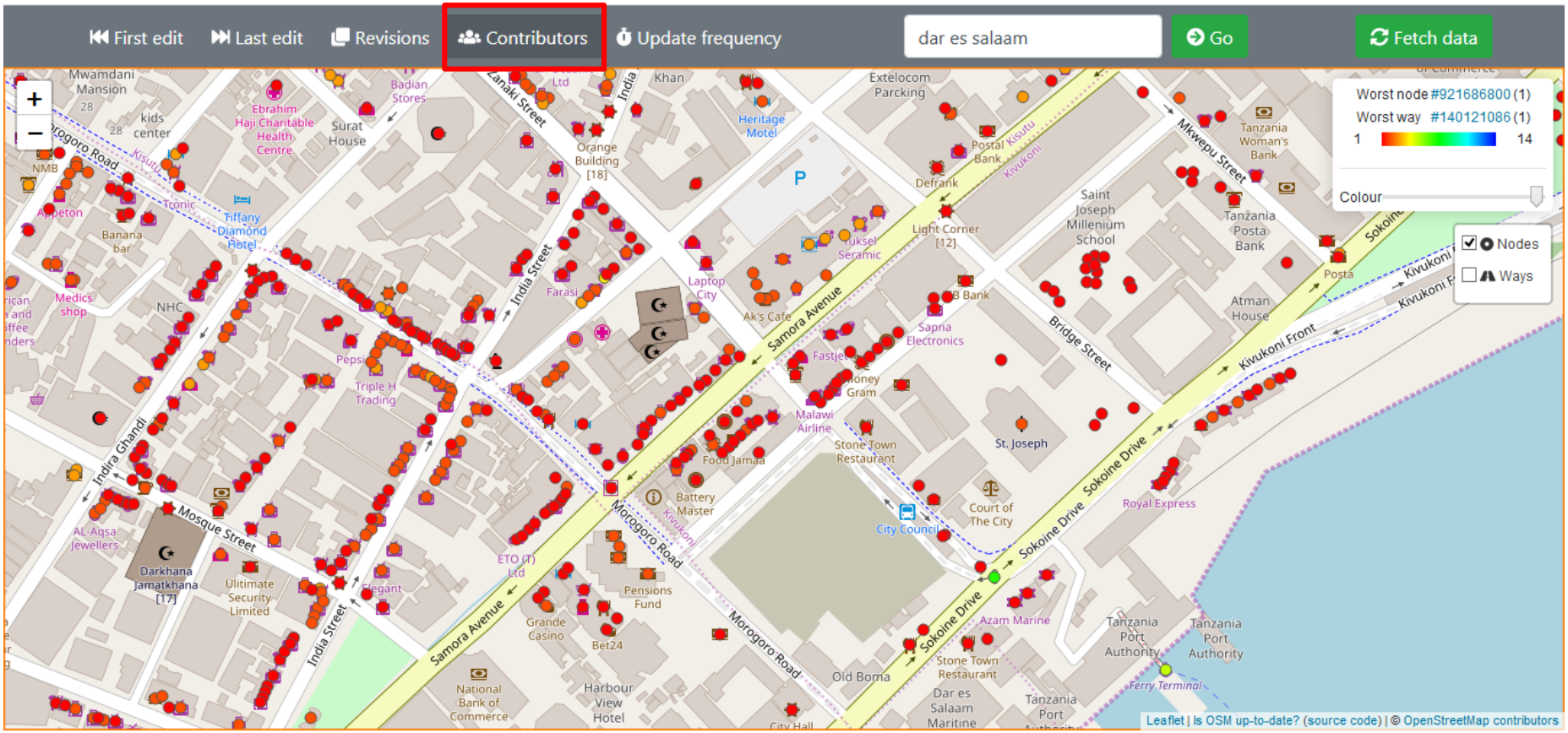


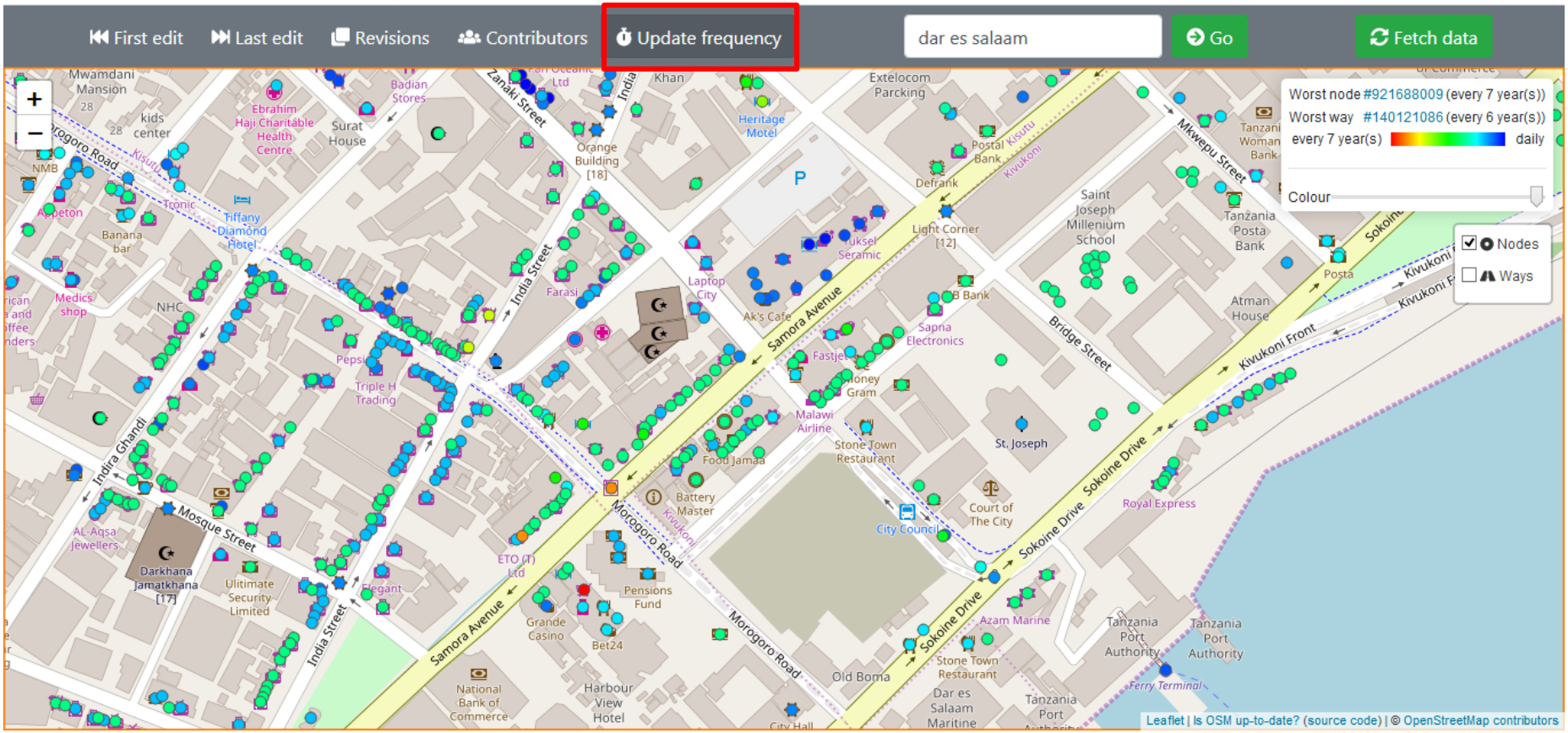
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - visualize color classifications of OSM nodes/ways based on the attribute
    - number of different contributors who have edited the nodes/ways



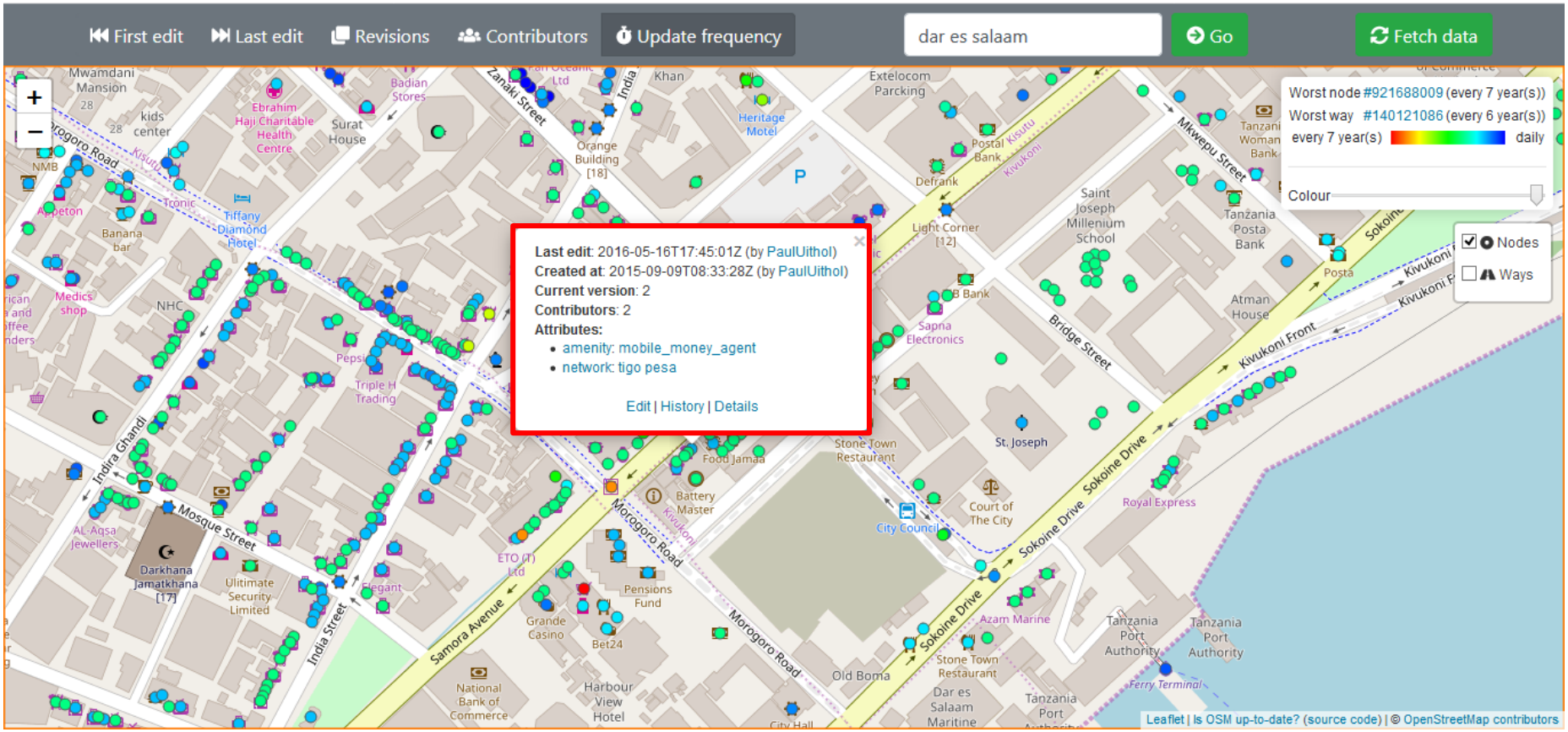
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - visualize color classifications of OSM nodes/ways based on the attribute
    - frequency of update of nodes/ways



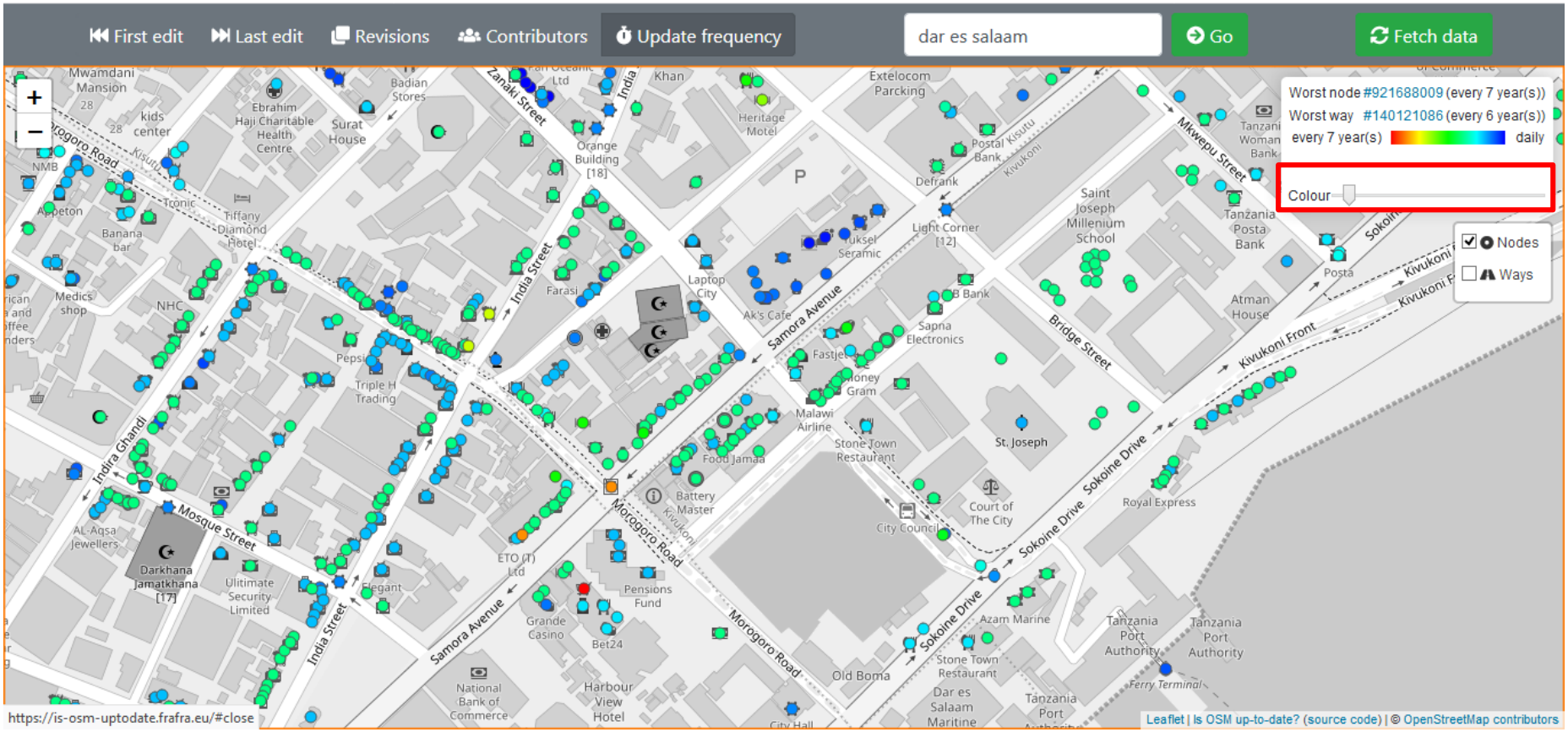
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - click on an OSM node/way to visualize a popup with all the attribute information, tags, and links to visualize/edit the node/way in OSM



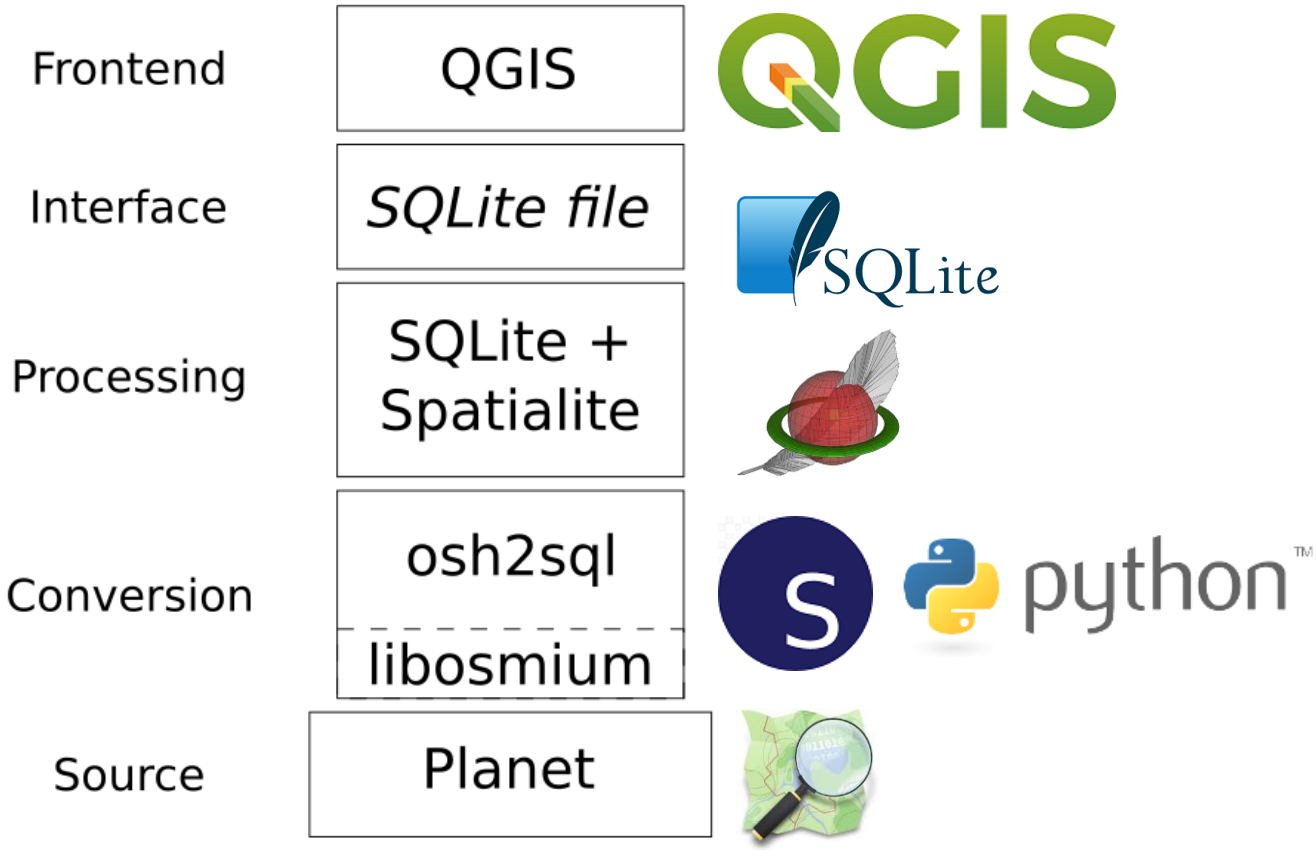
Methodology - Web application

- "Is OSM up-to-date?": https://is-osm-uptodate.frafra.eu
  - adjust the color of the basemap through a colorbar to improve the visualization of OSM nodes/ways



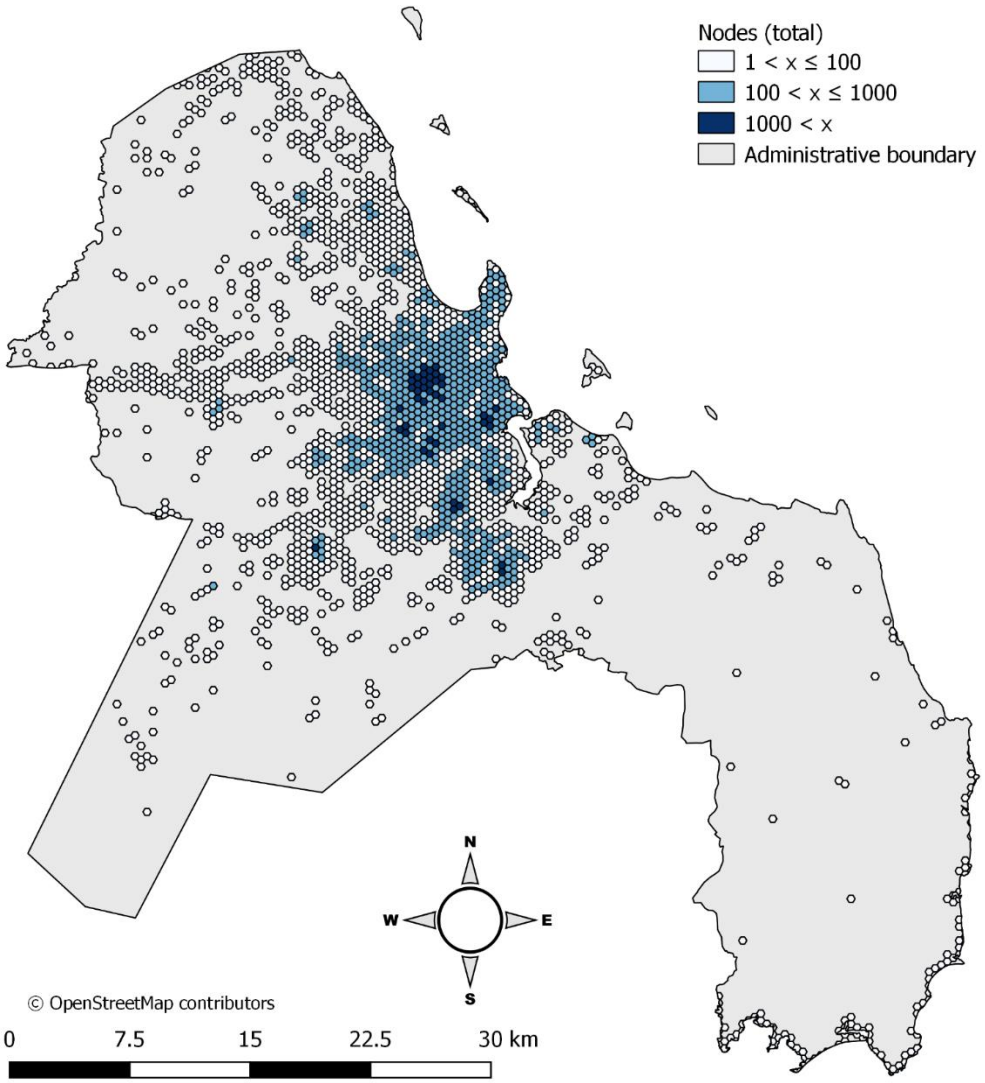
Methodology – Aggregated analysis

- More extensive analysis on a predefined area:
  - aggregate and store results in a database
  - suitable for further GIS processing



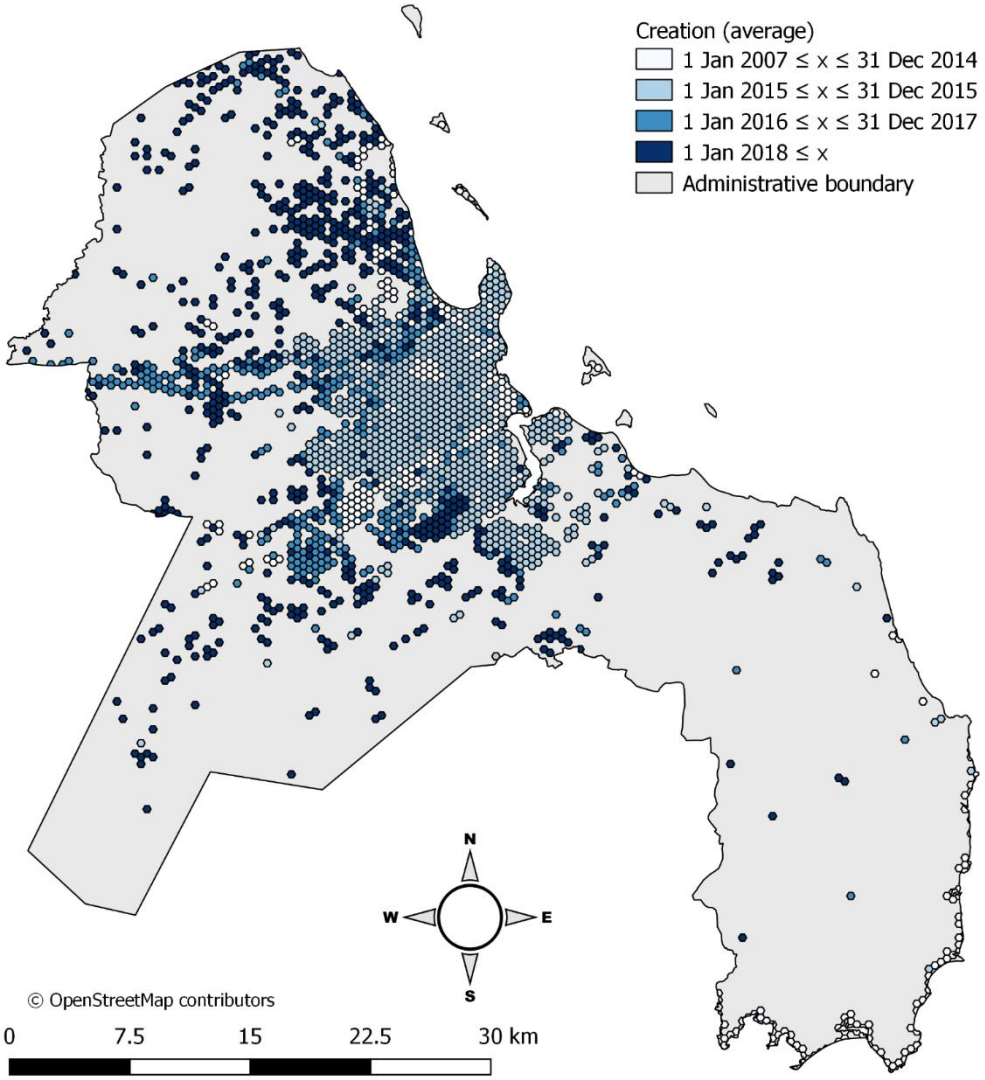
Results - Aggregated analysis

- Total number of OSM nodes:
  - 79% of the total area does not contain any node
  - density of nodes progressively increasing from the rural to the most urbanized areas



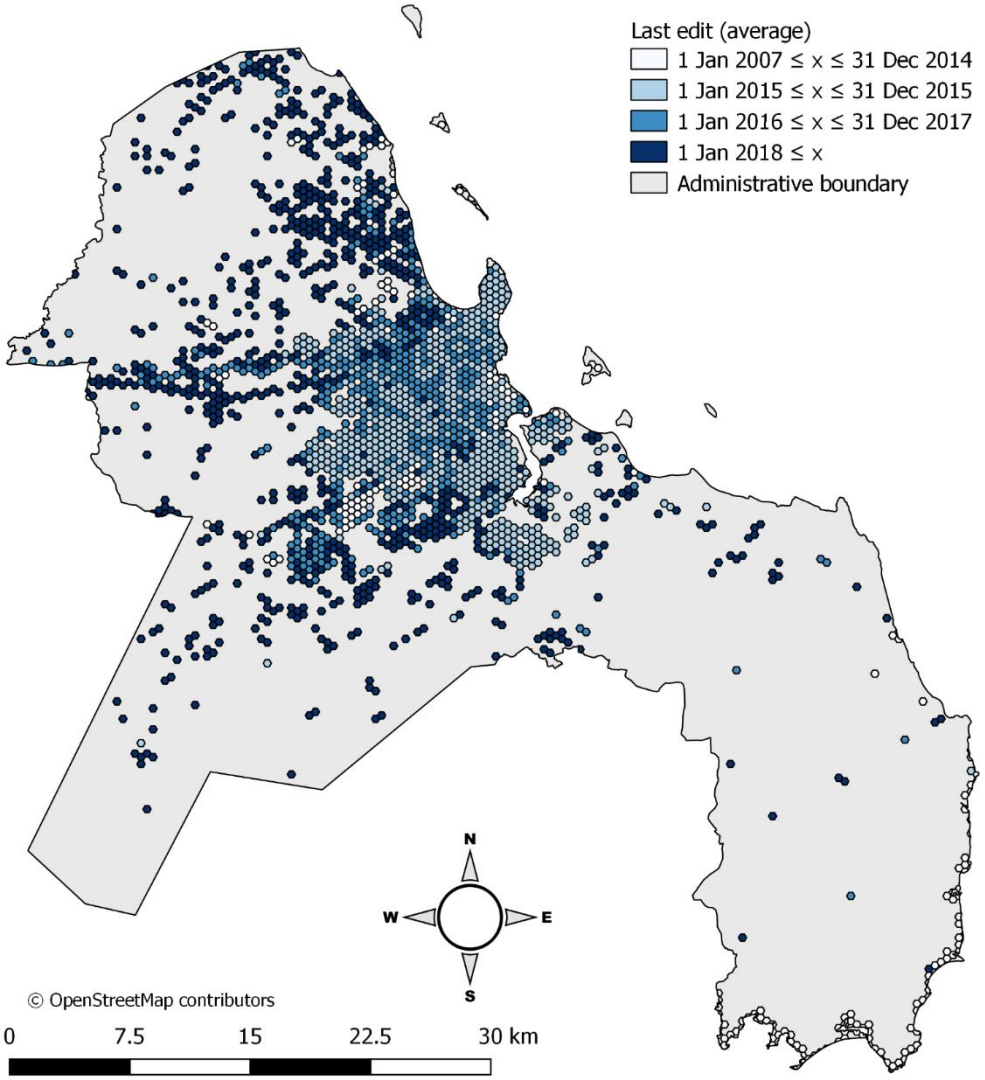
Results - Aggregated analysis

- Average date of creation of OSM nodes:
  - most of the nodes in the city center created in 2015
  - attention gradually moved to the peripheral areas in 2016, 2017 and 2018



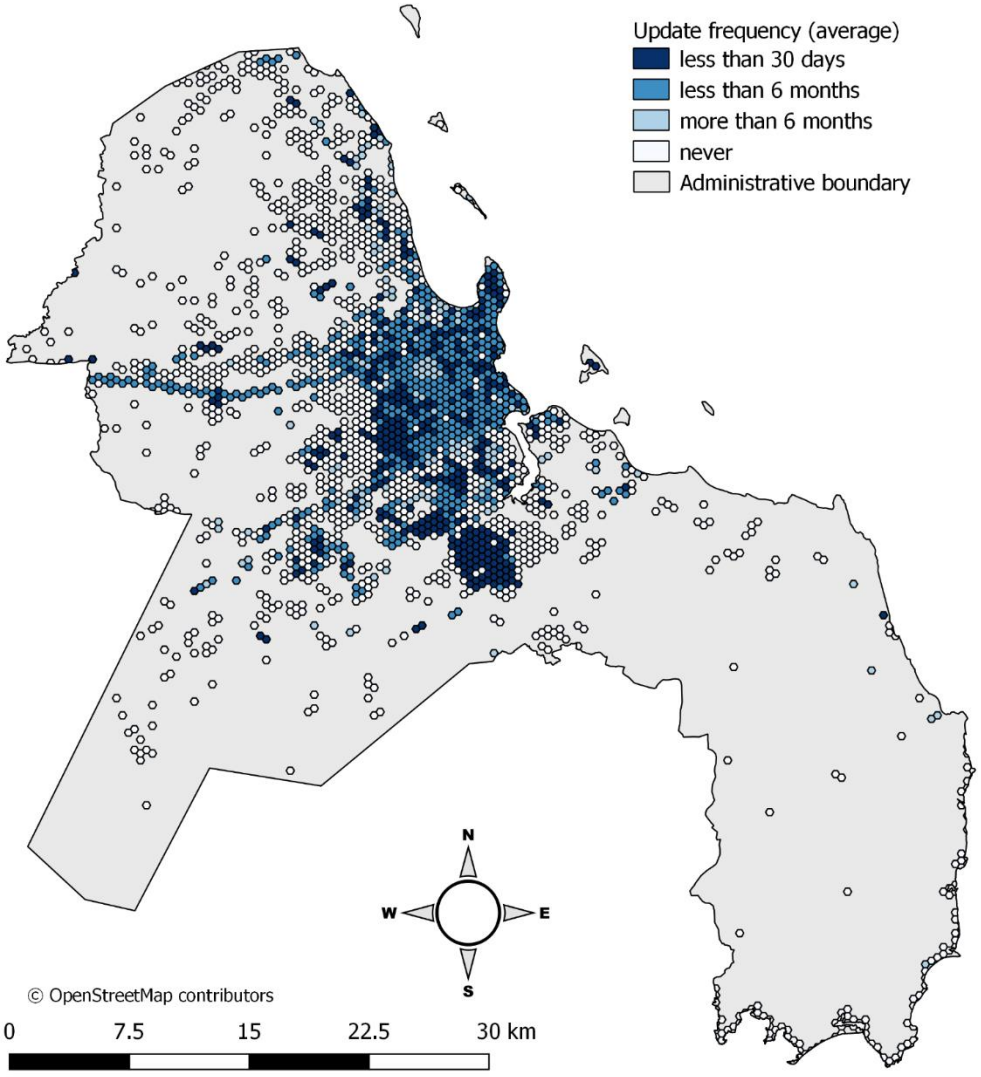
Results - Aggregated analysis

- Average date of last edit of OSM nodes:
  - few of the nodes created in 2014-2015 were later updated
  - mapping in 2018 focused on peripheral areas



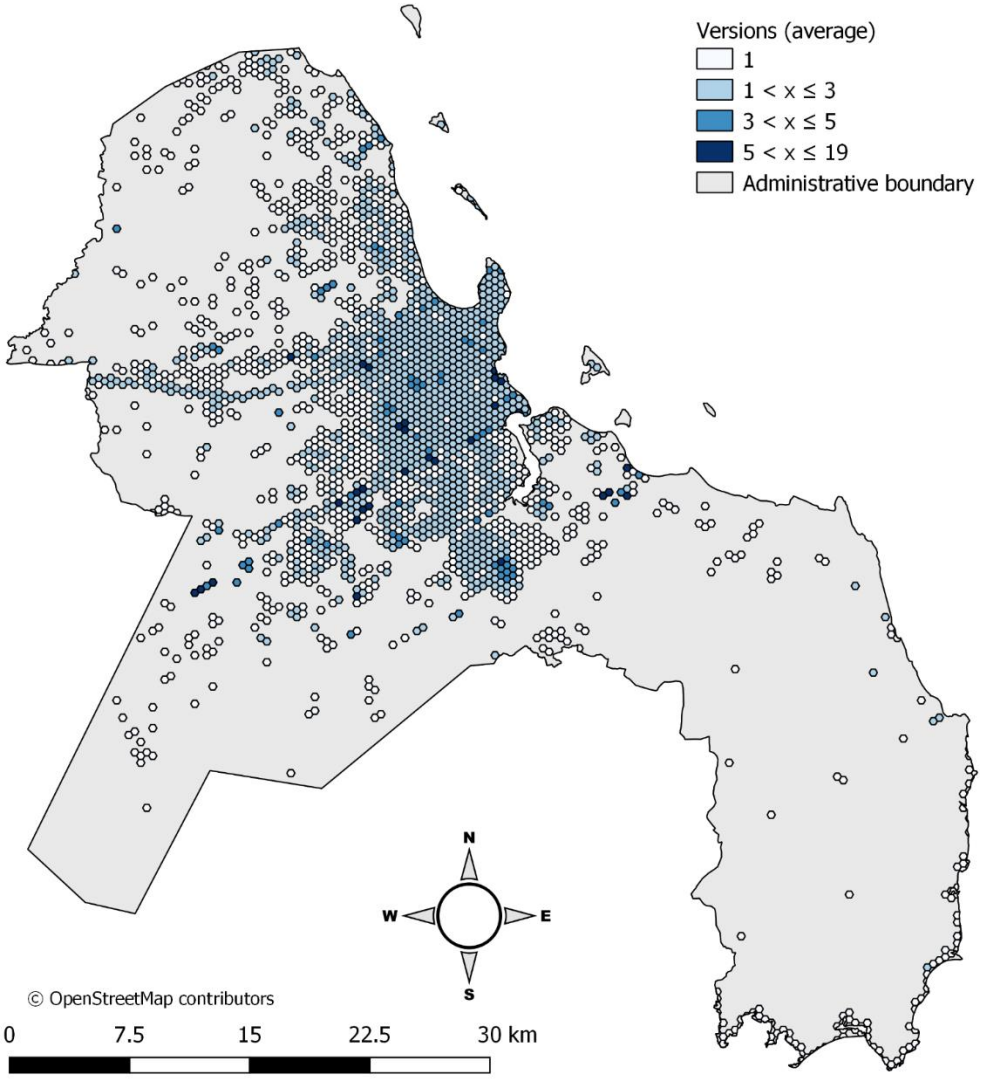
Results - Aggregated analysis

- Average update frequency of OSM nodes:
  - highest update frequencies in the city center
  - most of the nodes created in 2018 have not yet been updated



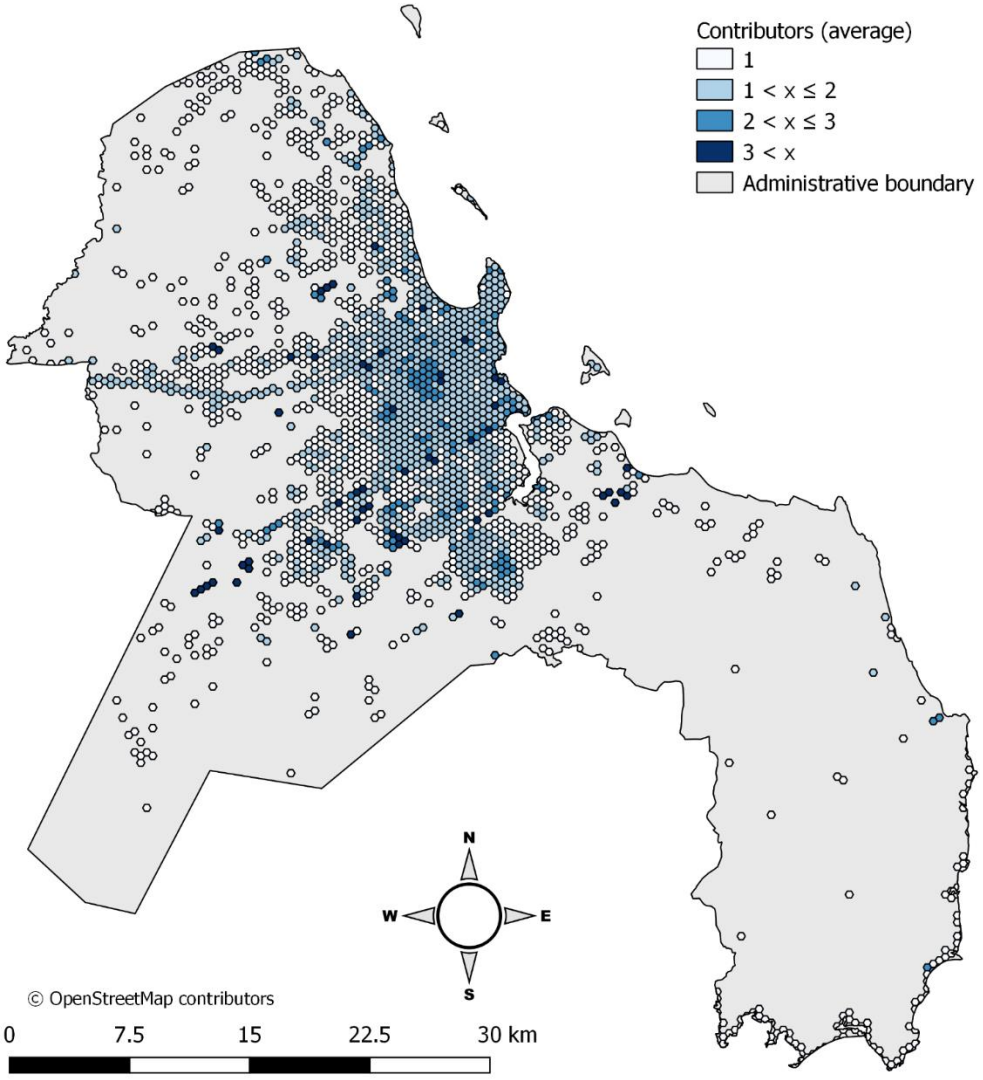
Results - Aggregated analysis

- Average number of versions of OSM nodes:
  - most of recently created nodes not (yet) updated
  - increase in the number of version when moving to the city center



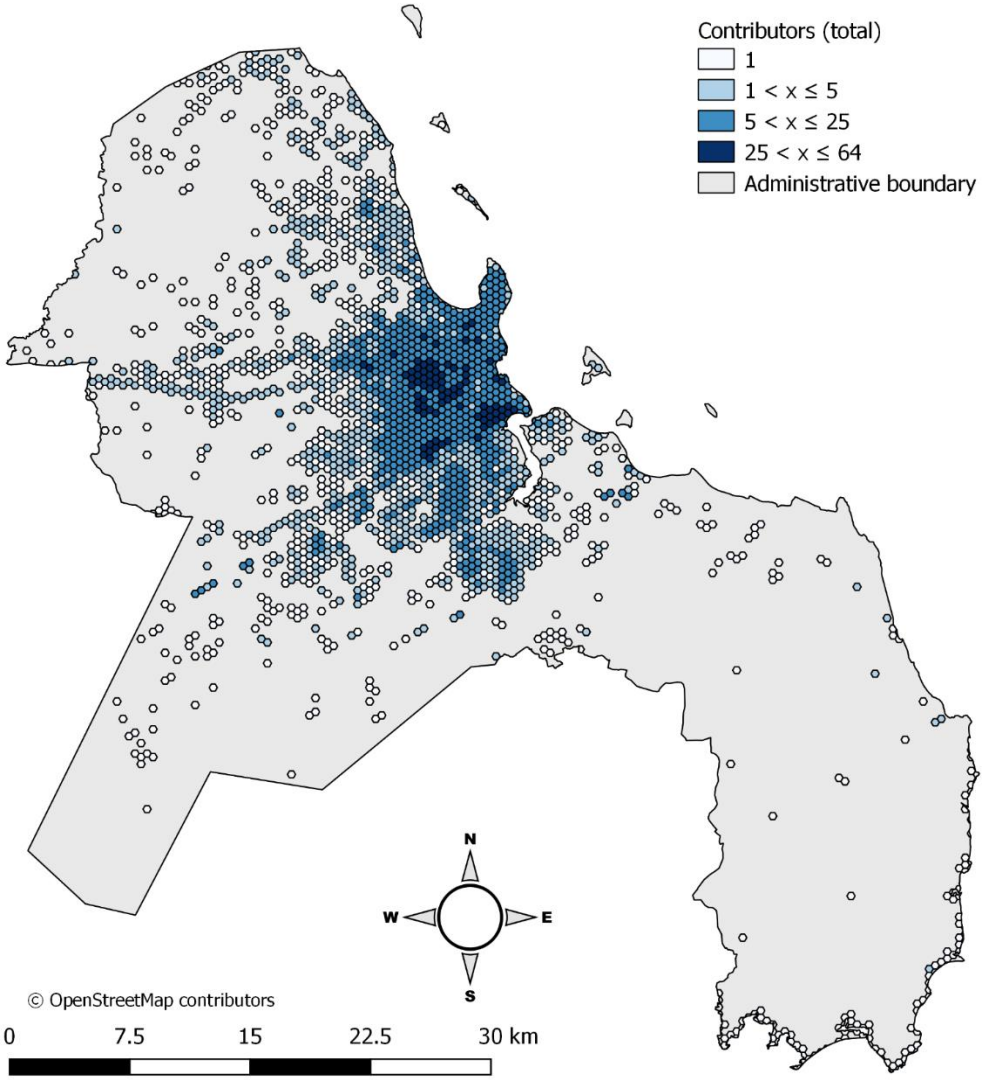
Results - Aggregated analysis

- Average number of different contributors on OSM nodes:
  - equal to 1 for 53% of the cells, mainly in the outskirts
  - increases towards the city center



Results - Aggregated analysis

- Total number of different contributors on OSM nodes:
  - generally equal to 1 in the periphery, increases towards the city center



Conclusions – Quality assessment

- OSM history to unveal the mapping process happened in Dar es Salaam:
  - driven by the Dar Ramani Huria project, started in 2015
  - OSM community was formed
  - mapping gradually expanded from the city center to the periphery

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- Quality (from the intrinsic assessment):
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  - (where OSM is available) temporal accuracy, up-to-dateness and lineage reflect the same center/periphery trend

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- Quality (from the intrinsic assessment):
  - OSM development still at a young stage
  - (where OSM is available) temporal accuracy, up-to-dateness and lineage reflect the same center/periphery trend
  - completeness decreases fom center to periphery
  - fitness-for-use for the requirements of the Dar Ramani Huria project is high (infastructure networks)

Conclusions – Future work

- Customize the intrinsic analysis for specific categories of OSM objects:
  - addresses, commercial activities, natural elements, etc. which have very different update cycles
- Combine the history of OSM objects with the history of OSM contributors:
  - data reliability may depend on the contributor's experience
  - a single quality index?
- Correlate quality elements with demographic/territorial parameters:
  - population density, elevation, land cover/land use, etc.

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- FOSS4G technology was key to achieve this!

References & Acknowledgements

- Reference material:
  - SQLite database table with aggregated OSM data: https://frafra.eu/archive/osm/dar-es-salaam.zip
  - corresponding paper: https://tinyurl.com/y7ryboqb
  - this presentation: https://tinyurl.com/ybmrukwt

- Special thanks to:

isprs

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Thank you!

Marco Minghini – marco.minghini@ec.europa.eu | @MarcoMinghini

A Special Issue of interest

- Special Issue: Open Source Geospatial Software
- Journal: Open Geospatial Data, Software and Standards (Springer)
- Guest Editors:
  - Marco Minghini, European Commission – Joint Research Center, Italy
  - Amin Mobasheri, Heidelberg University, Germany
  - Victoria Rautenbach, University of Pretoria, South Africa
  - Maria Antonia Brovelli, Politecnico di Milano, Italy
- Articles accepted:
  - standard research articles
  - software articles, focused on open source software of broad interest
- APC: $1030 – some fee waivers available, please contact us!
- Deadline: November 15, 2018
- Link: https://opengeospatialdata.springeropen.com/osgs