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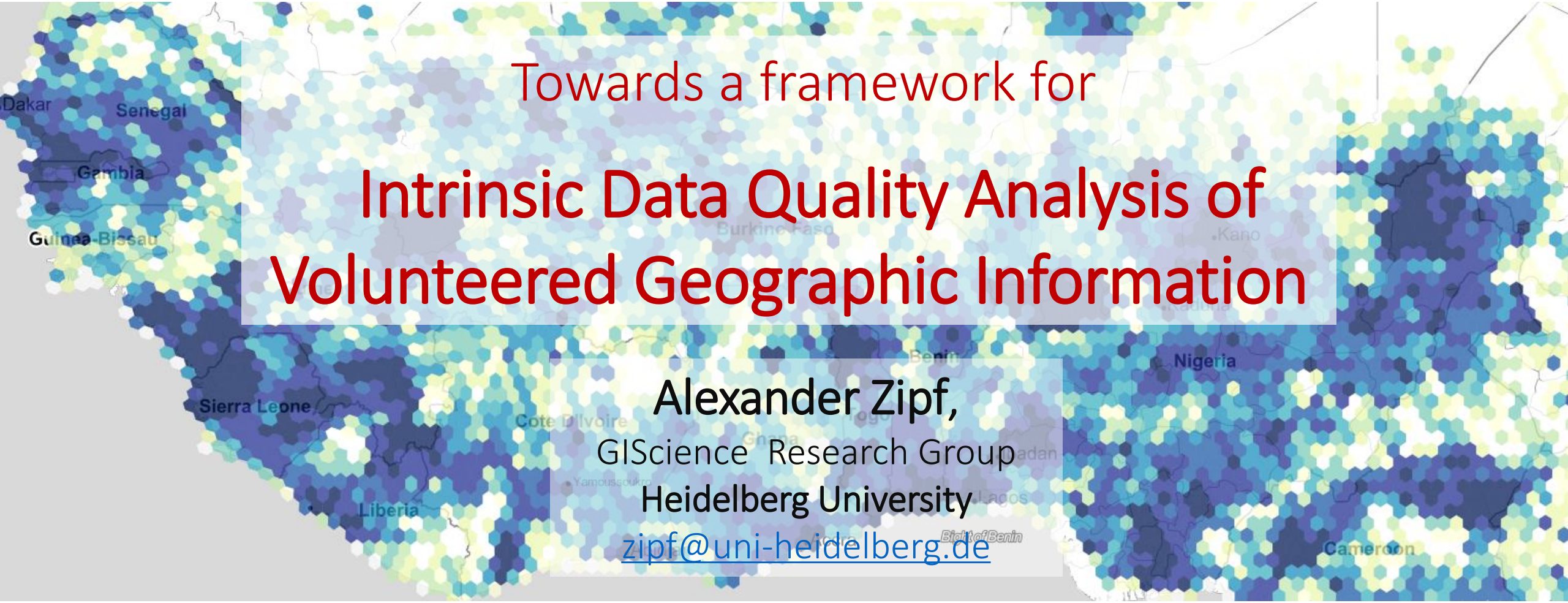

Towards a framework for

Intrinsic Data Quality Analysis of Volunteered Geographic Information

Alexander Zipf,
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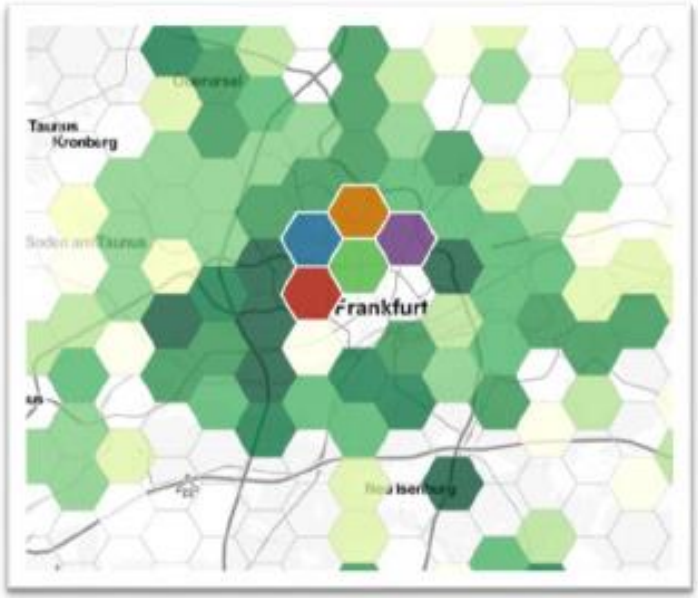

Smart Mobility
OpenRouteService.org

VGI for Humanitarian Aid

Big Spatial Data Analytics

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Dimensions of Spatial Data Quality

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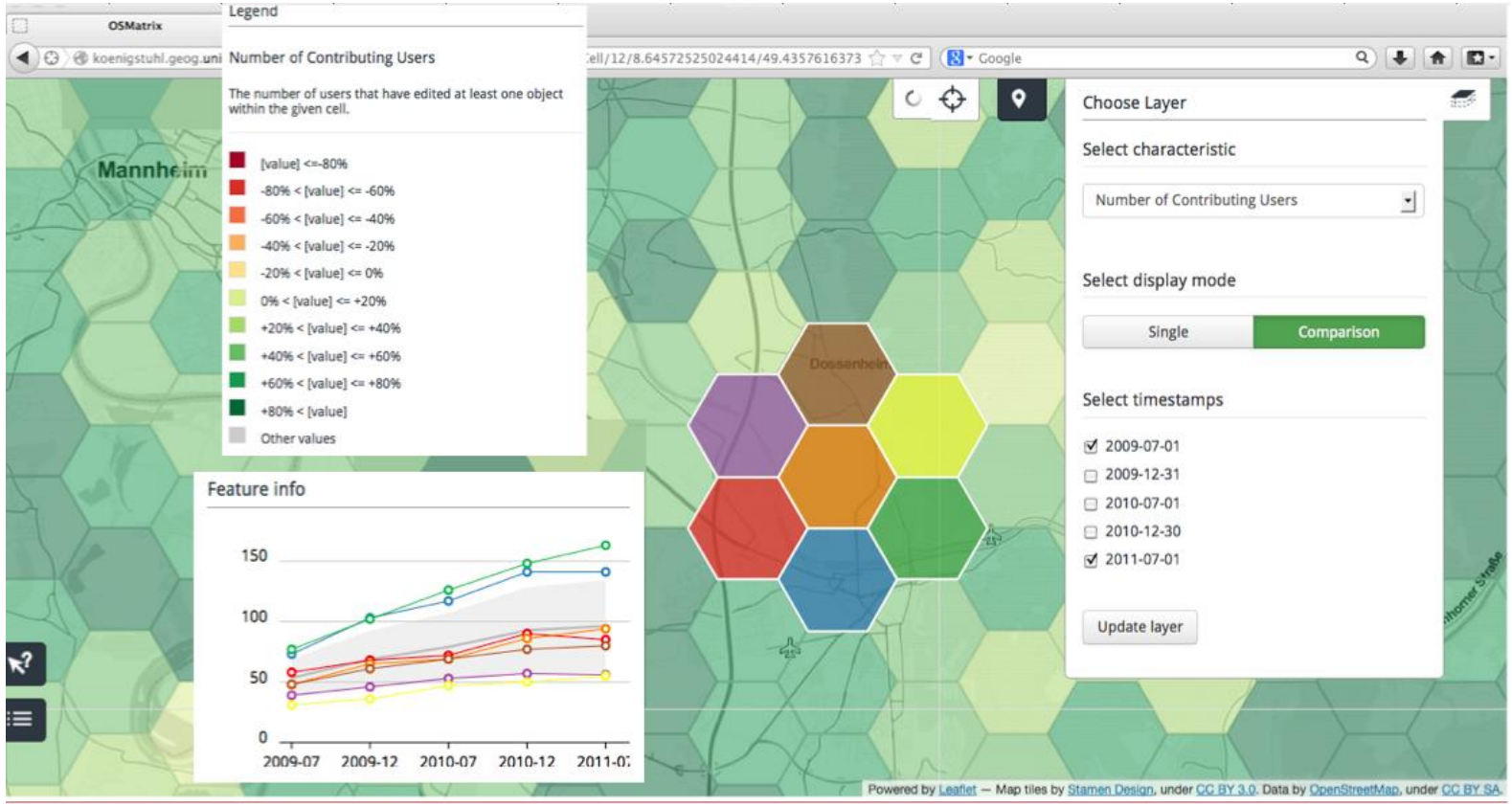
- Lineage
- Completeness
- Logical Consistency
- Positional Accuracy
- Attribute Accuracy
- etc…



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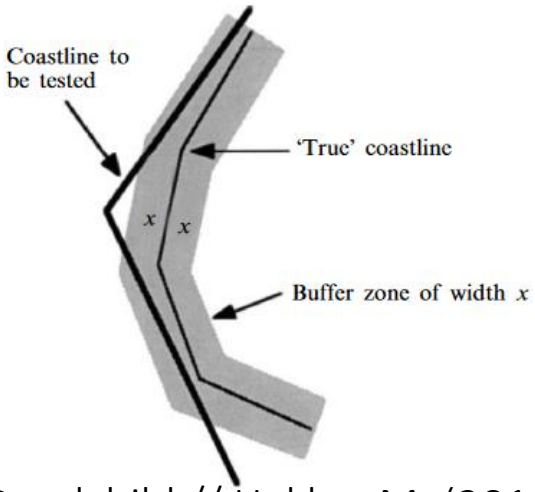
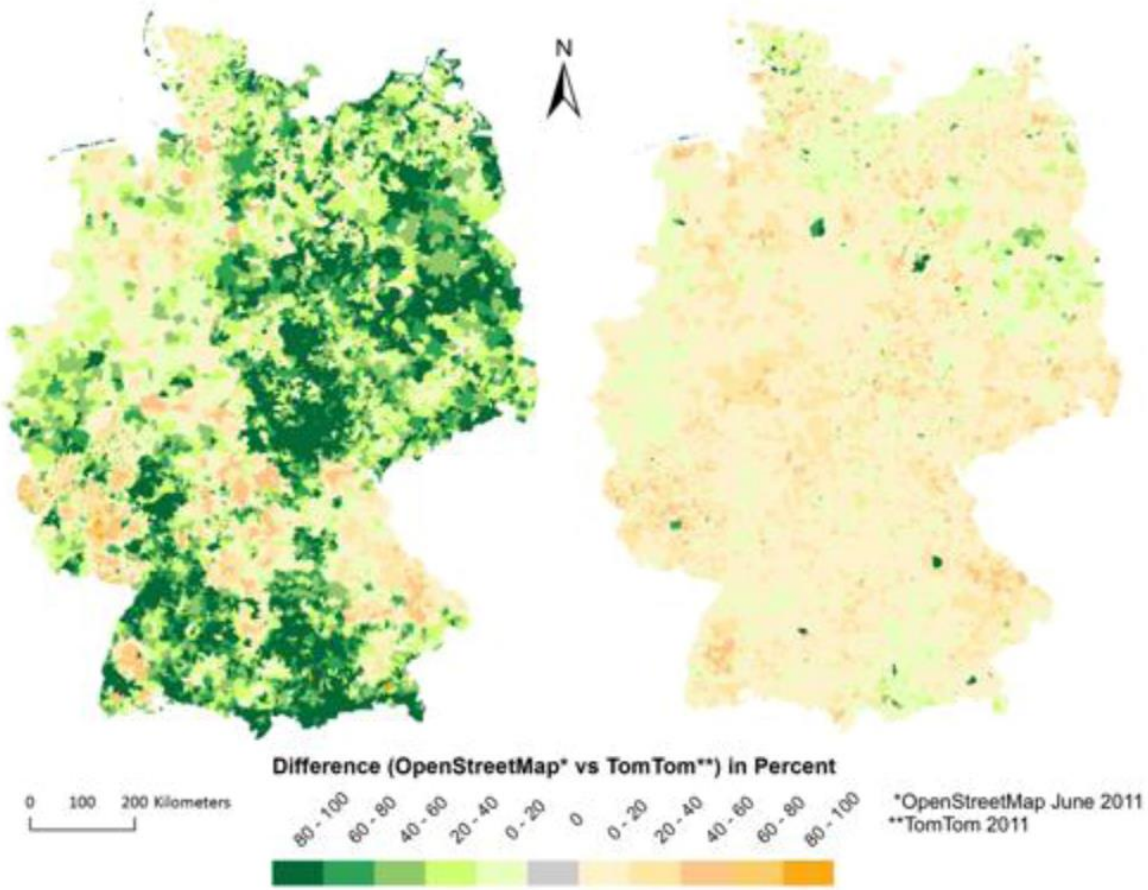
VGI Data Quality



Goodchild // Haklay, M. (2010)



Neis, Zielstra & Zipf (2012): The Street Network Evolution of Crowdsourced Maps - OpenStreetMap in Germany 2007-2011 Future Internet. Vol.4, pp.1-21 .

iOSManalyser: Intrinsic OSM Analysis

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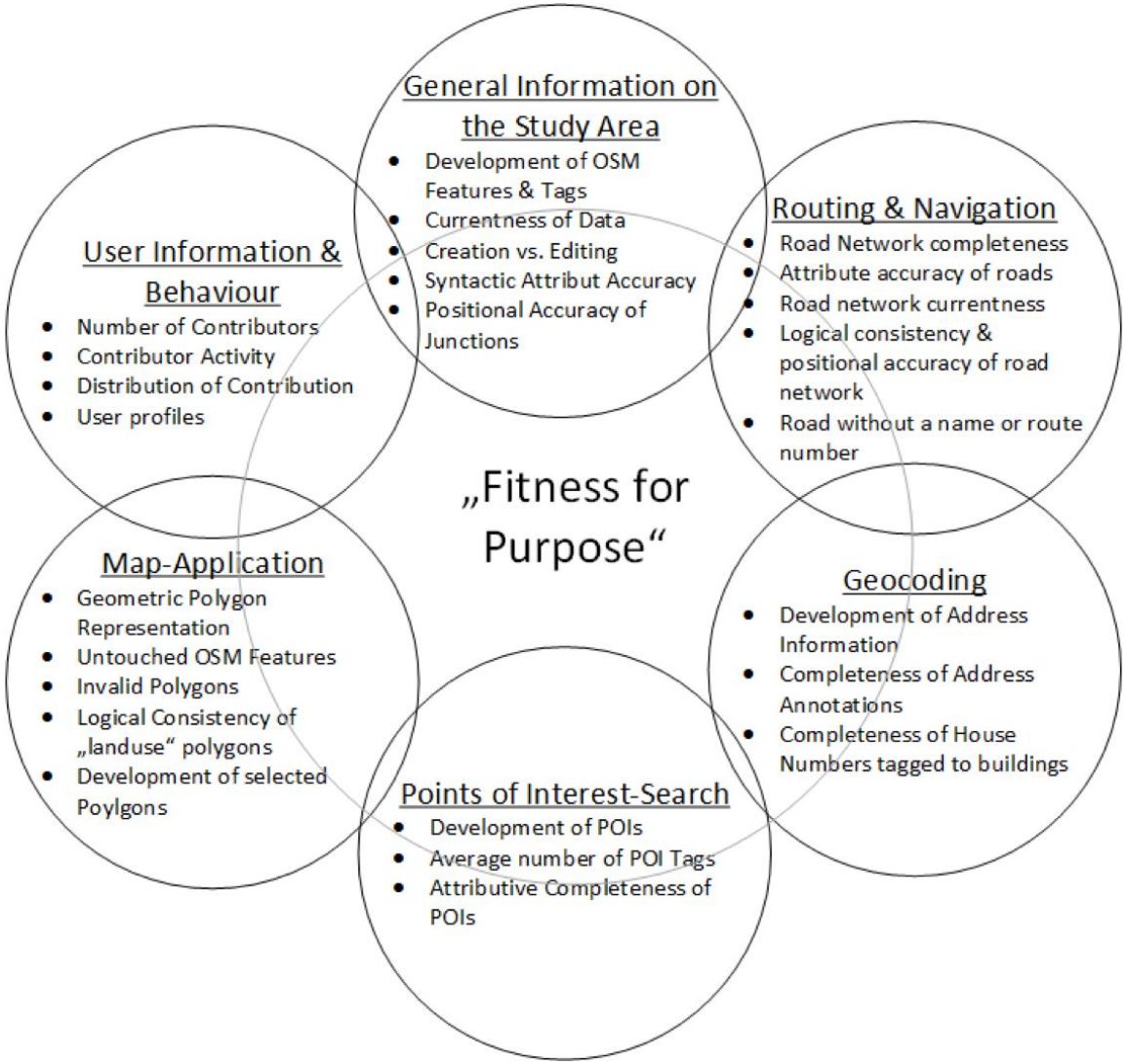

Barron, C., Neis, P. & Zipf, A. (2013):
A Comprehensive Framework for Intrinsic OpenStreetMap Quality Analysis.
Transactions in GIS DOI: 10.1111/tgis.12073.

OpenStreetMap Analytics *beta*

PyOsmium
Python bindings to Osmium Library

Epic-OSM

etc.

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iOSManalyser: Intrinsic Quality Indicators

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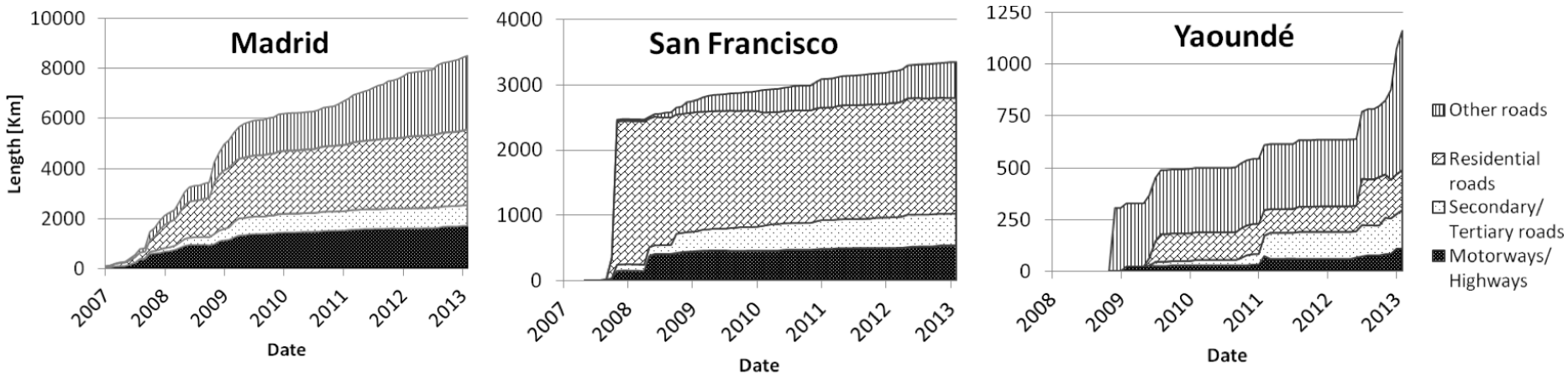

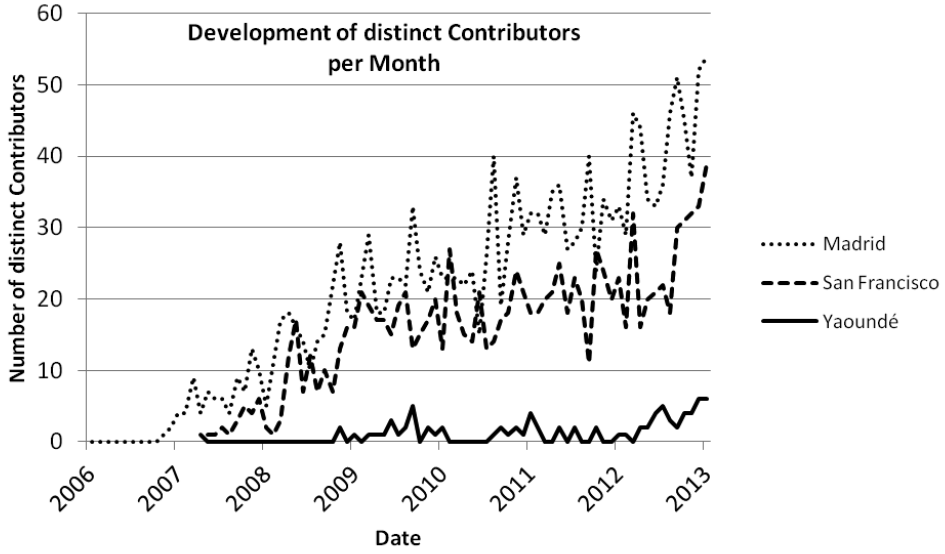

Barron, C., Neis, P. & Zipf, A. (2013): **A Comprehensive Framework for Intrinsic OpenStreetMap Quality Analysis**. Transactions in GIS, DOI: 10.1111/tgis.12073.

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OSMapper Contribution Index

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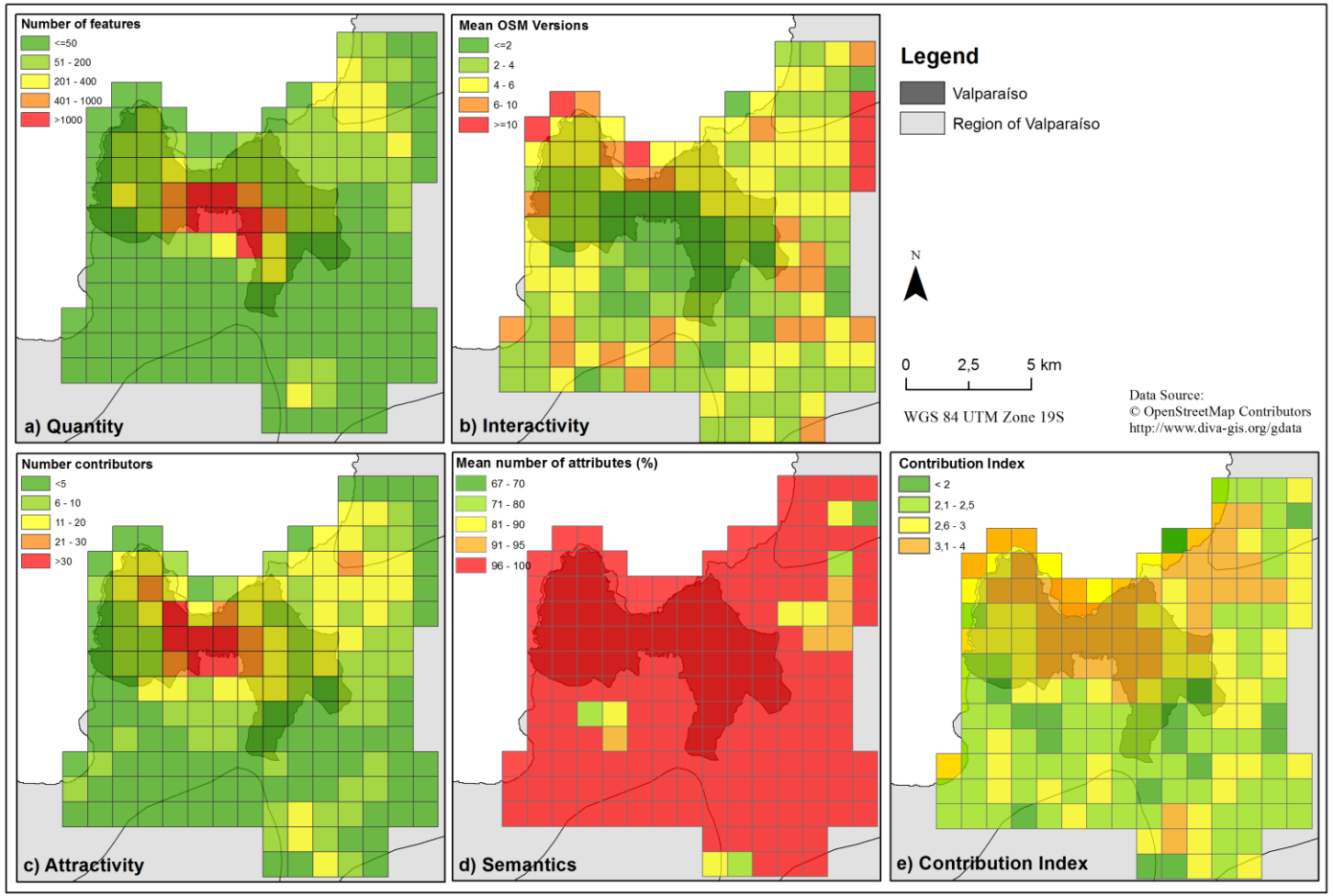

Jokar Arsanjani, J., Mooney, P., Helbich, M., Zipf, A., (2015): **An exploration of future patterns of the contributions to OpenStreetMap & development of a Contribution Index** Transactions in GIS. DOI: 10.1111/tgis.12139.

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ID	Method	Description	Primary Studies
M1	Geographic context	Investigating the area surrounding the location of CGI to determine its geographical features and employ them to assess the quality of CGI.	Senaratne et al. (2013); Zielstra & Hochmair (2013)
M2	Redundancy of volunteers' contribution	Requesting several volunteers to provide information about the same geographic feature to find out if or not there is a convergence of the information produced by different volunteers.	Comber et al. (2013); Foody (2014); See et al. (2013)
M3	Scoring volunteered contribution	Asking volunteers to rate every piece of CGI that is contributed by other volunteers.	Lertnattee et al. (2010)
M4	Expert assessment	Submitting CGI to experts who are responsible for checking the information content and correcting it if necessary.	Foody et al. (2013); Karam & Melchiori (2013)
M5	Automatic location checking	Estimating the quality of CGI by the distance between geocoded coordinates, obtained from multiple geocoding services, and the location (i.e., an address) provided by the volunteer.	Cui (2013)
M6	Spatiotemporal clustering	Creating spatiotemporal clusters of CGI elements using prior information about a phenomenon of interest and, later, evaluating the significance of the resulting clusters for a specific purpose.	Longueville et al. (2010)
M7	Volunteer's profile; reputation	Analyzing volunteer's profile or reputation and using it to estimate the quality of CGI.	Bishr & Janowicz (2010); Bishr & Kuhn (2013); Bodnar et al. (2014)
M8	Error detection /correct by crowd	Several volunteers acting as gatekeepers and, thus, correcting errors introduced by other volunteers.	Haklay et al. (2010)
M9	Extracting/learning of characteristics	Extracting characteristics from each type of geographic feature, learning the information implicit in them and, later, using the information to estimate the quality of CGI.	Ali & Schmid (2014); Jilani & Corcoran (2014); Mohammadi & Malek (2015)
M10	Ranking/filtering by linguistic terms	Evaluate CGI items based on different criteria that are expressed linguistically, rank them in degrees of criteria satisfaction and, later, filter them based on the constraints of the application domain.	Bordogna et al. (2014)
M11	Historical data analysis	Deriving (intrinsic) indicators from the history of the data and, later, using them to make statements regarding the quality of CGI.	Keßler & de Groot (2013)

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Degrossi LC, Albuquerque JP, Rocha RS, Zipf A. (2018) :

A taxonomy of quality assessment methods for volunteered and crowdsourced geographic information.

Transactions in GIS. 2018; 00:1–19.

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Conceptual Quality Dimension for VGI

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- **Accuracy** Indicators: E.g. Number of features with multiple classications; number of contributors.
  Distance between conceptualization &domain knowledge. Degree of correctness in the classication of features in classes
- **Granularity** E.g. Depth of classes in the class hierarchy
  Level of thematic description , from abstract to specifc concepts
- **Completeness** E.g. Number of classes; number of attributes
  Coverage in the conceptualization of the features of interest..
- **Consistency** E.g. Number of features in a class with the same attributes; ratio between consistent features or attributes to all others,...
  Degree of homogeneity in the descriptions of geographic features
- **Compliance** E.g. Ratio between the number of classes and attributes dened in an external source S and the total number of classes &attributes.
  Degree of adherence of an attribute, a feature, or a set of features to a given source S
- **Richness** E.g. Number of attributes describing a feature.
  Amount and variety of dimensions that are included in the description of the real-world entity.

Ballatore, A. & A. Zipf (2015):
A Conceptual Quality Framework for Volunteered Geographic Information.
COSIT 2015, Santa Fe.

Investigating the OSM folksonomy

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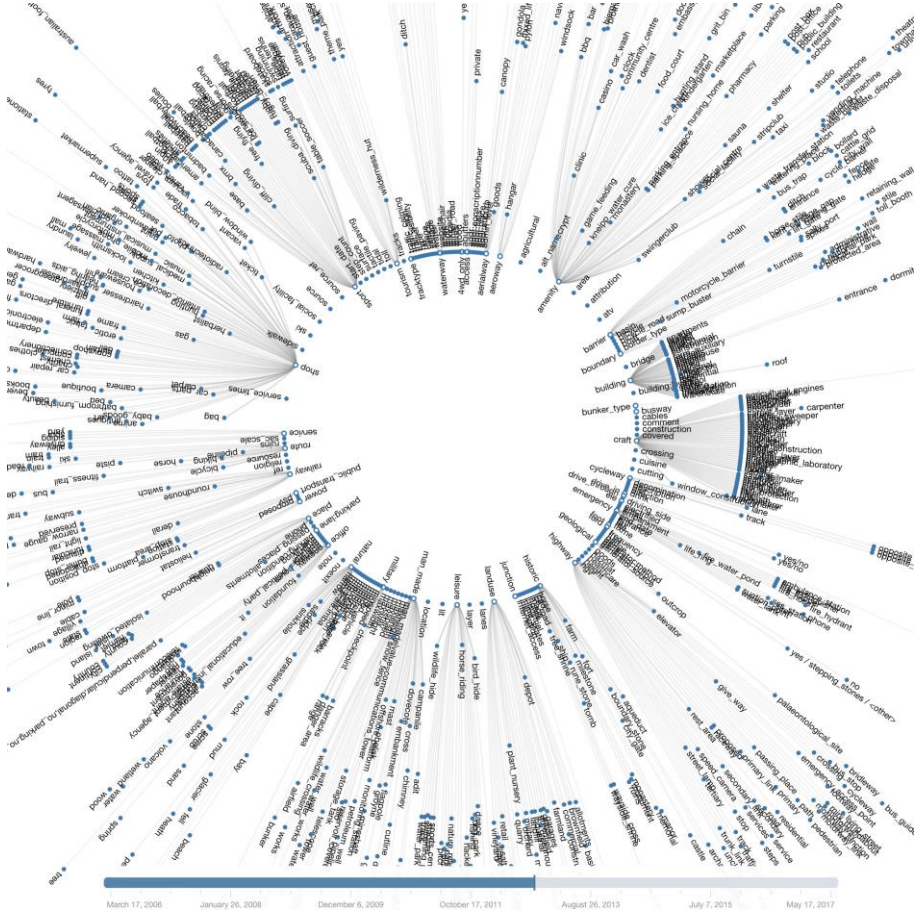
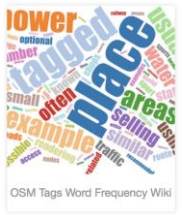
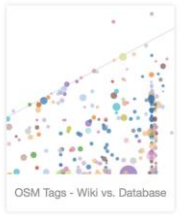
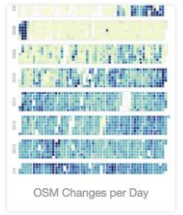


Development of the OSM Wiki

Mocnik, F.-B.; Zipf, A., Raifer, M. (2017): The OpenStreetMap folksonomy and its evolution. Geo-Spatial Information Science. GSIS. Taylor & Francis. Vol 20, 2017. pp 219-230.







osm-vis.geog.uni-heidelberg.de

osmatrix.uni-hd.de

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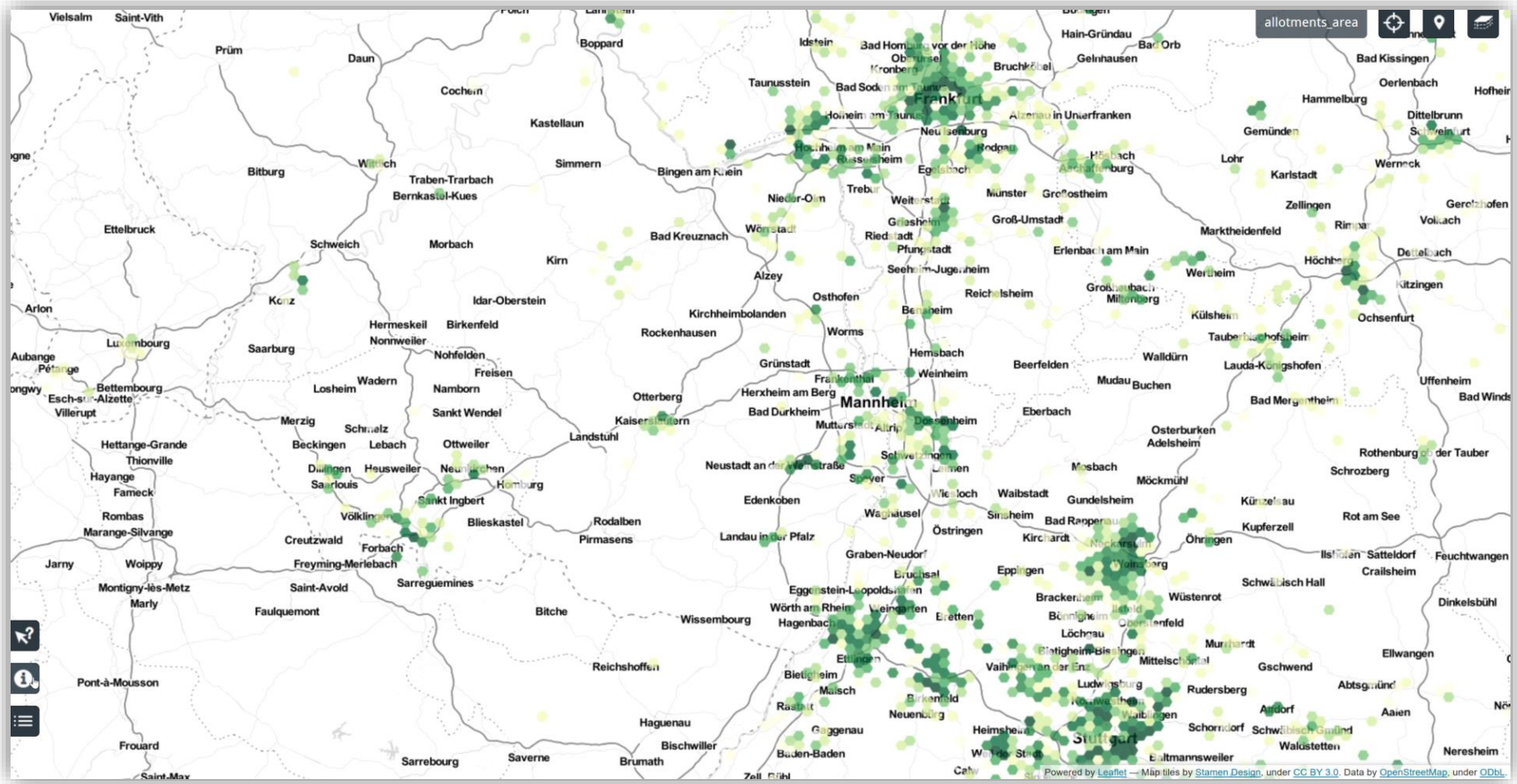

Roick, O., Loos, L. & Zipf, A. (2012): Visualizing spatio-temporal quality metrics of Volunteered Geographic Information – A case study for OpenStreetMap. Geoinformatik 2012. Braunschweig.

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ohsome.org

OSM-History Platform

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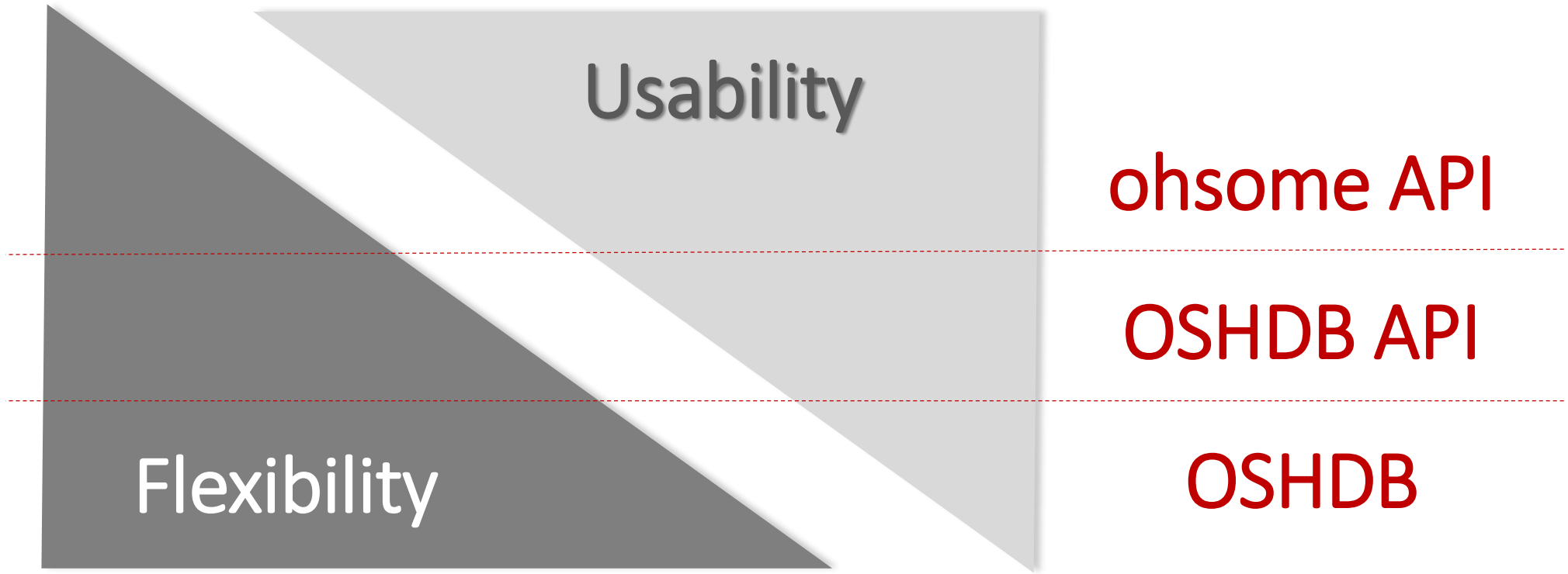

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OSM-History Platform

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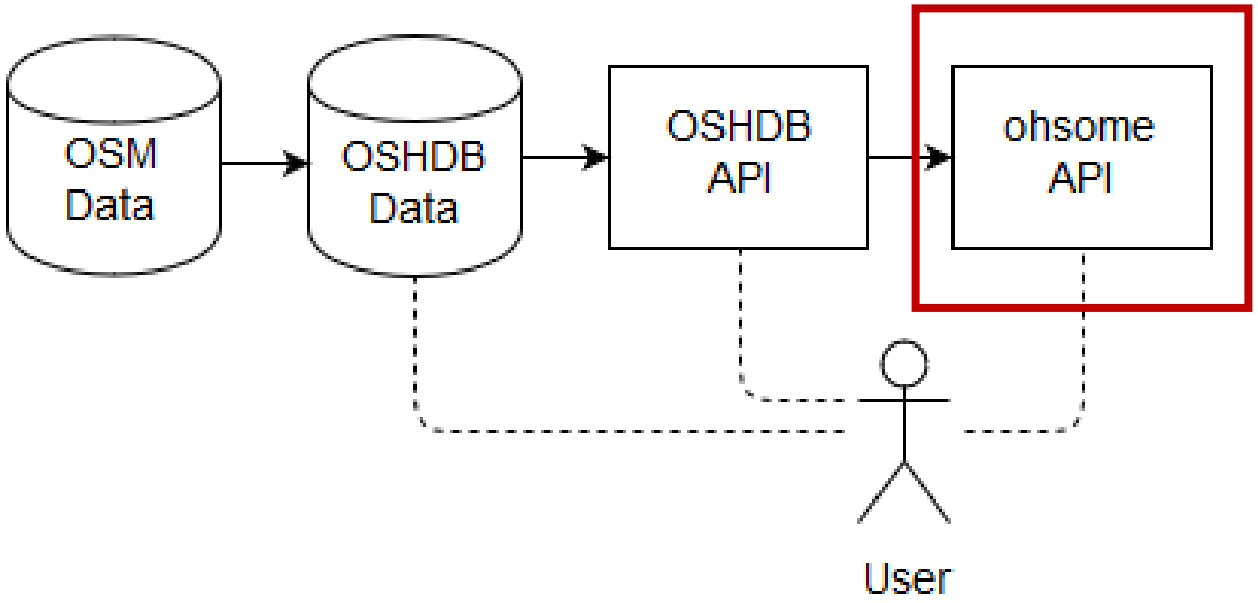

ohsome API

→ REST web service

→ interactive analyses and visualizations in browser

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OSM-History Platform

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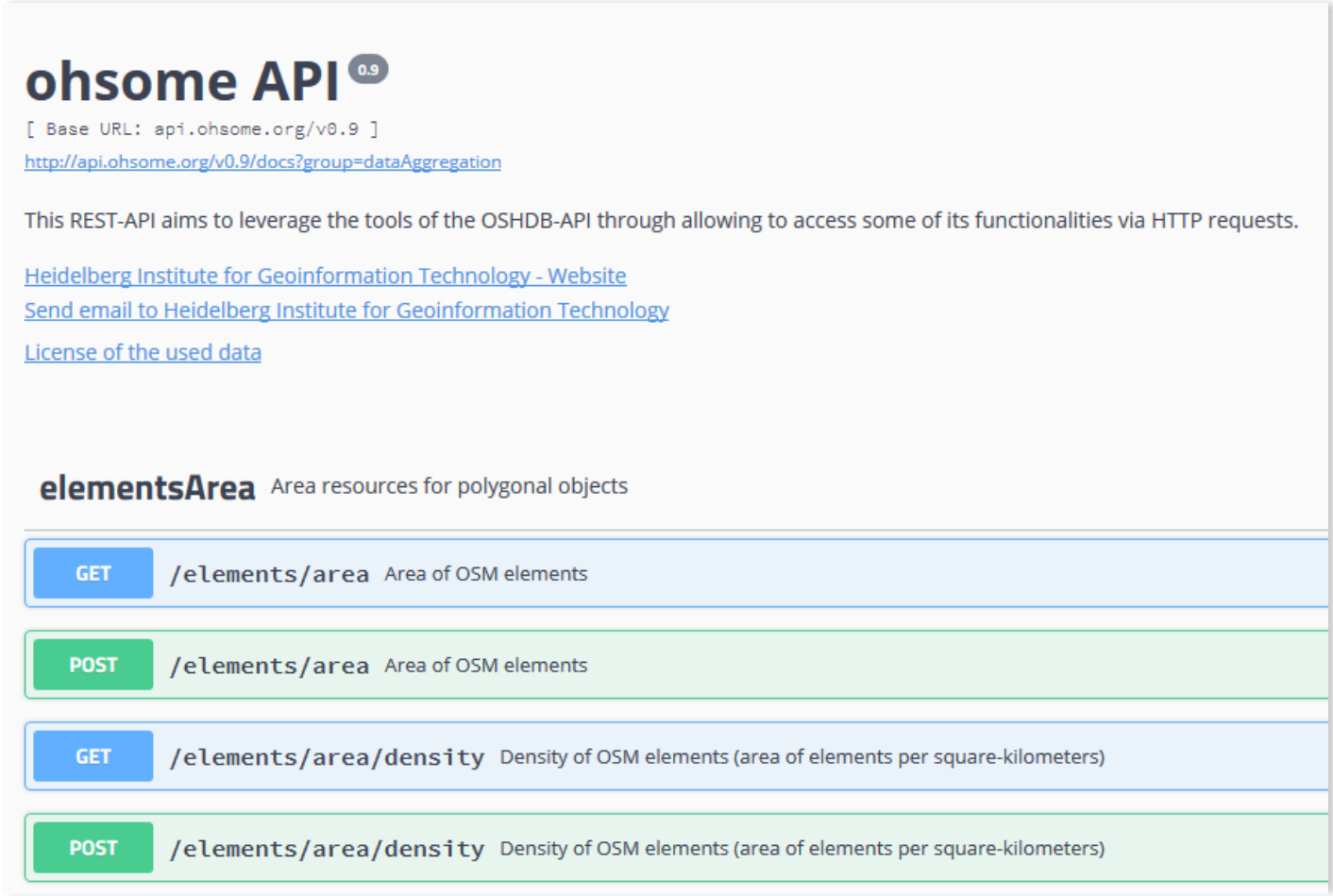

api.ohsome.org/v0.9/swagger-ui.html

Example
https://api.ohsome.org/v0.9/elements/count/groupBy/boundary?bboxes=Kathmandu:85.2,27.6,85.45,27.8|Pokhara:83.9142,28.1693,84.0775,28.2687&types=way&time=2015-01-01/2017-01-01/P1M&keys=building&values=residential&showMetadata=true

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ohsome dashboard (preview)

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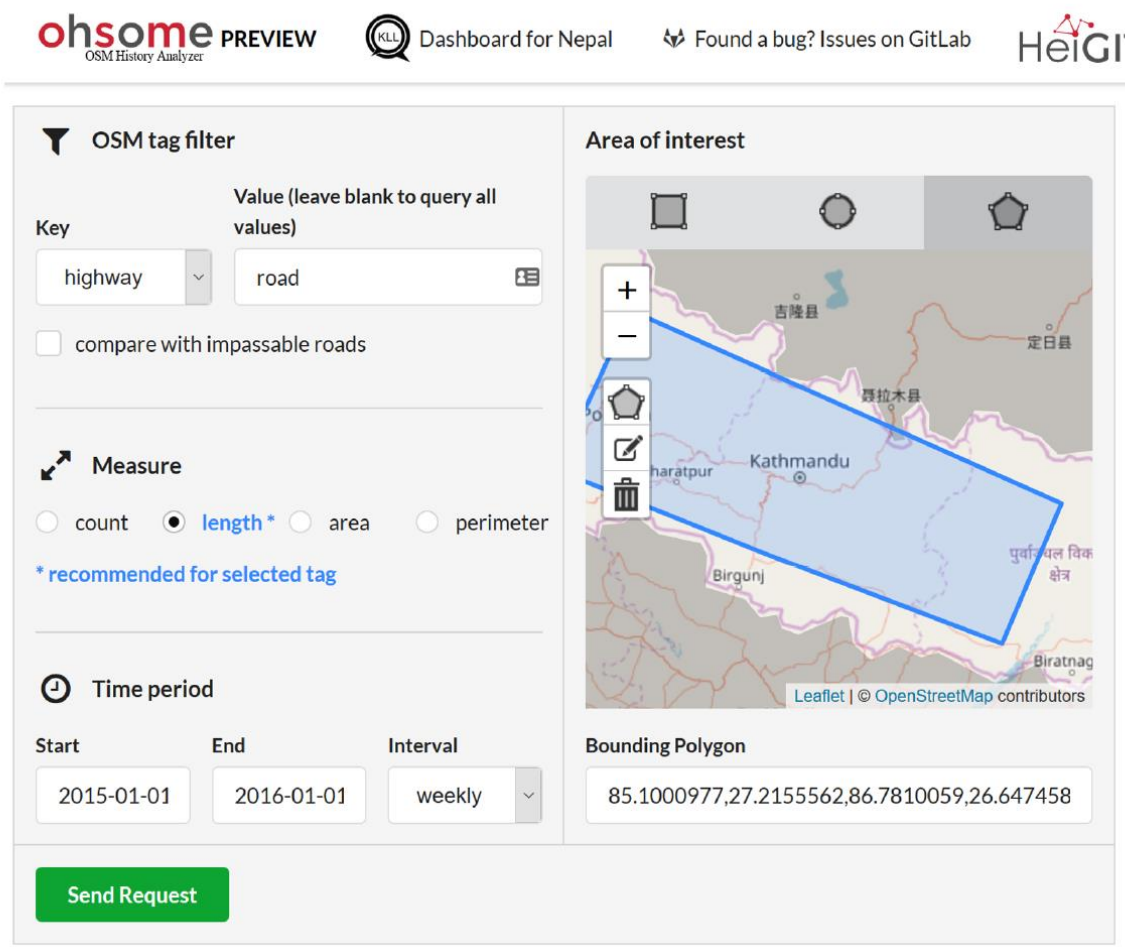

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ohsome examples

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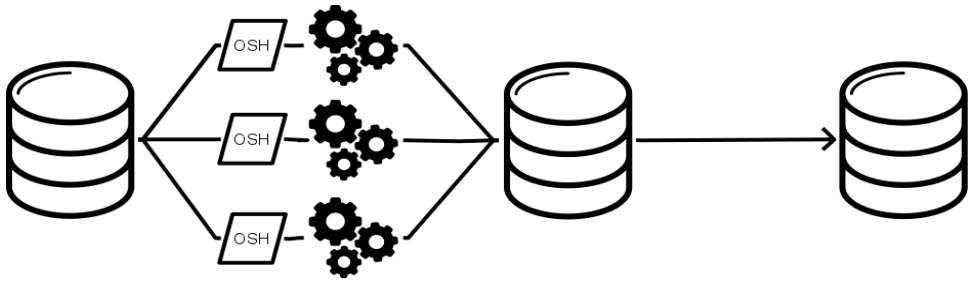
total number of OSM buildings 2008 - 2017

Evolution of OSM buildings in Africa

Context: HOT coordinates OSM building mapping tasks within their Malaria Elimination Campaign.



Processing using Big Data Frameworks (Apache Ignite, Spark etc.)

Routing Nepal Earthquake 2015

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http://disaster.openrouteservice.org

- Completeness:
  - street lengths aggregated for street categories
  - percentage of streets which include street names
- Topological correctness:
  - percentage of intersecting OSM ways that do not share a common node
  - percentage of OSM endpoints close (distance 1 m), but not connected to an OSM way
- User activity: Number of users that edited OSM streets

Routing Nepal Earthquake 2015

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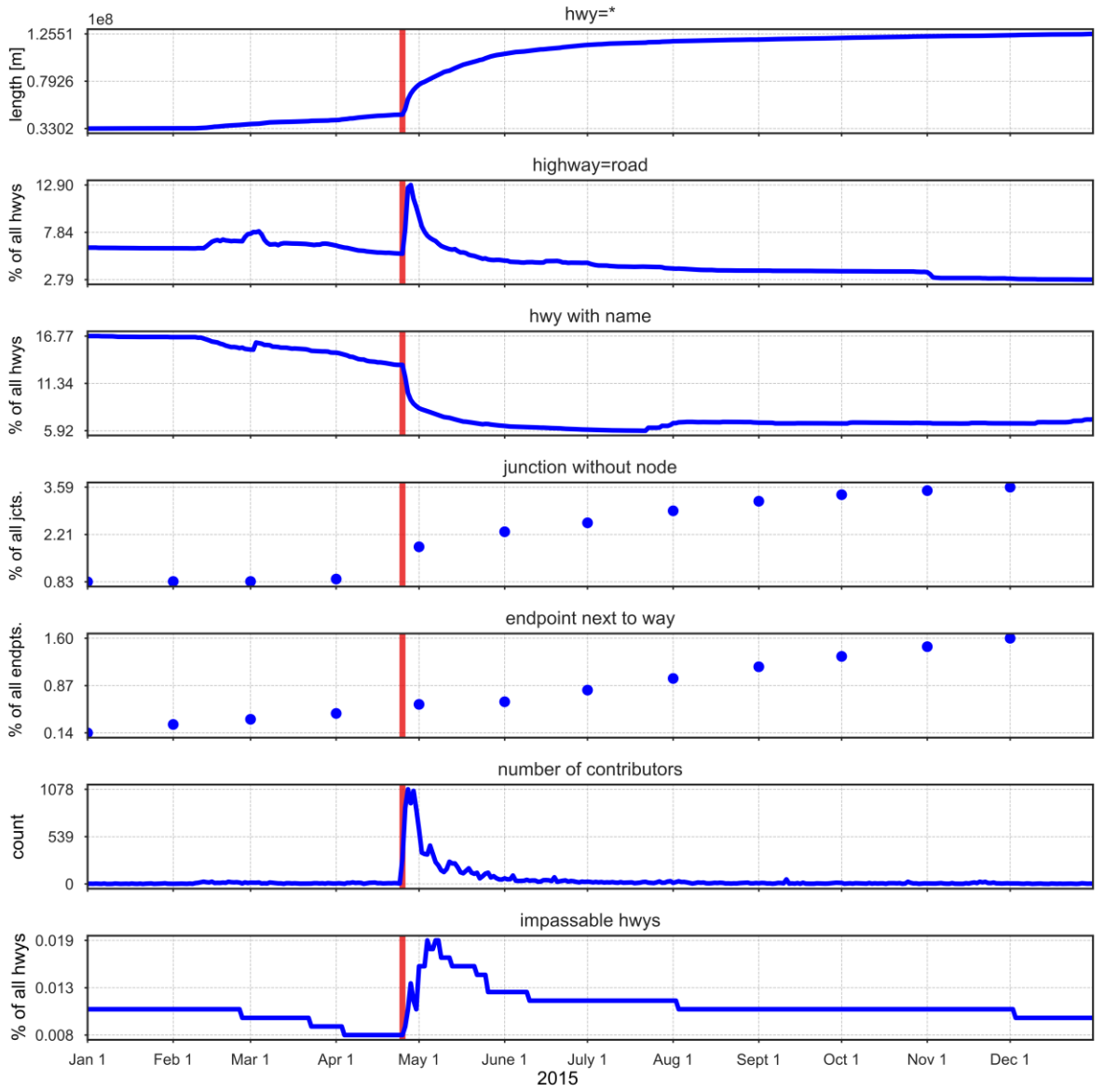

Auer, Eckle, Fendrich, Griesbaum, Kowatsch, Marx, Raifer, Schott, Troilo, Zipf (2018): Towards Using the Potential of OpenStreetMap History for Disaster Activation Monitoring. ISCRAM 2018. Rochester.

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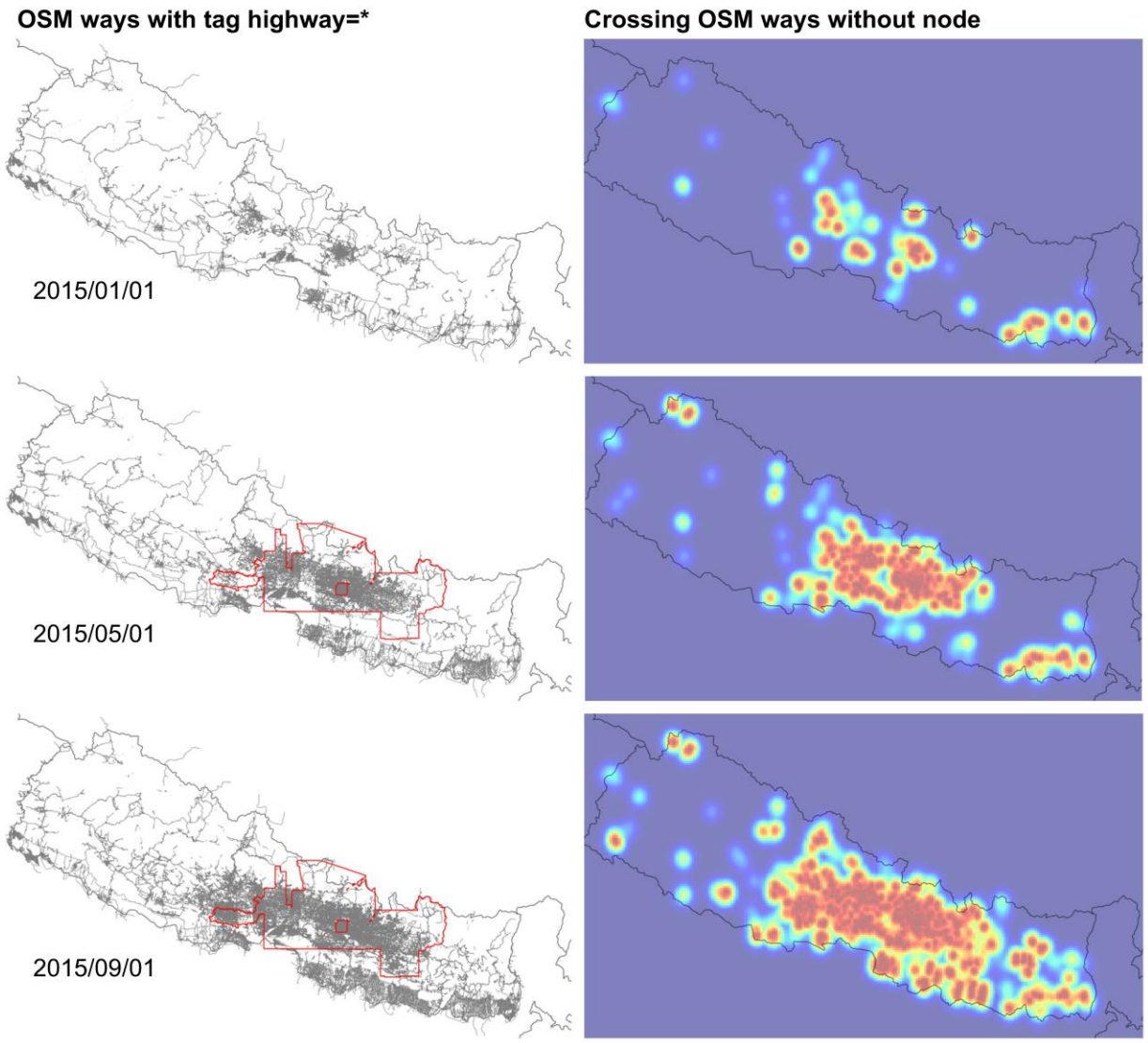
Evolution Topological Correctness



Want to try it yourself?

- github.com/GIScience/oshdb
- api.ohsome.org/v0.9/swagger-ui.html
- ohsome.org/apps/dashboard

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Get in touch…

zipf@uni-heidelberg.de

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Conclusion & Outlook

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- The *ohsome* platform enables analyses of data evolution & quality, the detection of contribution patterns etc.
- Future versions will facilitate monitoring OSM data in near-real time on a global scale and bring extended functionalities
- Your ideas welcome!
- Further work on *enhancing* OSM

MISSING MAPS

Thank you very much!

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Questions?

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OSM Research Overview

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Jokar Arsanjani, J., Zipf, A., Mooney, P., Helbich, M., (eds) (2015):

OpenStreetMap in GIScience: experiences, research, applications.

373p. Springer Science. Heidelberg, Berlin. ISBN 978-3-319-14279-1

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