ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

Potentials of big data for integrated territorial policy development in the European growth corridors

Anto Aasa

UNIVERSITY OF TARTU
Mobility Lab

UNIVERSITY OF TARTU
Department of Geography

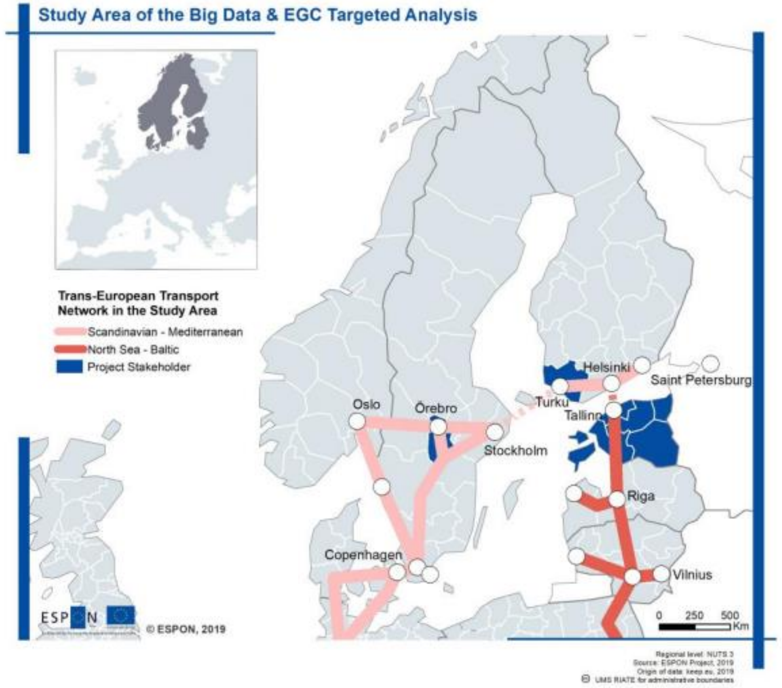
ESPON scientific report 2019

- “The **speed of change** in Europe in economic and social terms is accelerating, accompanied by an increasing **fragmentation of society** and territories that implies a real **threat to integration**.”
- /---/
- “In ESPON we develop research to **support policymakers** to narrow this gap. It is important though to ensure that we are asking the right questions, those that policy-makers raise seeking to receive **answers from the researchers**.”

- Fresh scientific approaches and tools in territorial research
  - iii) New data sources
    - **Mobile phone data**: these can be used to track the movement patterns of tourists, residents and students and generate new territorial insights on a more granular scale.
    - Estonia mobile positioning data have been used to produce an official nationwide mobility database and investigate mobility patterns

Big Data & European Growth Corridors

- one-year-long project that addressed the challenge of data utilization in corridor development by analysing the potentials of big data for integrated territorial policy development in the European growth corridors



Scientific partners

- University of Turku, Finland
- University of Tartu, Mobility Lab, Tartu, Estonia

Practical needs of stakeholders

- The Regional Council of Southwest Finland (lead stakeholder),
- the Region of Örebro in Sweden,
- the Ministry of Economic Affairs and Communications in Estonia

Project themes

- During the first project workshop, the stakeholders identified three themes as the most important policy dimensions related to corridor development that would benefit from big data:
    1. infrastructure and connectivity planning;
    2. regional economic development, and;
    3. land-use planning

Box 1.1: Three Policy Themes Identified by Project Stakeholders

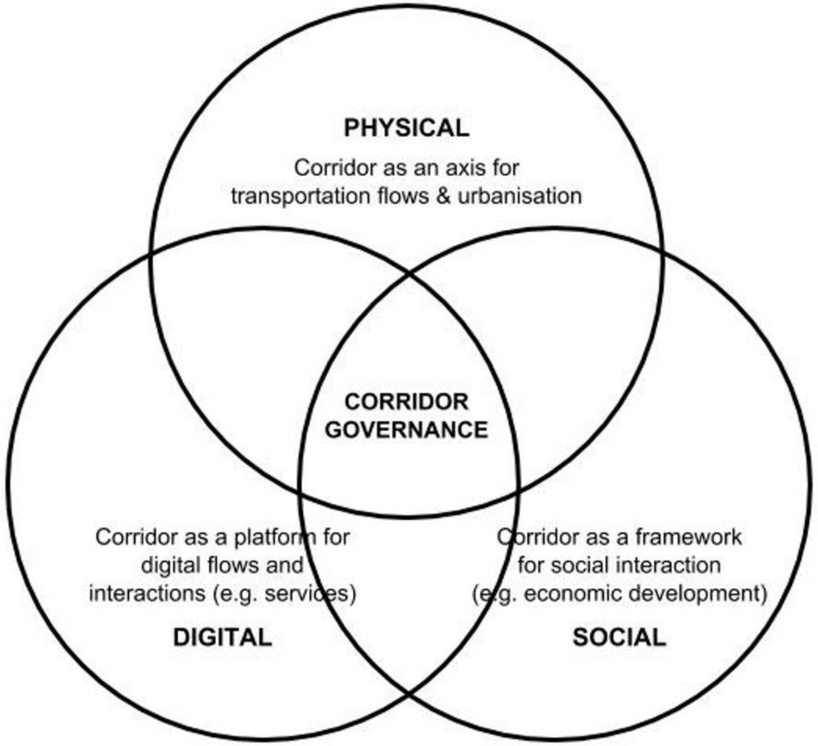
Infrastructure and connectivity planning. Considering infrastructure, stakeholders stressed that promotion of connectivity and investments in transportation infrastructure is an important policy area in territorial development that could benefit from big data. The investments can be more efficiently directed based on the more accurate knowledge e.g. about the flows of people and goods, which are at the core of corridor development. Especially, mobility data is needed at the corridor level to support integrated policymaking combining mobility with economic development, housing and service provision.

Economic development. Policies related to economic development, and particularly new business and thus job creation, could benefit greatly from big data. New types of data are needed to support regional economic development, enhancing partnerships with private companies and more efficient allocation of investments. Knowledge about different territorial networks related to, for example, organizational interlinkages and project networks, as well as interregional collaboration in education and between companies as well as research and development would be useful for actors at various organisations and scales. In addition, development of education and culture contribute to economic development. For instance, knowledge on the mobility of students in the corridor would be useful for planning collaboration in higher education. Stakeholders also brought out that there is enough data on migration, but there is a data gap on detailed data on international migration, and particularly in migration and out migration.

Land-use planning. Land use is another policy area that could benefit substantially from big data. Knowledge about the mobility of people, information and goods is again needed for future land use planning. In addition, safety related policies, as well as environmental sustainability policies were brought out as policies that could benefit be renewed based on new insights. On the other hand, those policies are strongly interlinked with land-use and infrastructure promoting connectivity.

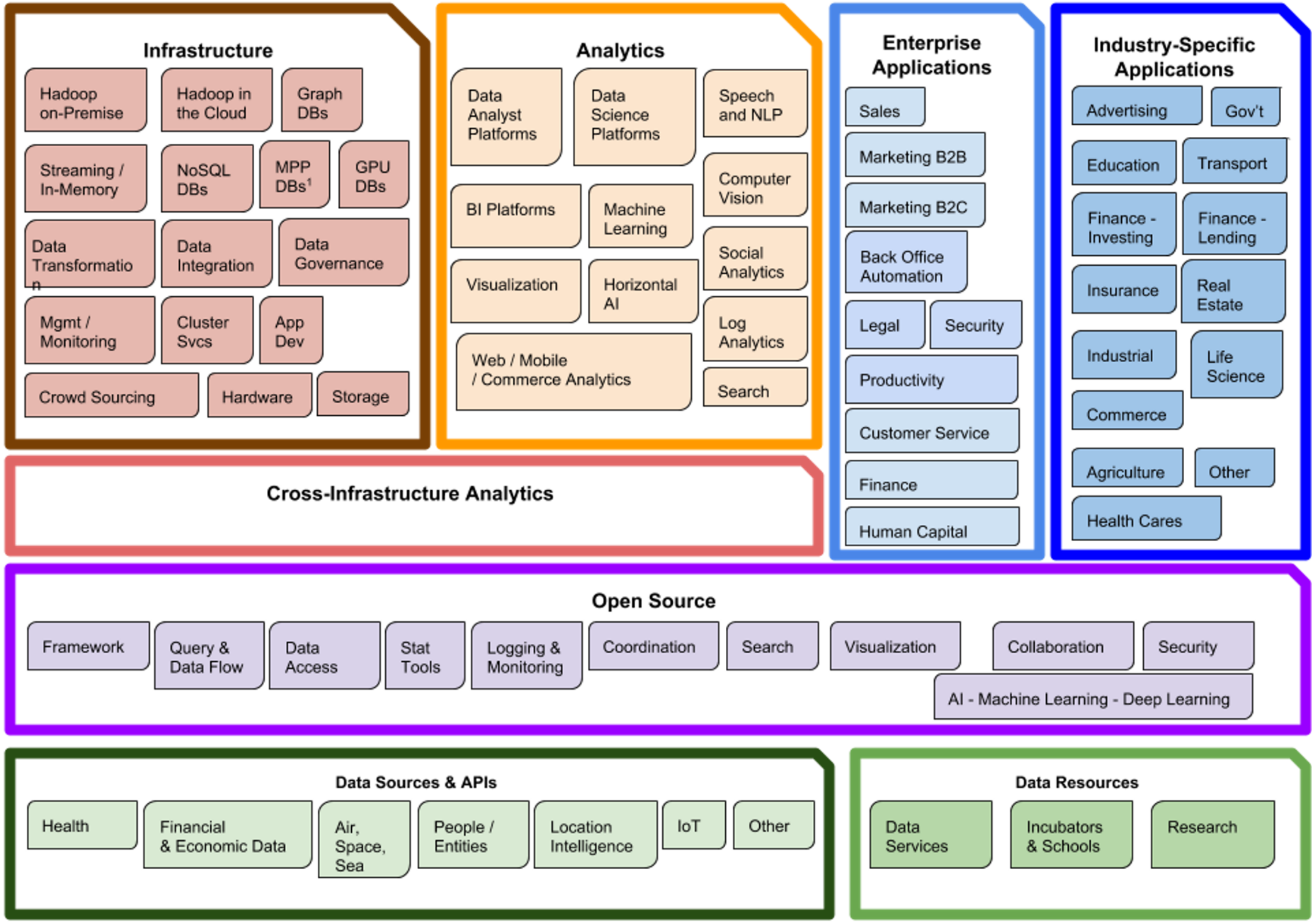
Corridor development

Figure 2.1: Conceptual framework describing the three overlapping spatial dimensions of corridor development that should be taken into account in comprehensive corridor governance



Mapping of Big Data and AI landscape

Figure 3.1: Categories and subcategories of big data tools from FirstMarks Capital's Big Data and Artificial Intelligence Landscape.



Source: Turck & Obayomi (2018).

Mapping the potential data sources

Table 3.1: Typology of new data sources by variables and ranges of attributes

Data Categorization Variables	Range of Attributes
Availability	Open Data ←→ Exists but not easily Available ←→ Purchasable Proprietary Data ←→ Unavailable Proprietary Data
Level of Processing	Raw (e.g. direct from sensors)←→ Pre-Processed Data ← → Processed Data← → Highly Processed Data
Intended Audience	Humans ←Programmers of Machines → Machines
Observational Qualities	Direct Observation ← → Synthetic
Level-of Detail	Fine-Grained (e.g. vehicle journeys) ← → Rolled-up (e.g. average household income by zip code)
Level of Structure	Highly Structured ← → Semi-Structured ← → Unstructured
Refresh Frequency	Instant ←→ Milliseconds ←→ Daily ←→ Weekly ←→ Monthly ←→ Quarterly ←→ Annually ←→ Every few years
Confidence in Updates	Low Confidence (updates are uncertain) ← → High Confidence (updates are highly likely to occur)
Extraction Effort	Requires much effort and resources to extract data ← → Requires little effort to extract data
Clarity of Ownership	Ownership is clear and singular ← → Ownership is clear but shared ← → Ownership is clear on paper and unclear in practice (e.g. "Do I or Facebook or 3rd party app makers own my Facebook data?") ← → Ownership is unclear or no longer traceable
Spatial Resolution	Individual, Local, Neighbourhood, Municipal National, Multi-national, Global
Temporal Resolution	Milliseconds ← → Decades

Case studies

1. Traffic Flows on Highway E18 in Finland
2. Project Partnerships in the EU
3. Mobile Positioning Data for an Estonian Everyday Mobility Database

Case 1: Traffic Flows on Highway E18 in Finland

- Traffic Flows on Highway E18 in Finland
  - Data: Traffic intensity data detected by 79 induction loop sensors

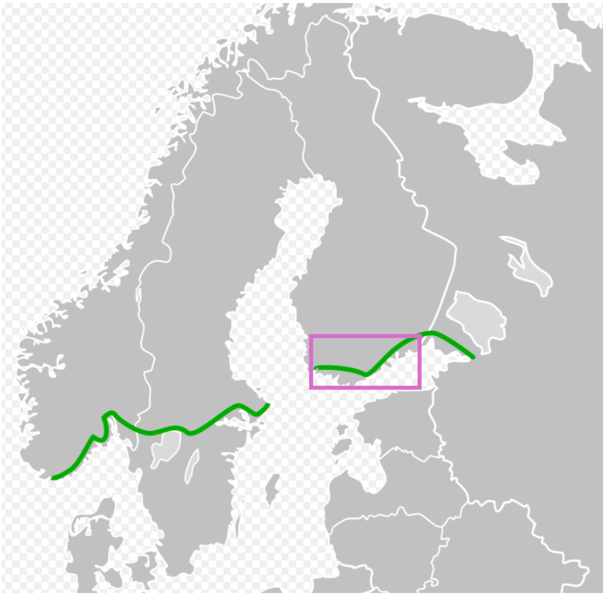
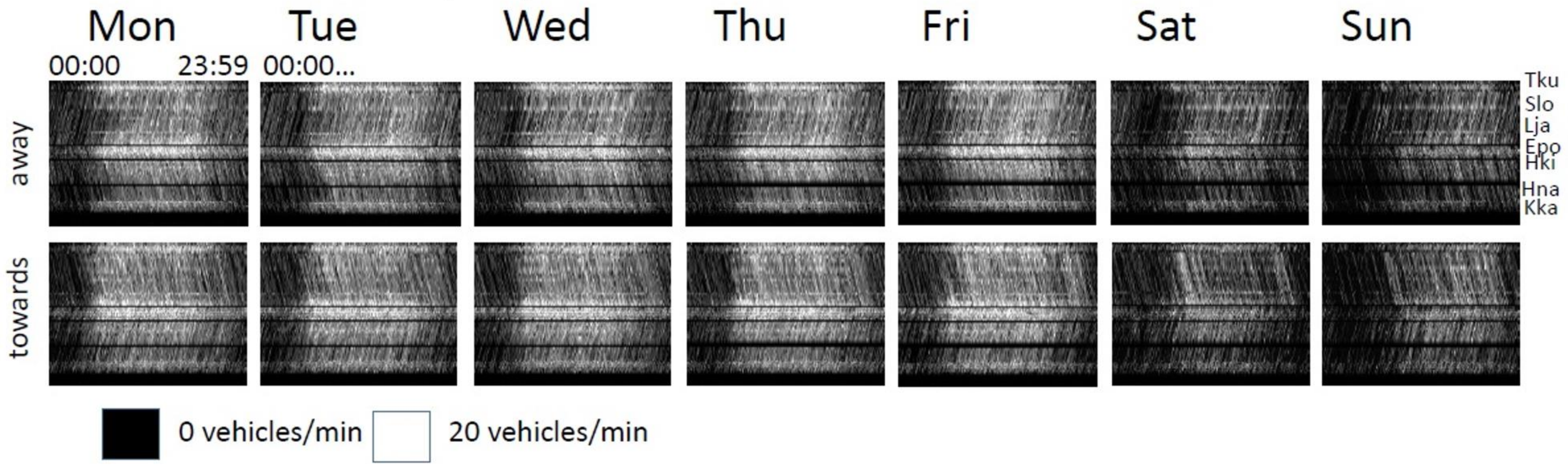
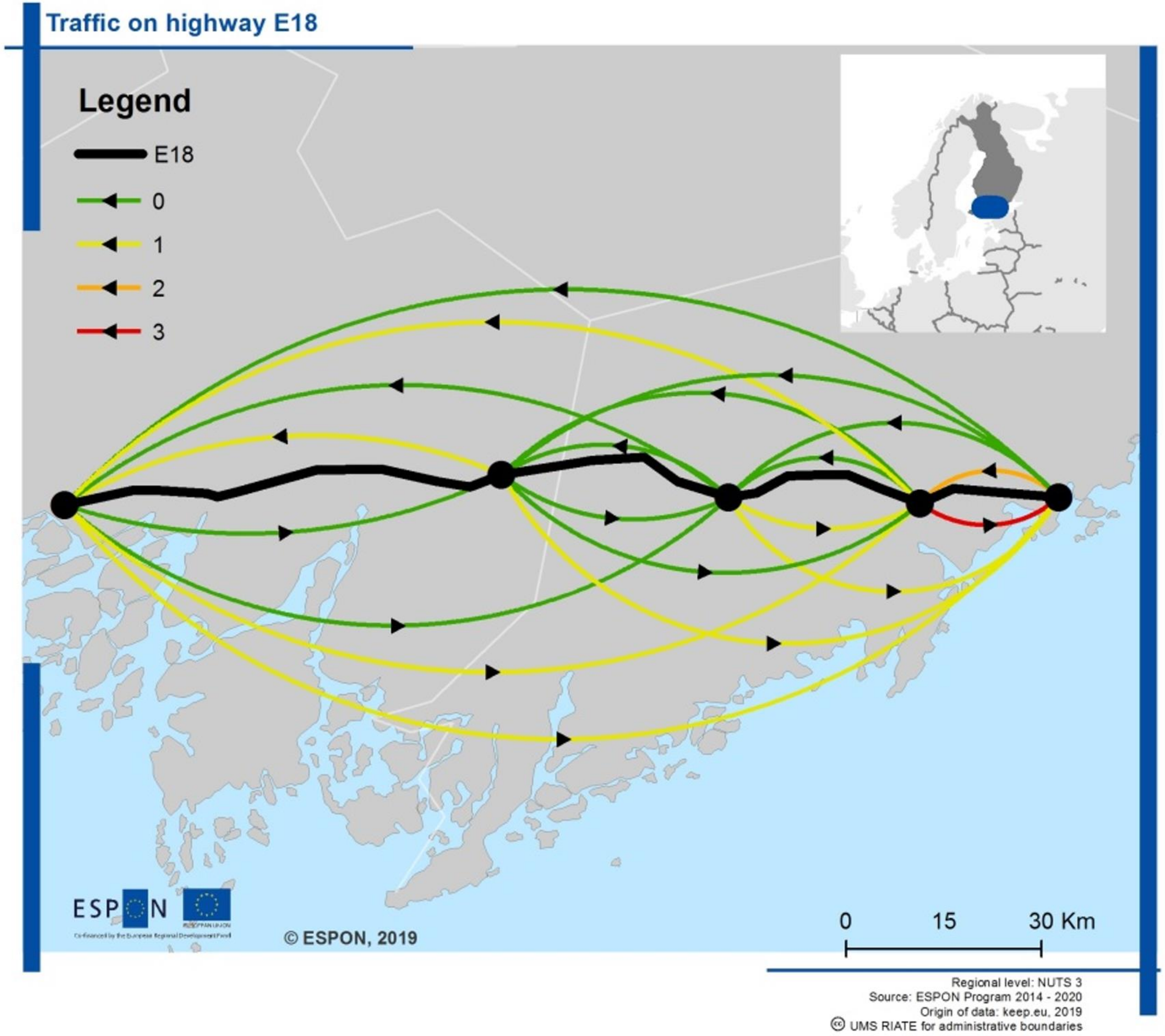


Figure 4.1: Difference between weekdays in the traffic flow pattern along the route E18. The upper row is the traffic intensity away from Helsinki, and the lower one towards Helsinki.



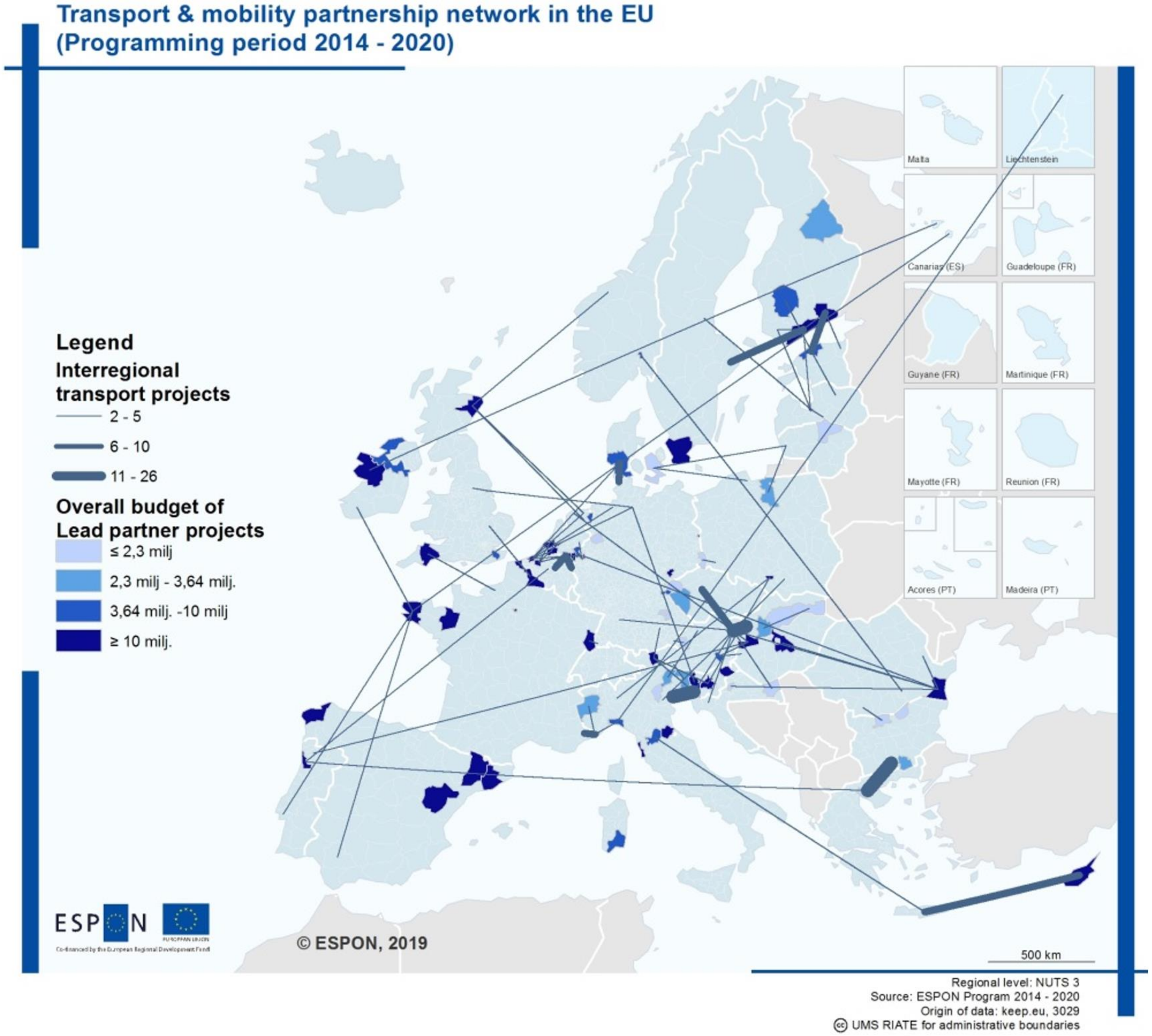
Map 4.1: Summary of the traffic flows from 7:30 to 9:30 Monday-Thursday, 23-26 January 2017 between Turku and Helsinki along the highway E18.



Case 2: Project Partnerships in the EU

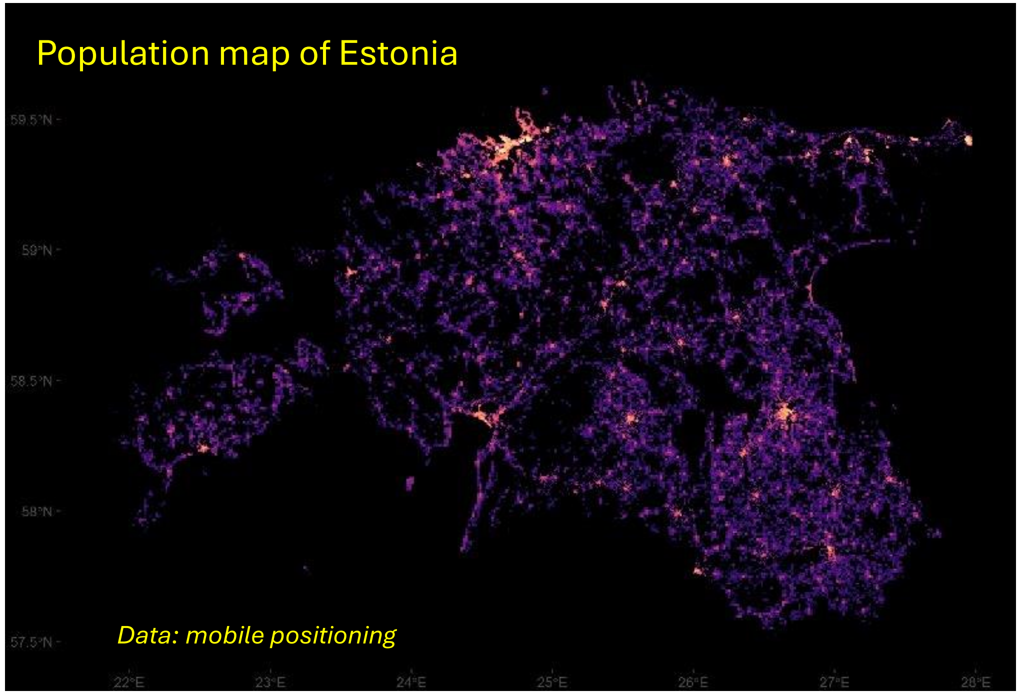
- goal is to analyse the open data about the EU funded regional development projects to create understanding about collaborative relationships and their characteristics across regional and national boundaries
- EU funded regional development programmes have a joint and openly available depository for the data about the projects and their partners, funding, themes and location. The project data acquired from programming period 2014-2020 contained 2353 projects. A new dataset was generated comparing projects and the NUTS areas, forming a pairing for all the projects and their respective NUTS3 areas.

Map 4.2: Transport and mobility partnership network in the EU for the programming period 2014-2020.



Case 3: Mobile Positioning Data for an Estonian Everyday Mobility Database

- **Objective:** To develop methodology for everyday mobility database which contains the OD-matrices of movements between territorial communities.



Data used:

- OD-matrices are based on mobile positioning data and applied to road network based on Dijkstra routing algorithm and Open Street Map roads data. Mobile positioning data contains locations of call activities (Call Detail Records (CDR)) in network cells (location, time and random unique ID).

Novelty of the approach:

- The mobile positioning data has high accuracy in time, the data allows to short-term differences (find the OD-matrices by months), include in addition to movements between the place of residence and the workplace, also other regular places and differentiate the movements of different social groups (gender, age, nationality) and the types of movers.

Challenges:

- The main limitation of passive mobile positioning data is access to data, because mobile network operators are hesitant to provide their data and relatively long value chain of implementing mobile positioning data, which requires expertise from several research fields.

Policy implications:

- The resulting database would support mobility-related policymaking.

Background and objectives

- Mobility Lab of University of Tartu
- Ministry of Economic Affairs and Communications of the Republic of Estonia

- objective of the Ministry is to develop high quality database of mobility and traffic data covering whole Estonia.
- Developed database would be an important data input for the Ministry in the spatial planning decision-making process to answer questions related to transport and mobility

- Mobile positioning provides more accurate spatio-temporal information than the conventional methods, and data can be collected almost in real-time.
- Passive mobile positioning has two main strengths – longitudinality and extensive sample.
- the Mobility Lab of the University of Tartu has already a continuous CDR data from Estonia since 2006

Data

- Call Detail Record
- Sample > 420000
- Period: 2016 – 2018
- Monthly OD-matrix

Figure 4.3: Structure of the mobile positioning dataset.

data table

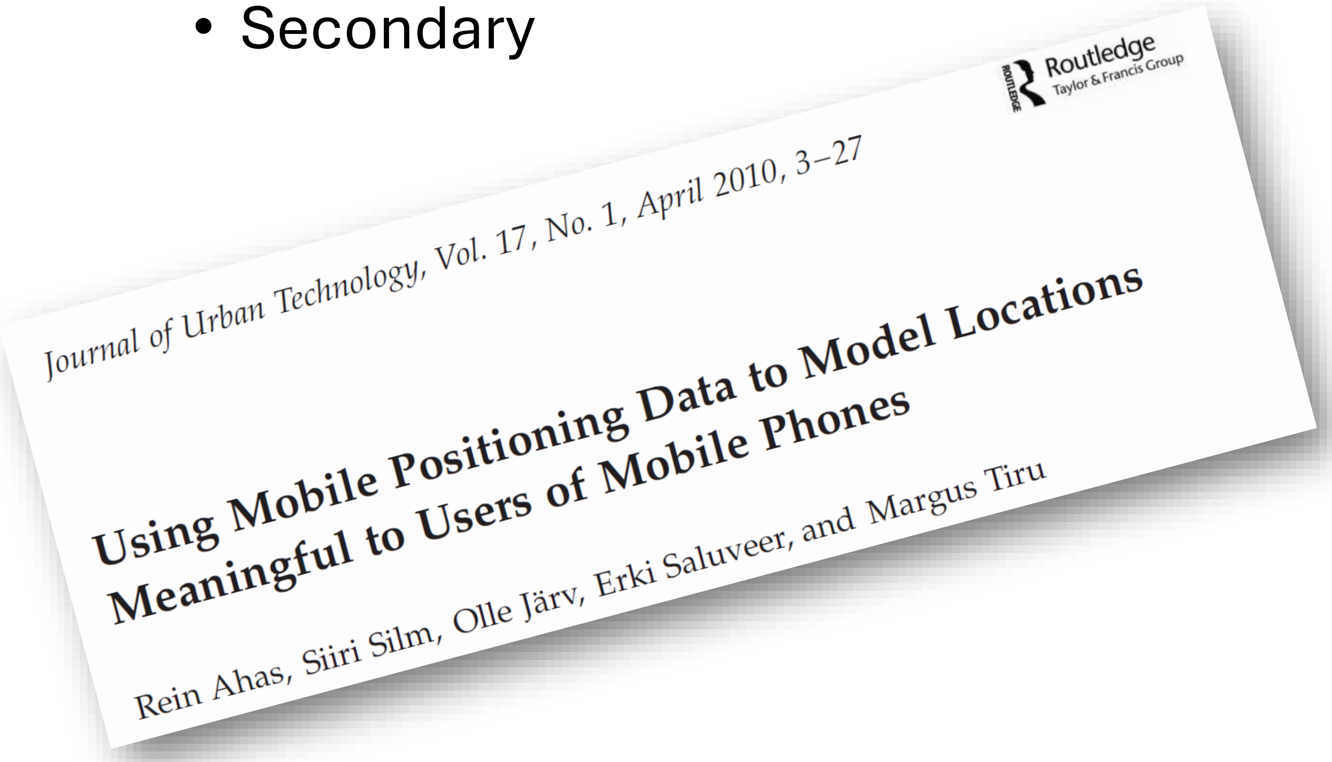
parameter	value
ID	246513389
event	call
timestamp	12:15:11 07/04/2014
cell ID	6547

antennas table

parameter	value
cell ID	6547
longitude	25.80527
latitude	58.34998

Anchor point model

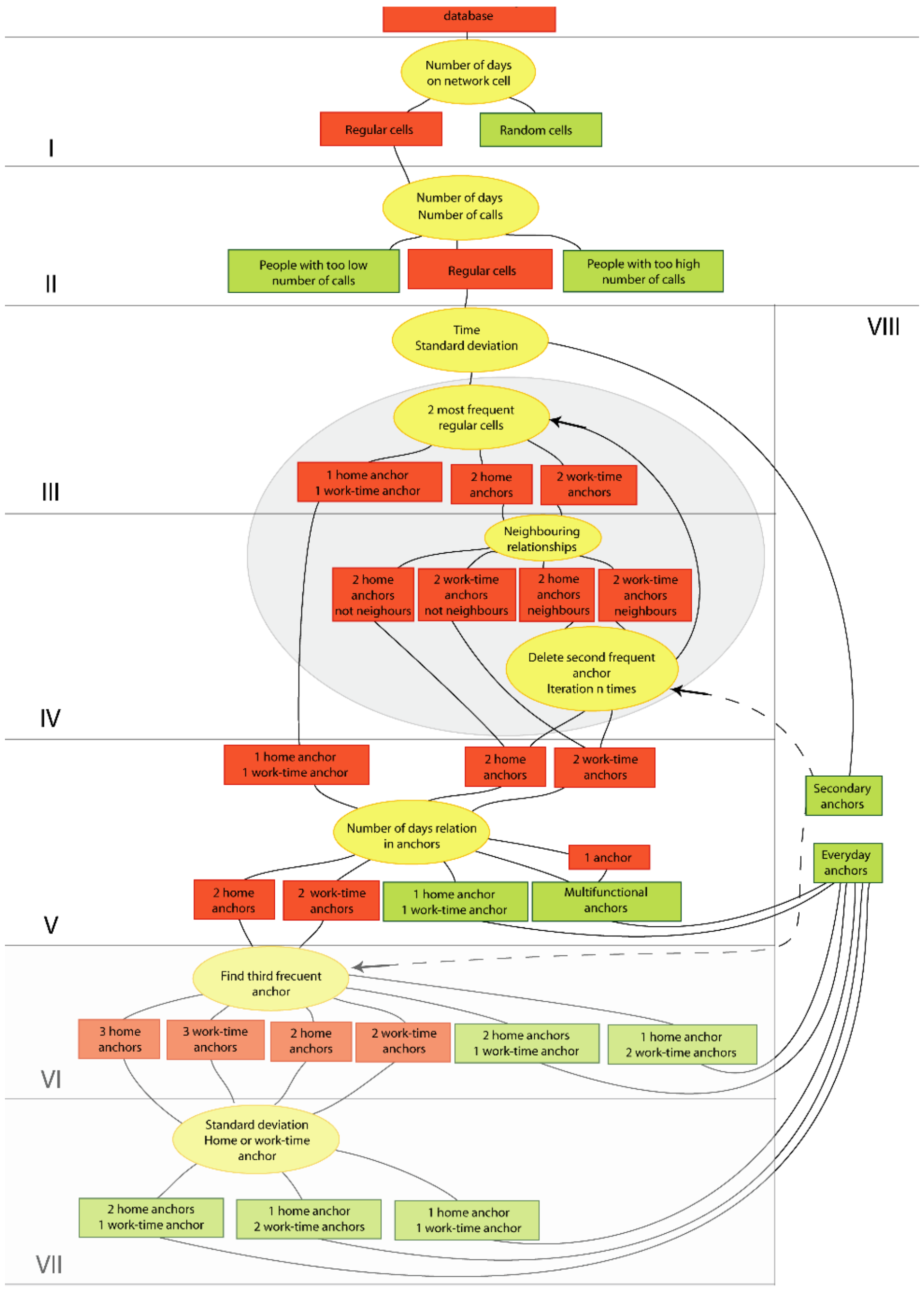
- Regularly visited places
  - Home
  - Work-time
  - Secondary


Routledge
Taylor & Francis Group

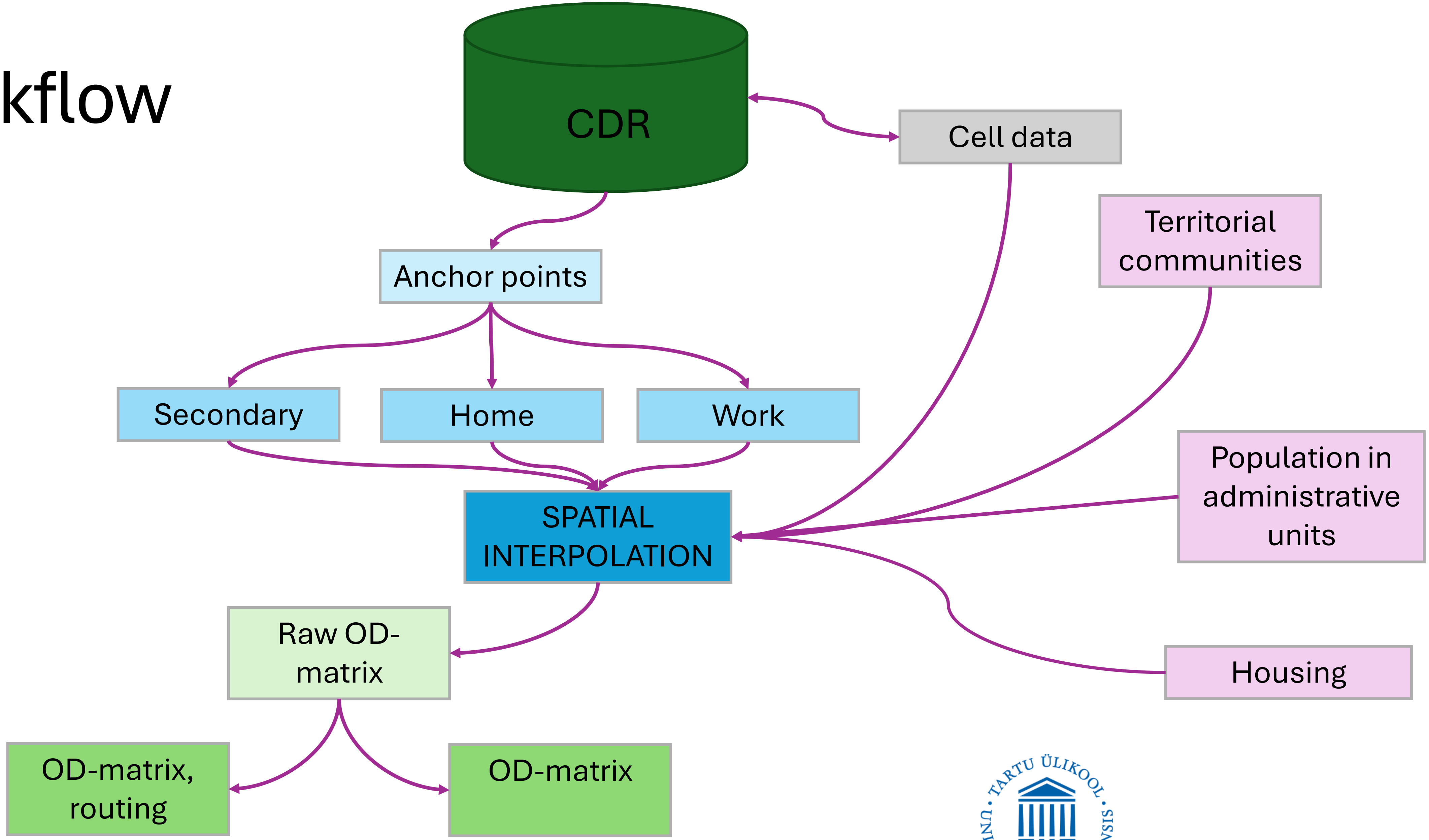
Journal of Urban Technology, Vol. 17, No. 1, April 2010, 3–27

Using Mobile Positioning Data to Model Locations Meaningful to Users of Mobile Phones

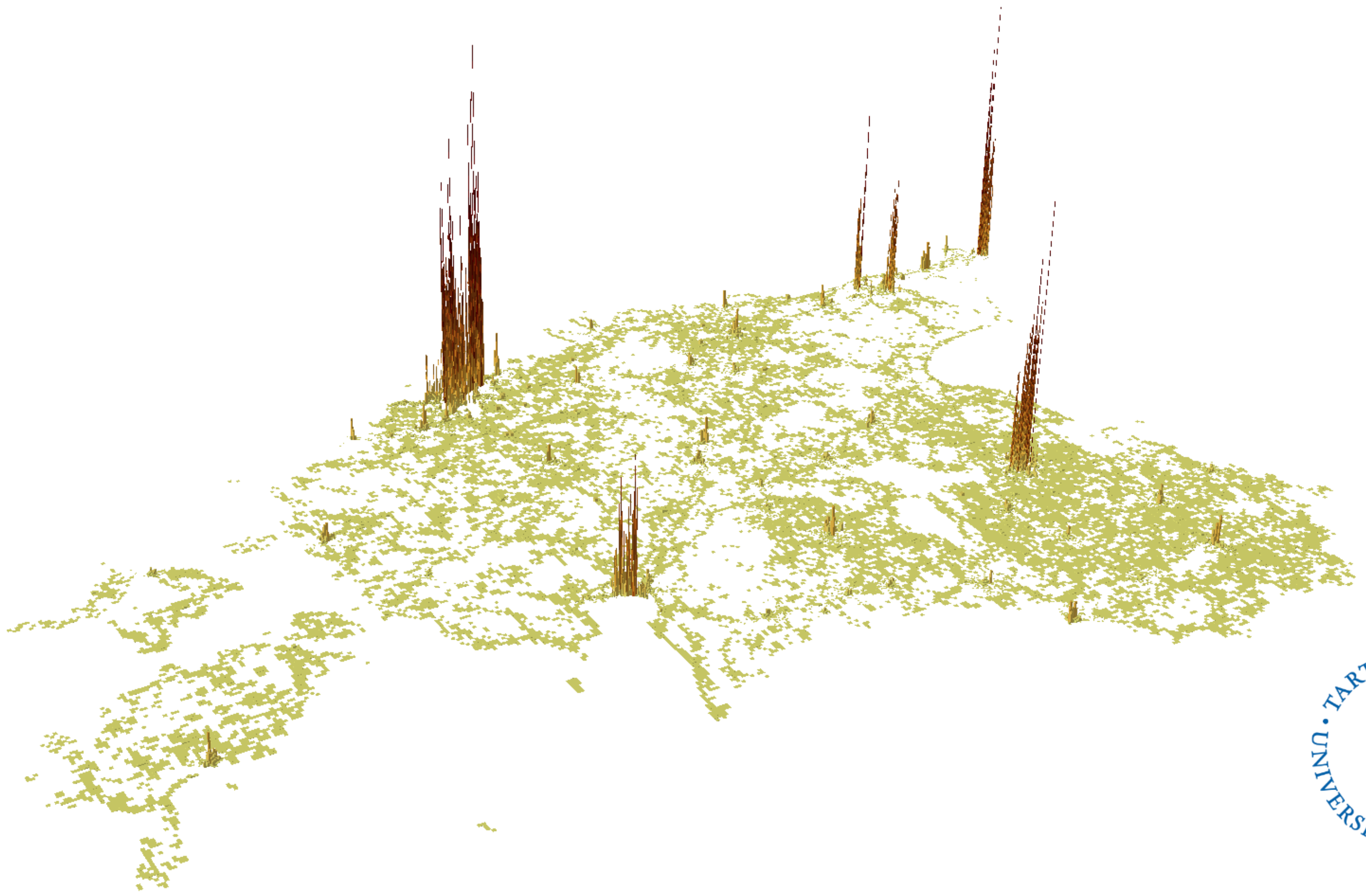
Rein Ahas, Siiri Silm, Olle Järv, Erki Saluveer, and Margus Tiru



workflow


CDR
Cell data
Anchor points
Territorial communities
Secondary
Home
Work
Population in administrative units
SPATIAL INTERPOLATION
Raw OD-matrix
Housing
OD-matrix, routing
OD-matrix

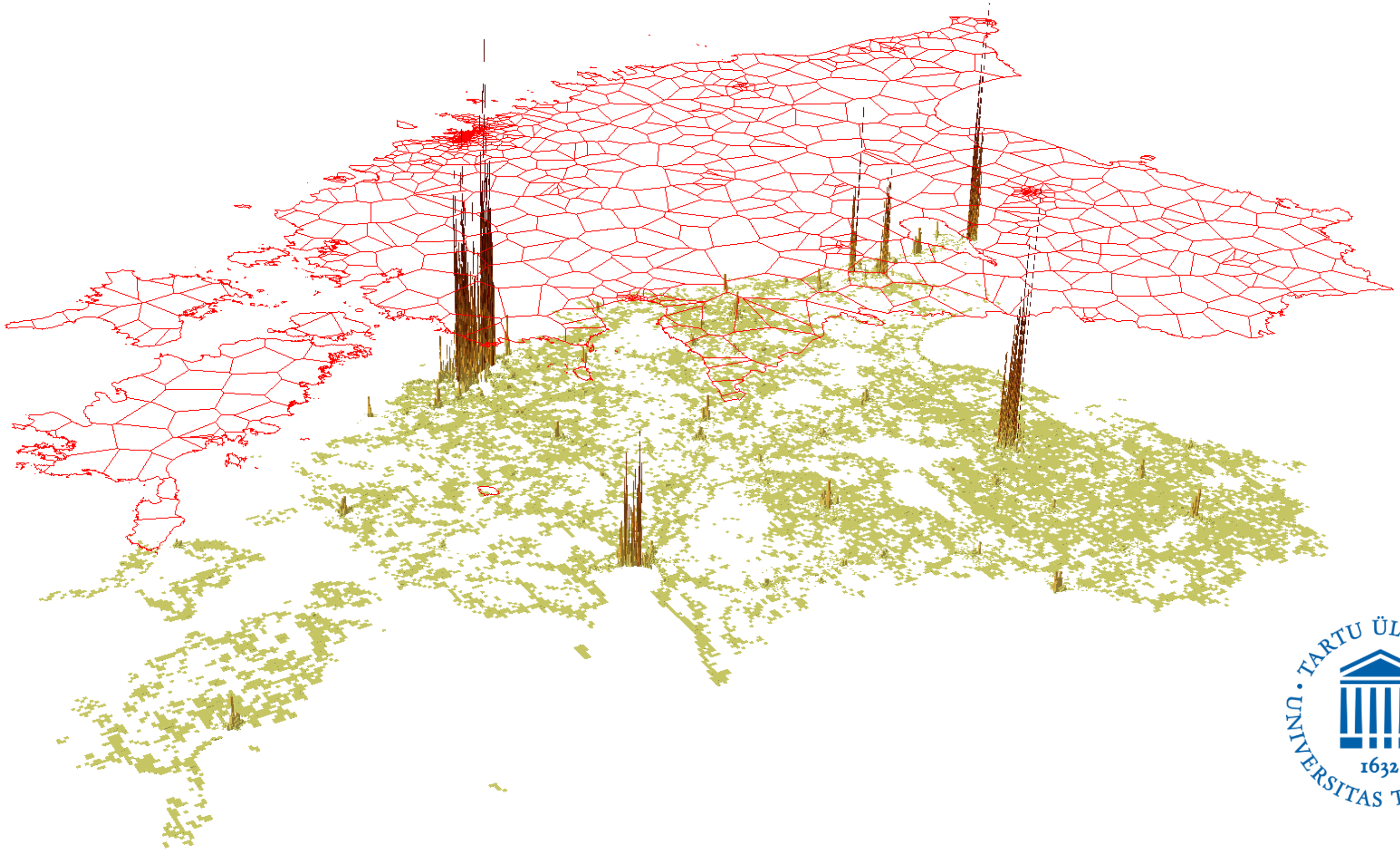
Population in 1km regular grid



Population in 1km grid

Theorethical coverage of mobile antennas

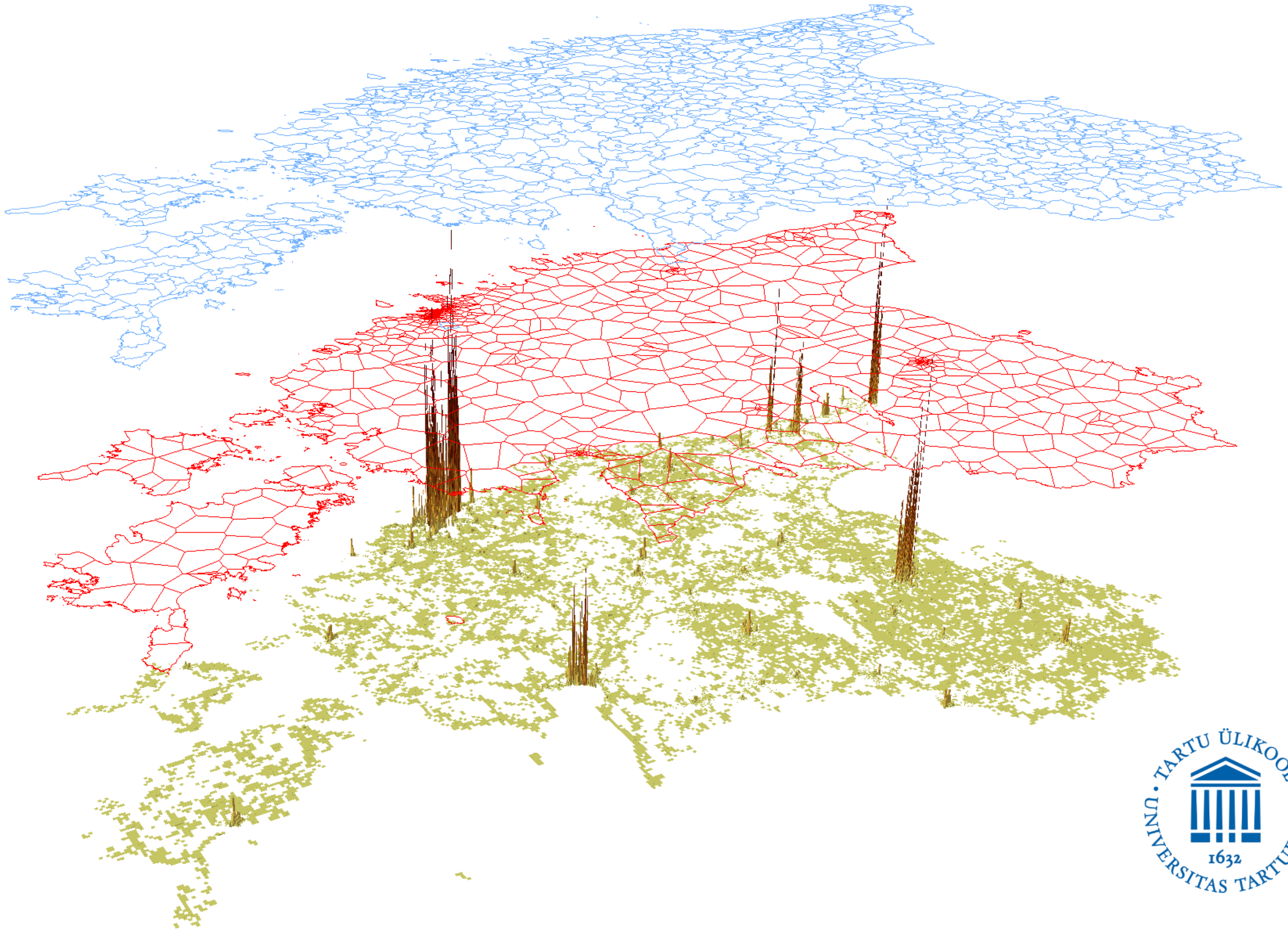
Population in 1km grid



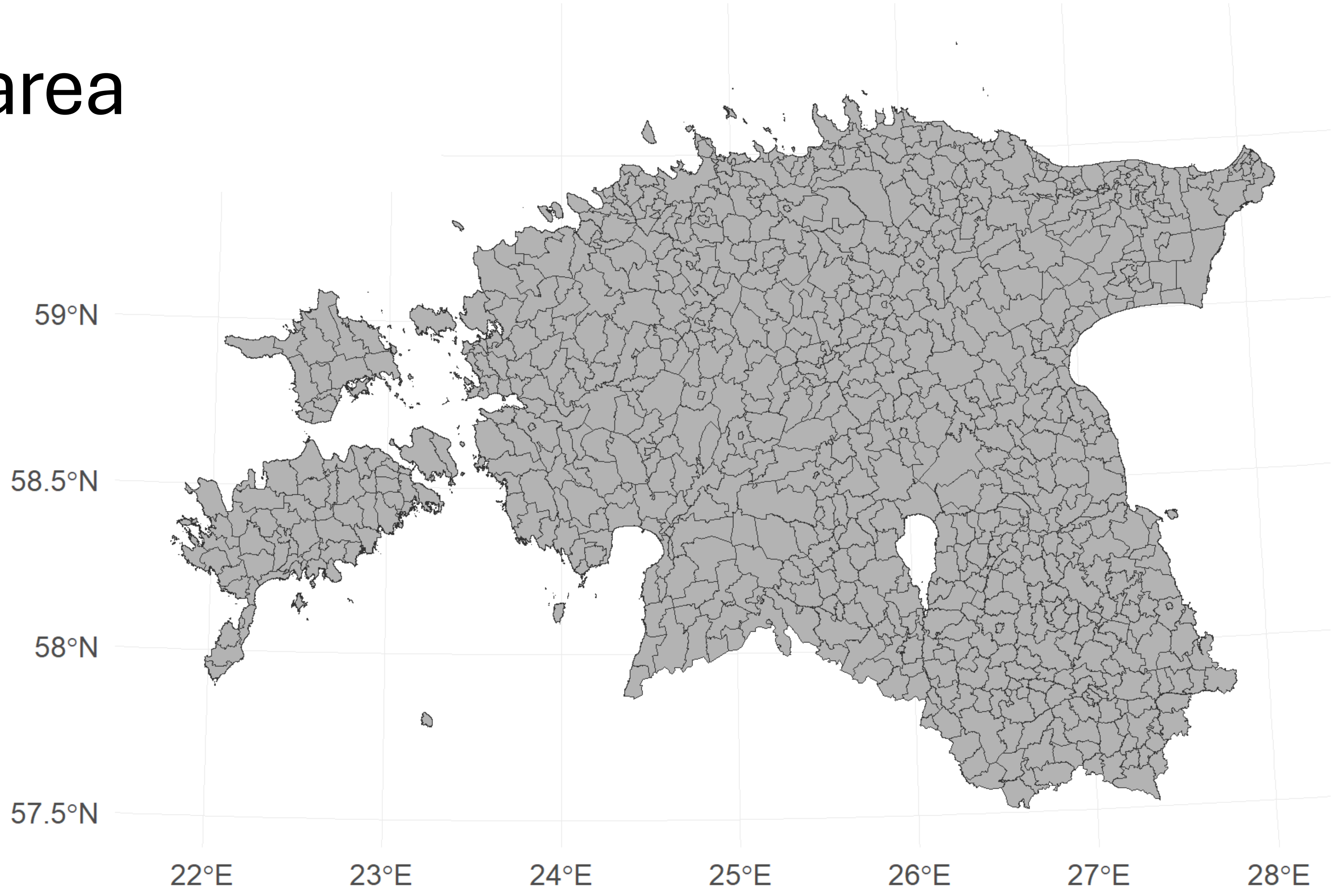
Territorial communities

Theorethical coverage of mobile antennas

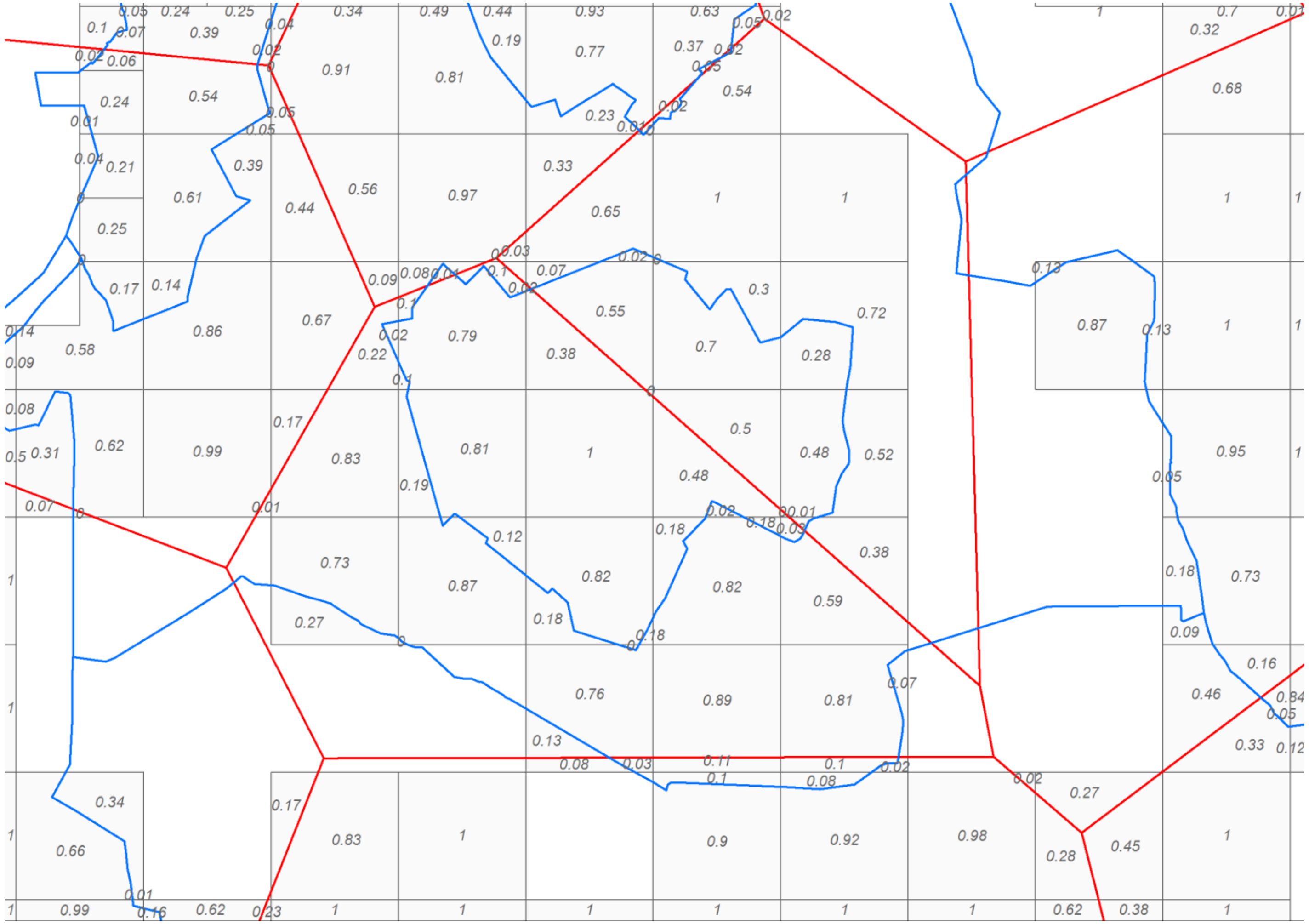
Population in 1km grid



Study area

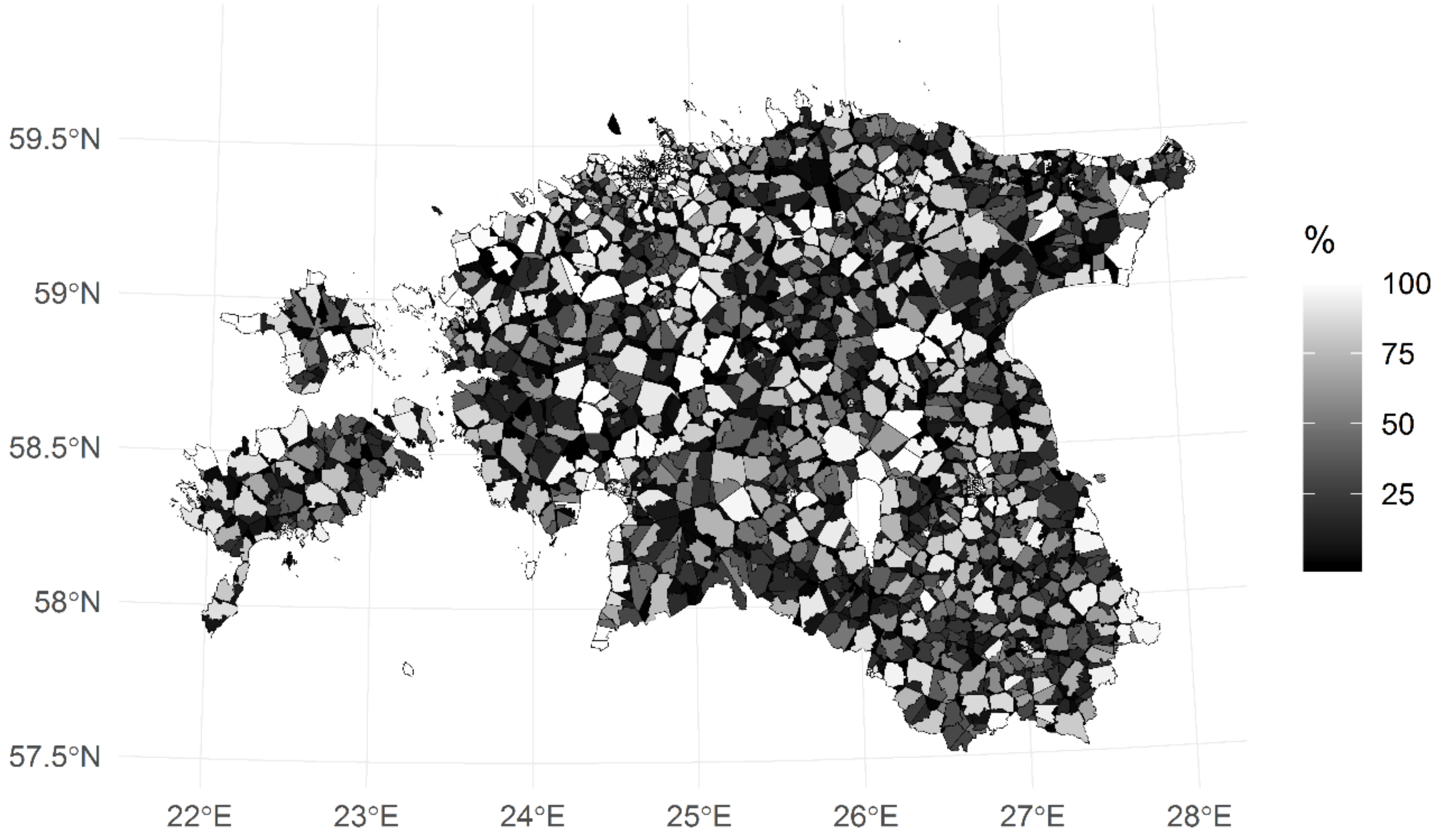


Spatial interpolation



TARTU ÜLIKOOL 1632 UNIVERSITAS TARTUENSIS

modelling surface



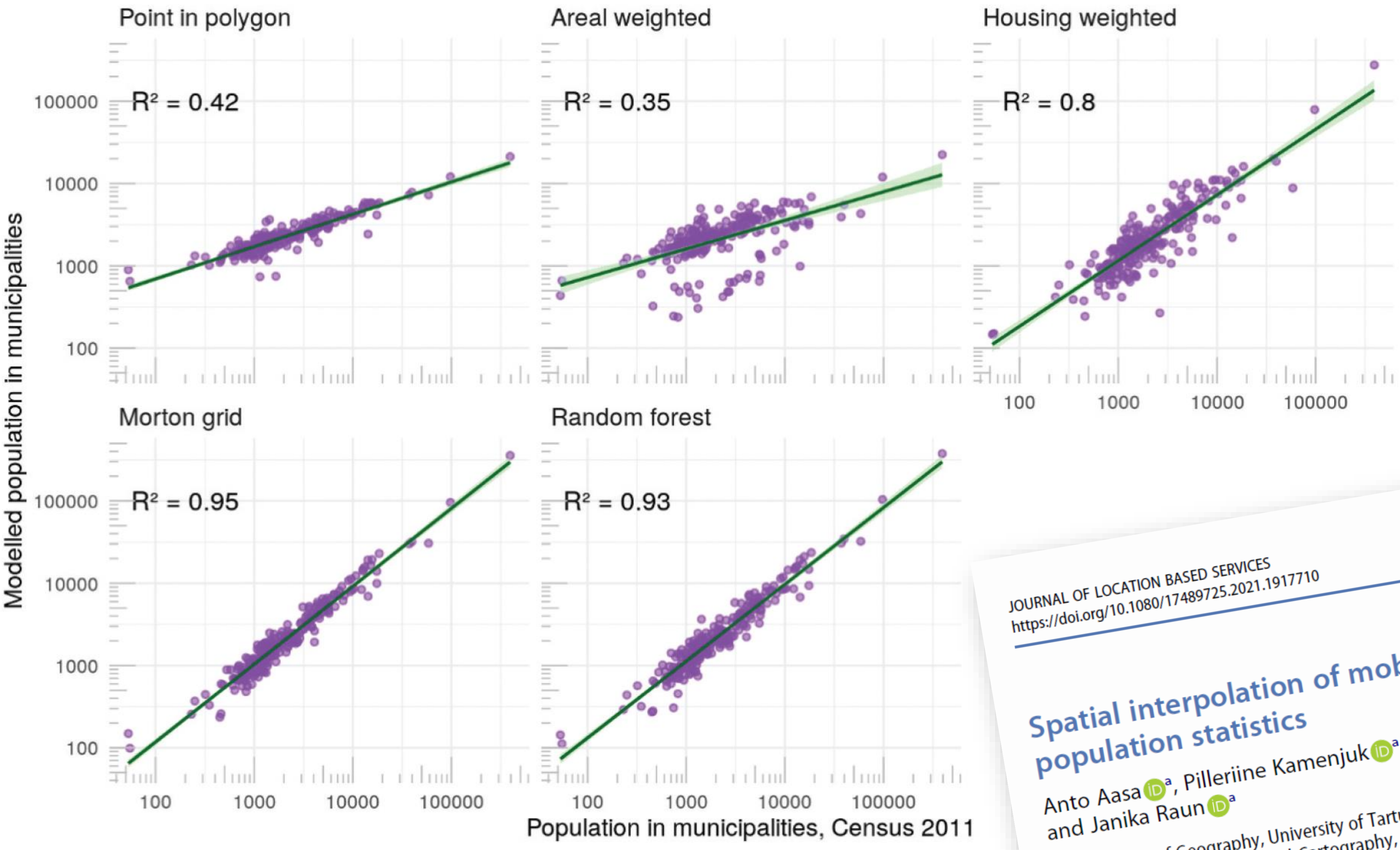
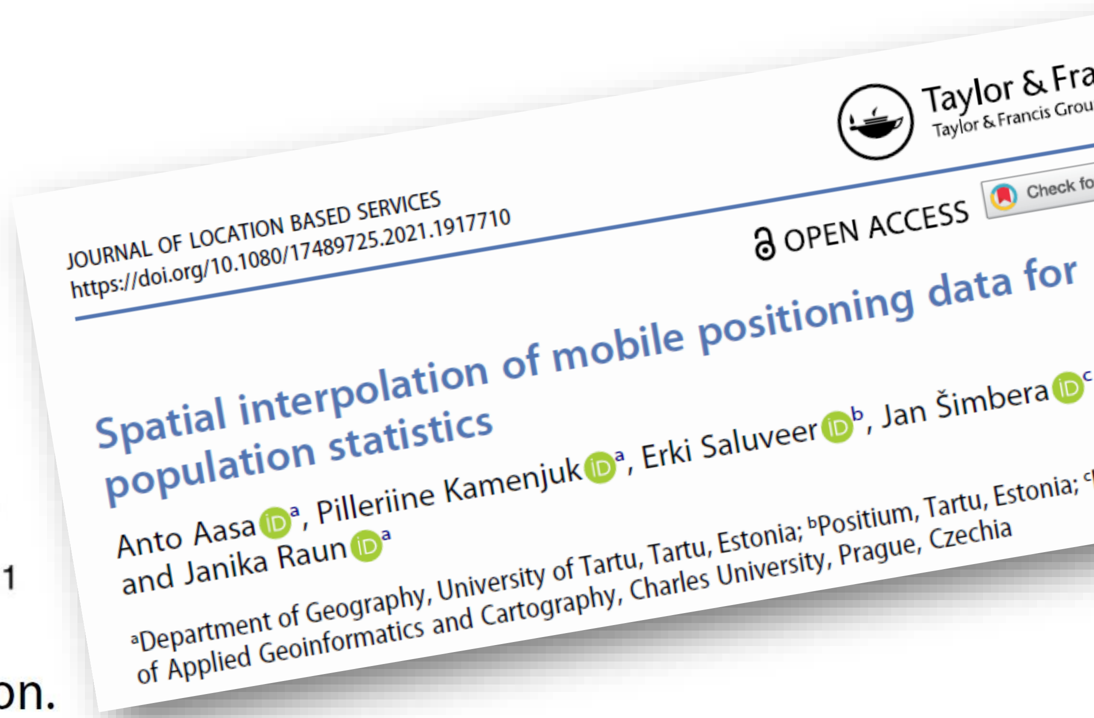


Figure 11. Relationship between modelled and census population.



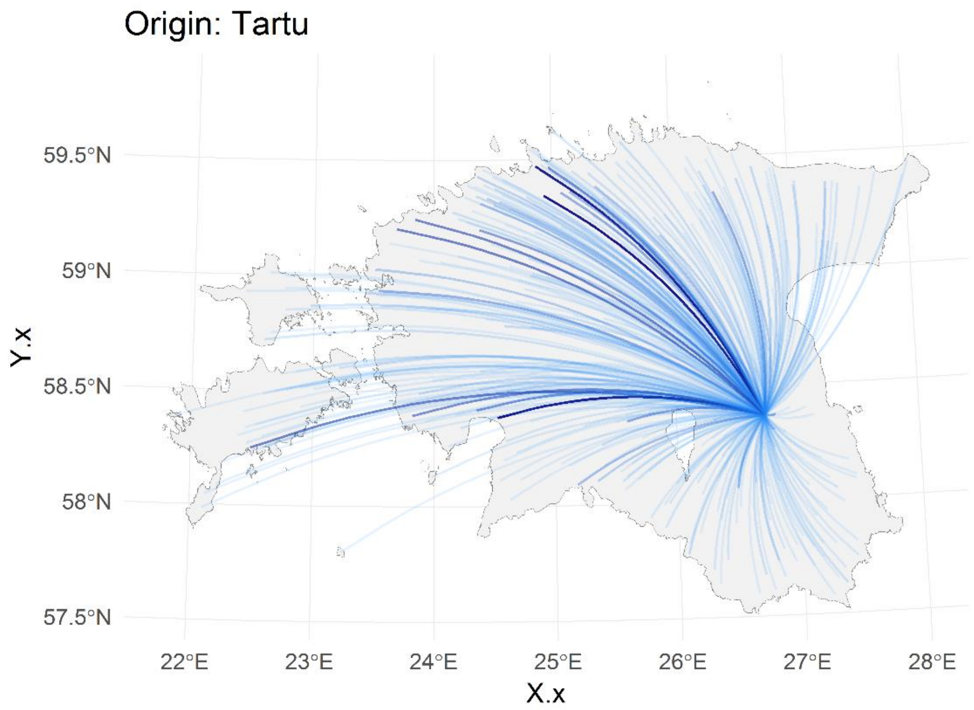
JOURNAL OF LOCATION BASED SERVICES
https://doi.org/10.1080/17489725.2021.1917710
OPEN ACCESS

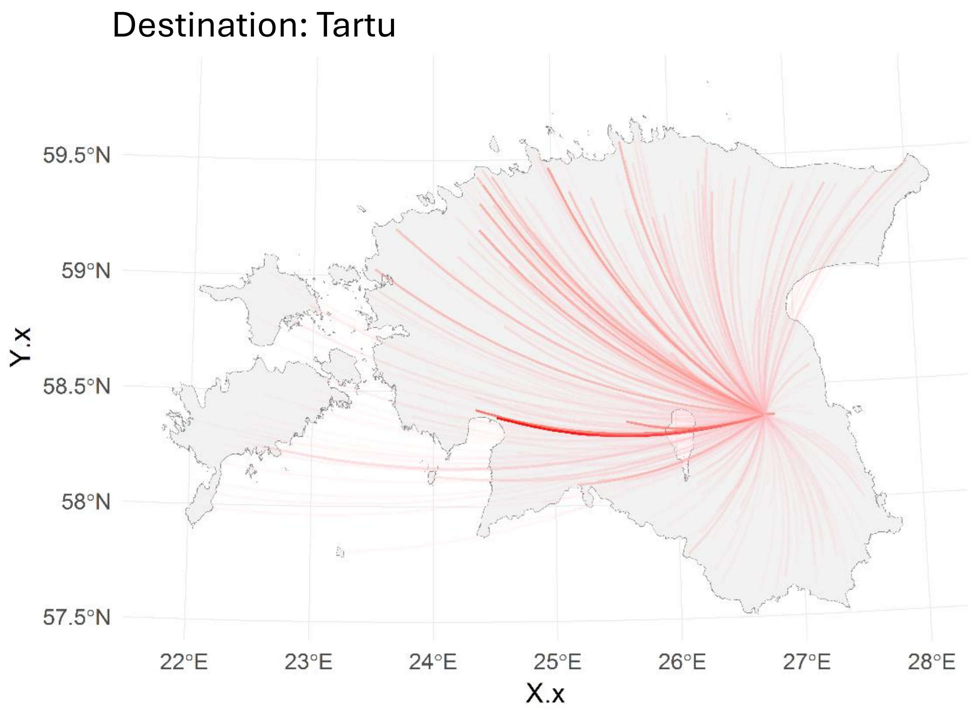
Spatial interpolation of mobile positioning data for population statistics

Anto Aasa [a], Pilleriine Kamenjuk [a], Erki Saluveer [b], Jan Šimbera [c] and Janika Raun [a]

[a]Department of Geography, University of Tartu, Tartu, Estonia; [b]Positium, Tartu, Estonia; [c]
of Applied Geoinformatics and Cartography, Charles University, Prague, Czechia

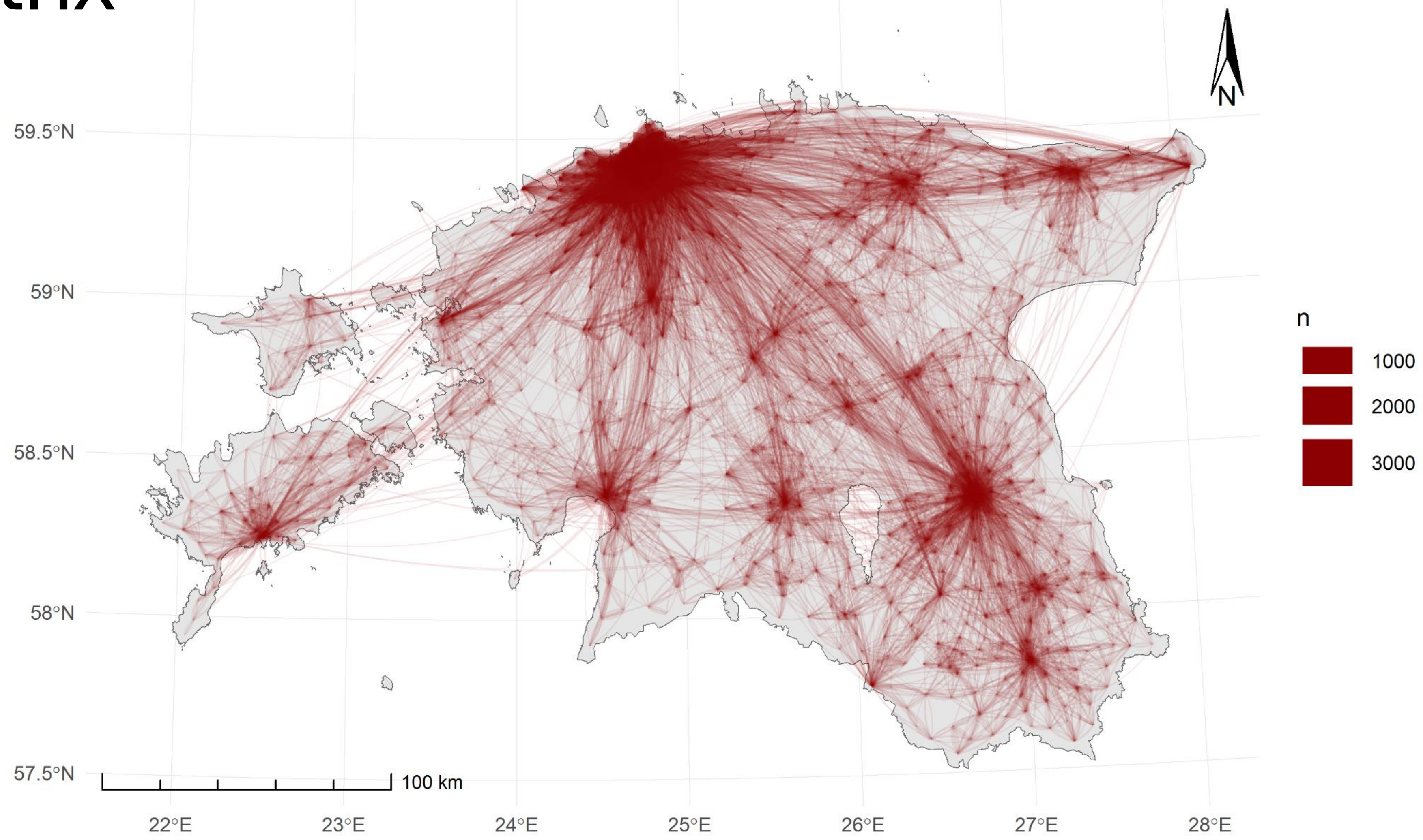
OD-matrix, Tartu





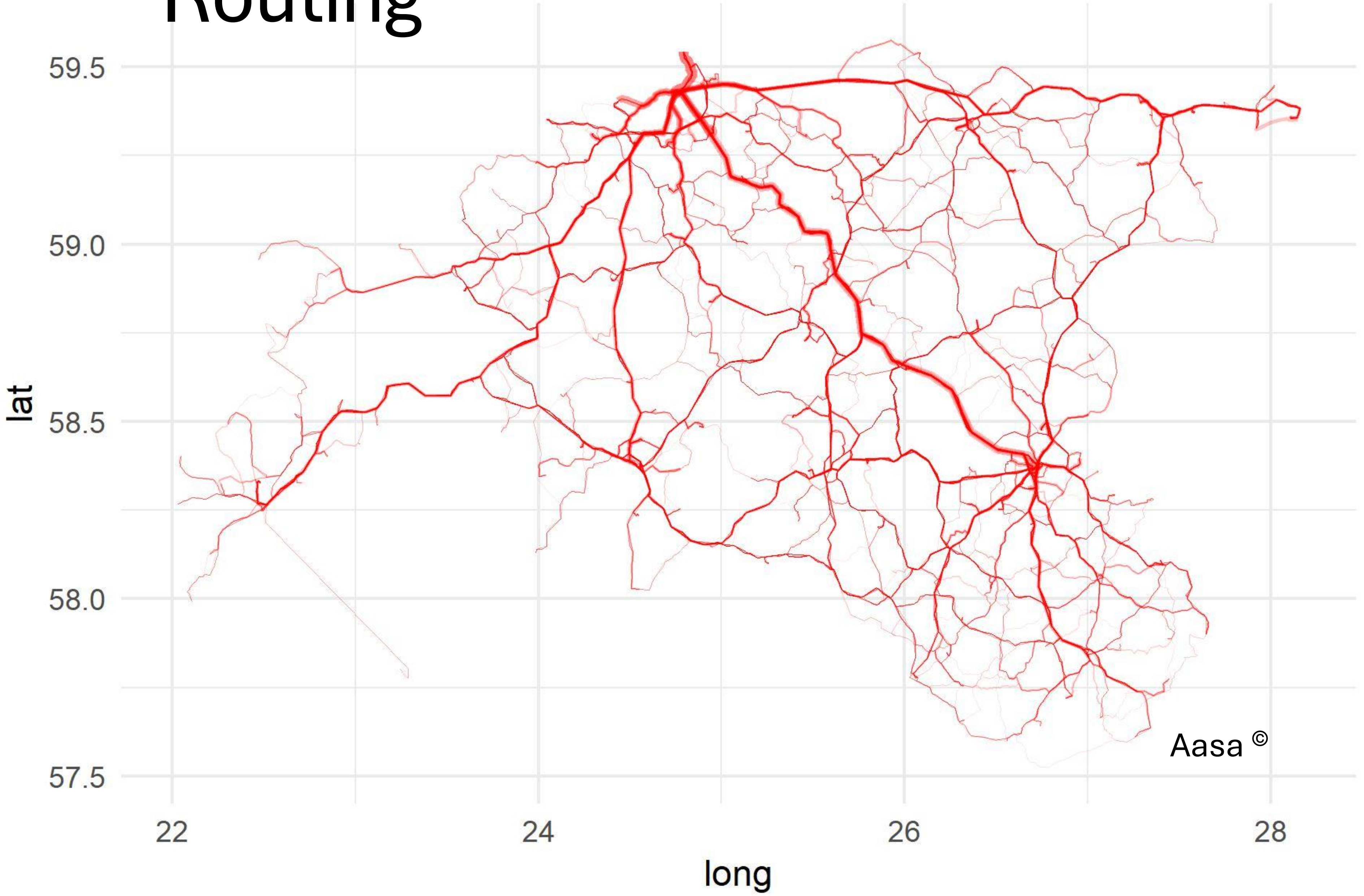
KANT_nk_or	KANT_nk_de	N	X.x	Y.x	X.y	Y.y
Aakre Valga	Aakre Valga	117	627213	6440209	627213.0	6440209
Aakre Valga	Albu Järva	1	627213	6440209	589941.9	6555843
Aakre Valga	Aruküla Harju	2	627213	6440209	561079.1	6580363
Aakre Valga	Emmaste Hiiu	1	627213	6440209	418365.2	6509690
Aakre Valga	Haabersti linnaosa	5	627213	6440209	535384.5	6587643
Aakre Valga	Haapsalu linn	4	627213	6440209	473490.5	6532856

OD-matrix

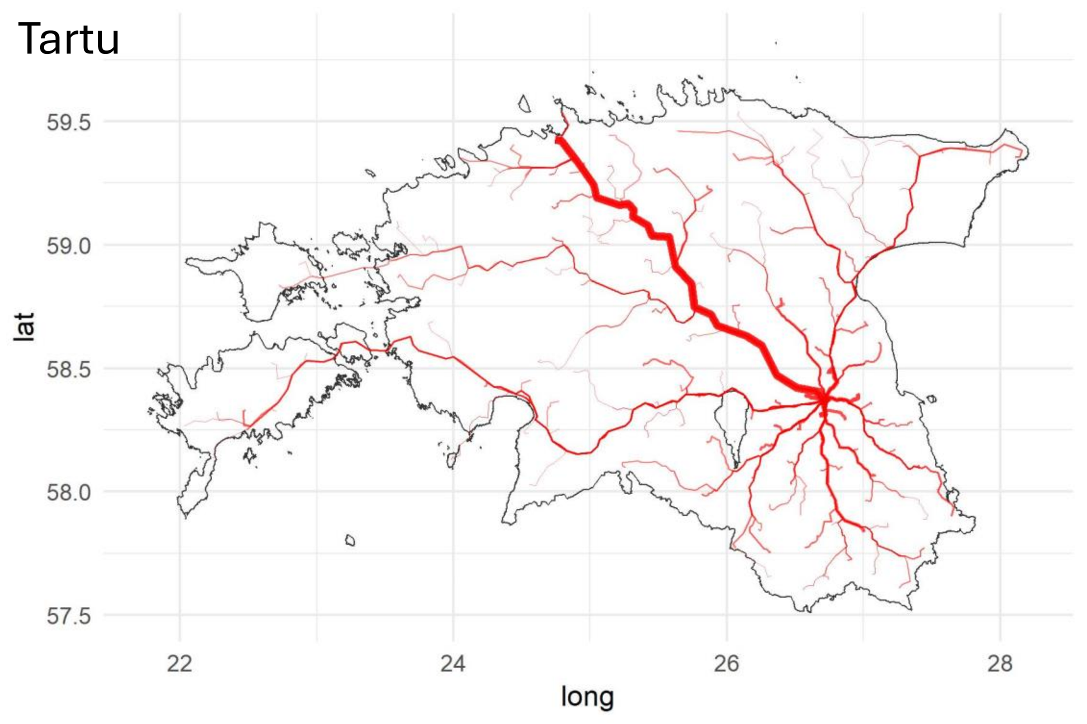


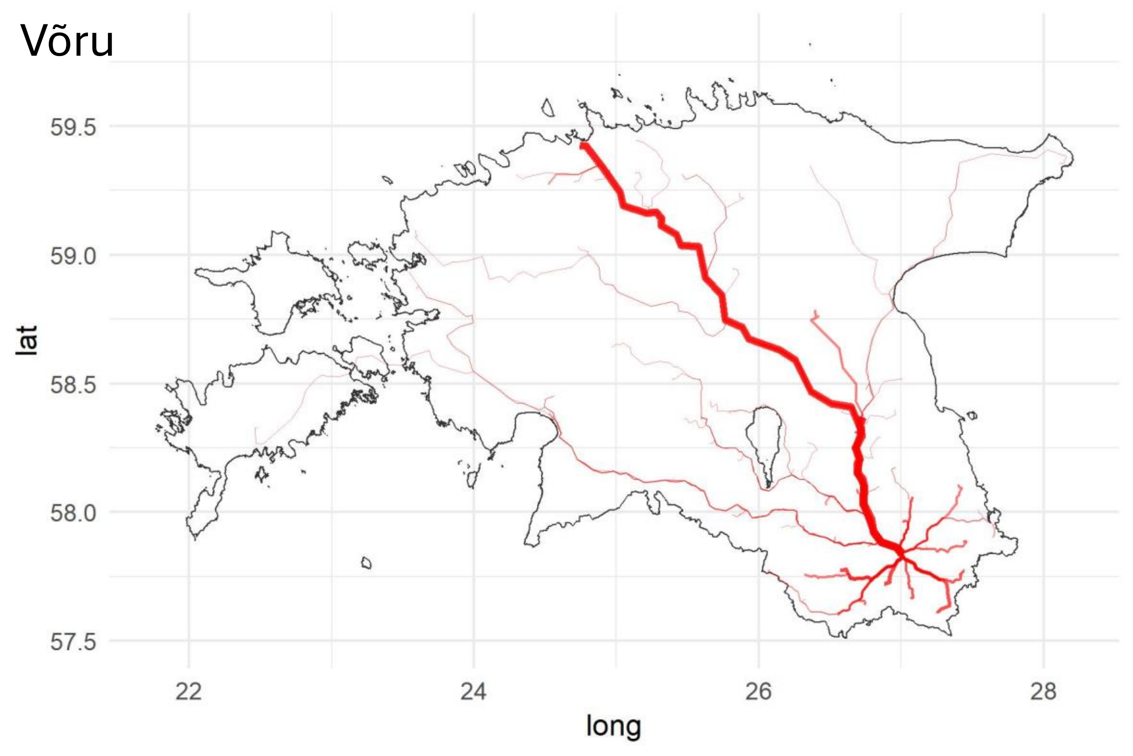
N
59.5°N
59°N
58.5°N
58°N
57.5°N
22°E
23°E
24°E
25°E
26°E
27°E
28°E
100 km
n
1000
2000
3000

Routing

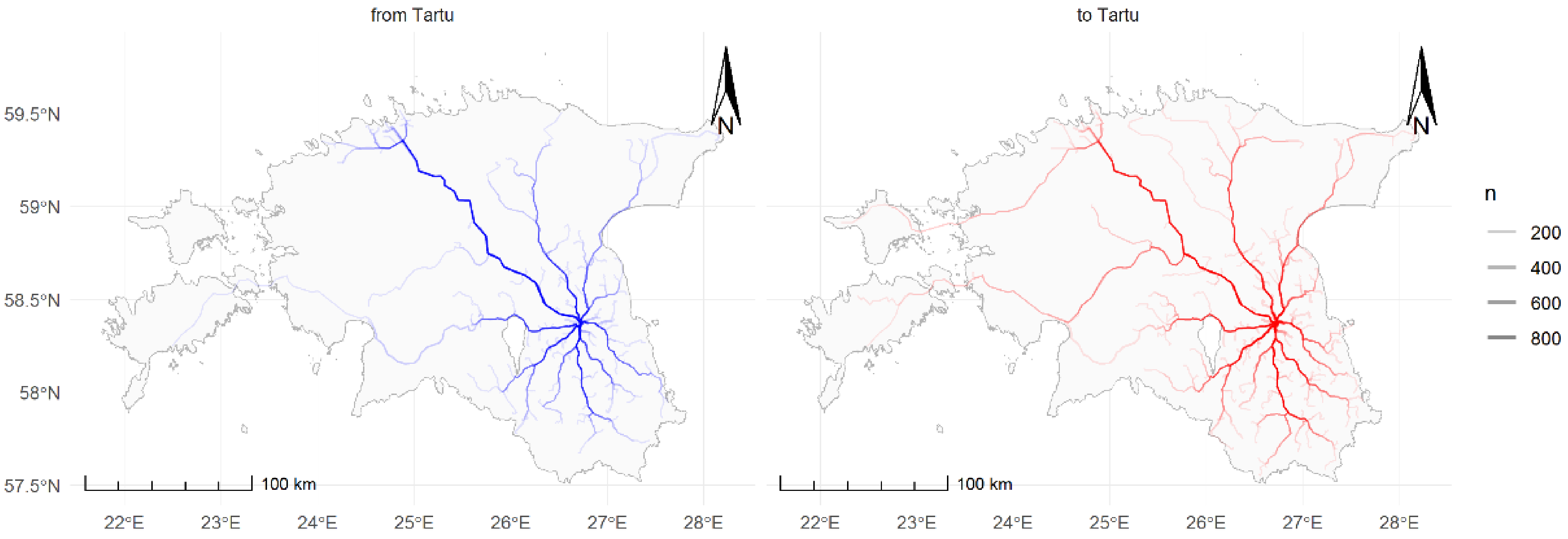


Next step: Routing!

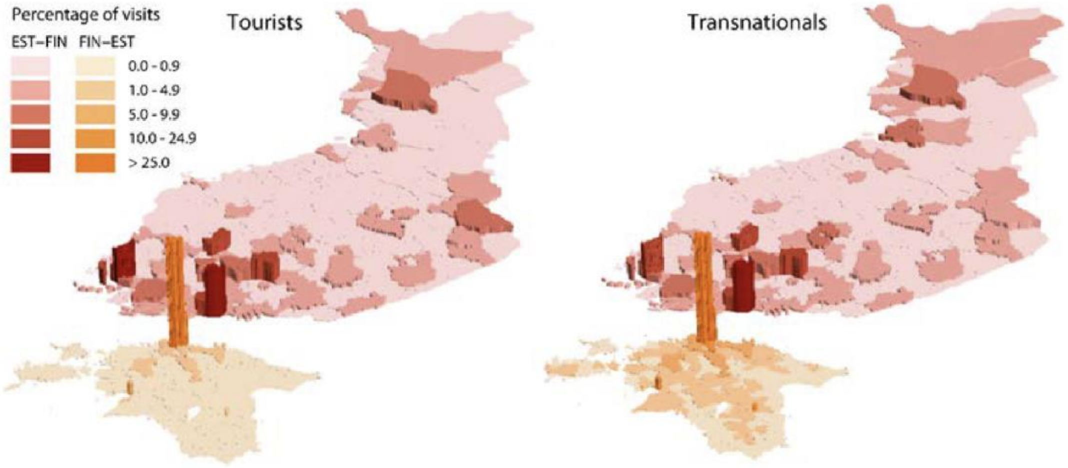


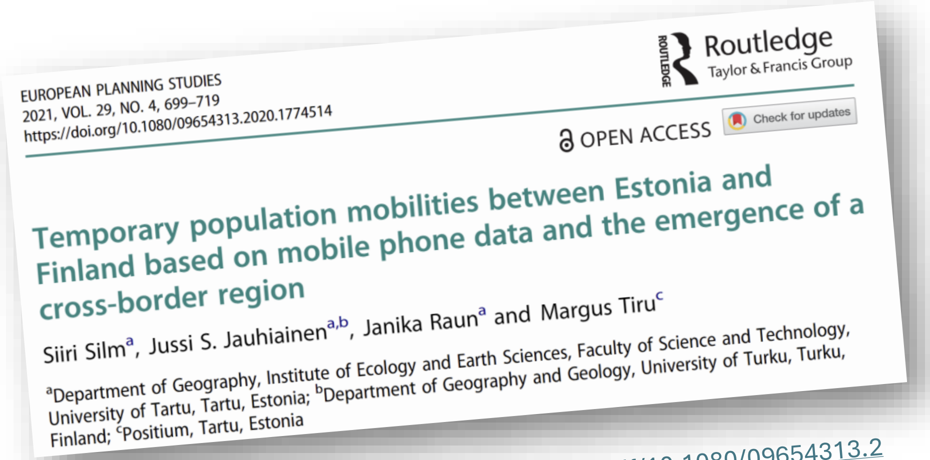


OD matrix & routing



Cross-border mobility





EUROPEAN PLANNING STUDIES
2021, VOL. 29, NO. 4, 699–719
https://doi.org/10.1080/09654313.2020.1774514

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Temporary population mobilities between Estonia and Finland based on mobile phone data and the emergence of a cross-border region

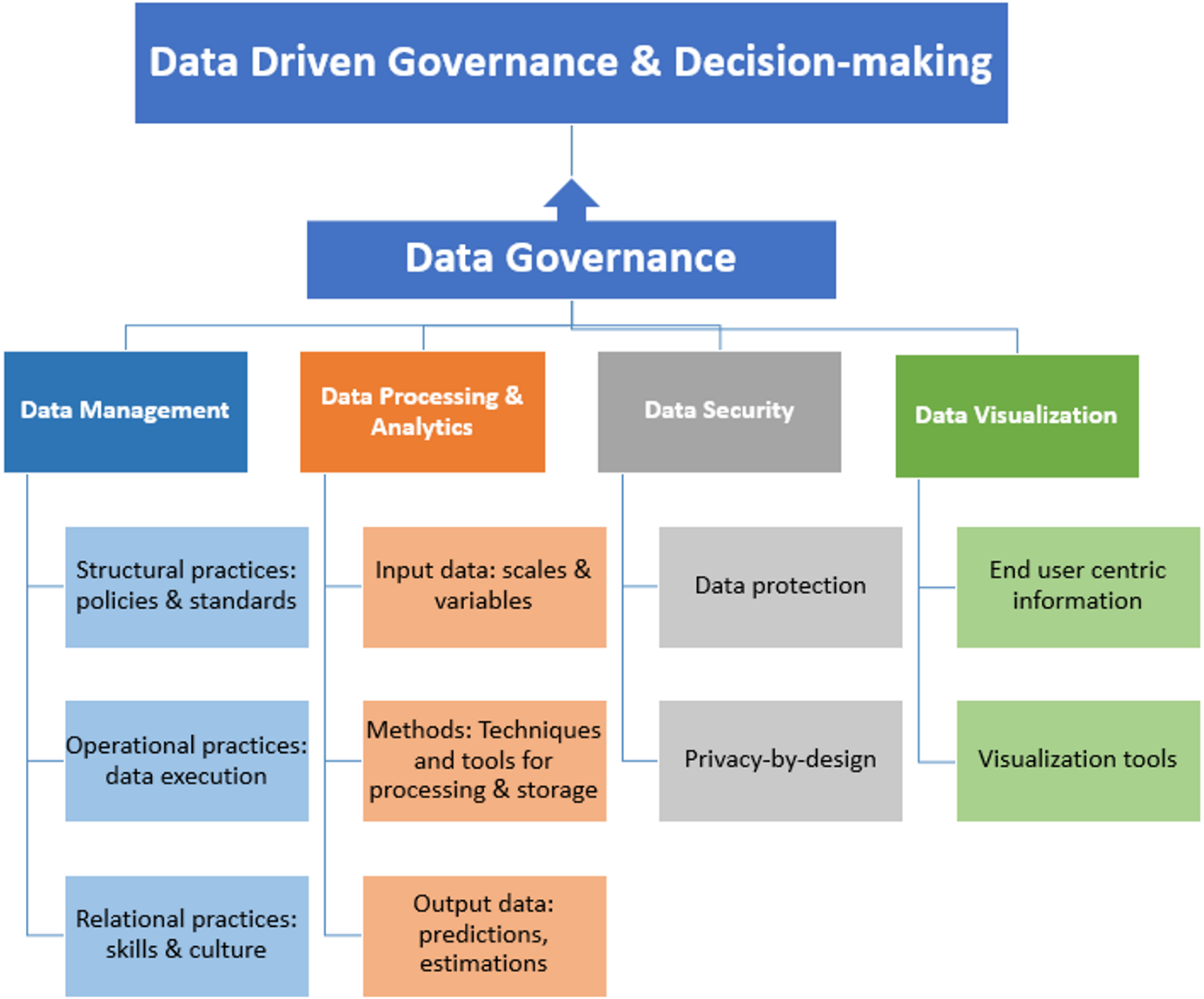
Siiri Silm[a], Jussi S. Jauhiainen[a,b], Janika Raun[a] and Margus Tiru[c]

[a]Department of Geography, Institute of Ecology and Earth Sciences, Faculty of Science and Technology, University of Tartu, Tartu, Estonia; [b]Department of Geography and Geology, University of Turku, Turku, Finland; [c]Positium, Tartu, Estonia

https://www.tandfonline.com/doi/epdf/10.1080/09654313.2020.1774514?needAccess=true

- Novelty
- Limitations
- Policy implications
- Recommendations

Figure 5.1: Aspects of capacity building for big data driven policy-making in growth corridors.



Freely following key aspects identified in the research roadmap for Europe (Cuquent & Fensel 2018).

https://mobilitylab.ut.ee/OD/

Reference:
Summary:
Background & objectives
Data & methods
Results
Data download

OD-matricies of regular movements in Estonia

ESPON project:

Potentials of big data for integrated territorial policy development in the European growth corridors

UNIVERSITY OF TARTU Mobility Lab

ESPON EUROPEAN UNION
Co-financed by the European Regional Development Fund

Reference:

Aasa, A. (2019). OD-matrices of daily regular movements in Estonia [Data set]. University of Tartu, Mobility Lab.
https://doi.org/10.23659/UTMOBLAB-1

Regular movements in Estonia in January 2016

Data: Aasa, A. (2019). OD-matrices of daily regular movements in Estonia [Data set]. University of Tartu, Mobility Lab. https://doi.org/10.23659/UTMOBLAB-1

@evelynuuemaa

ESPON

EUROPEAN UNION

Co-financed by the European Regional Development Fund

Inspire Policy Making with Territorial Evidence

Thank You!

anto.aasa@ut.ee

UNIVERSITY OF TARTU

Mobility Lab

UNIVERSITY OF TARTU

Department of Geography