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Wearable sensors for mobility statistics

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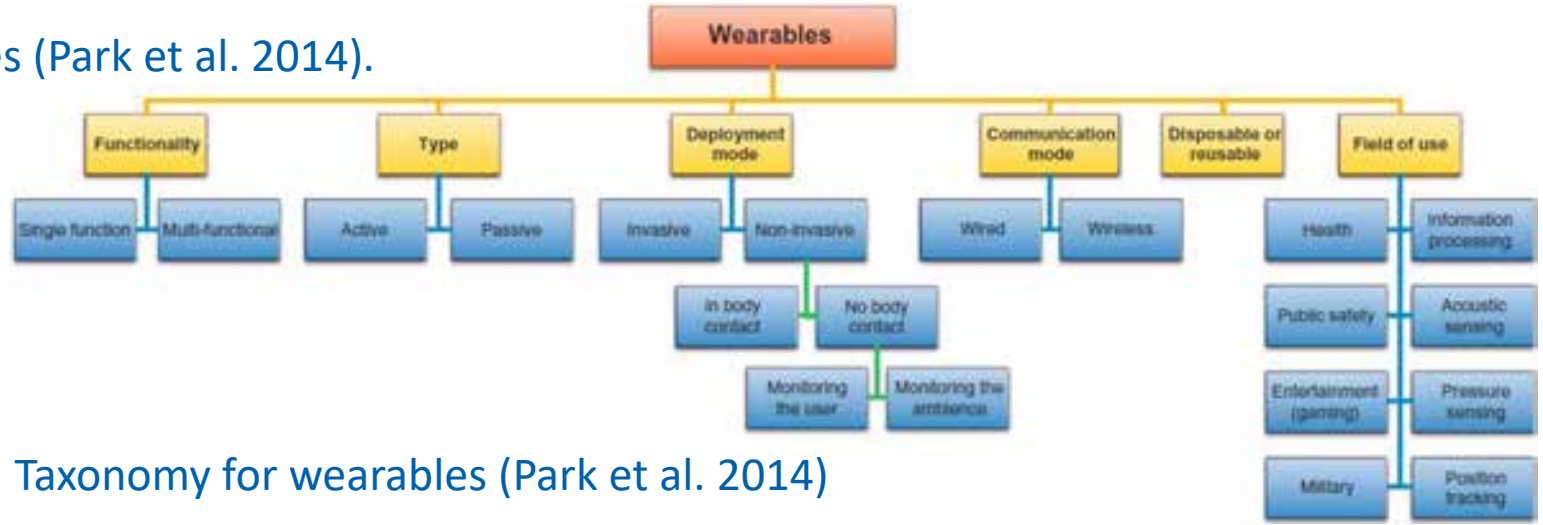
Migration and mobility are both the great potential and challenge of the 21st century!

- Mobility as a phenomenon has changed.
- Understand the context and causality.
- Different and new data sources.

Wearable technology and sensors

- Wearable technology – „refers to accessories and clothing incorporating computer and advanced electronic technologies“ (PwC 2016).
- Examples: smart glasses, fitness band, smart clothing, smart watch, smartphone, etc.
- Use cases: health & sports, public safety, entertainment, remote control, science, etc.
- „Keeping the wearable commitment“ (PwC 2016) – adoption, users’ needs, convenience.
  - Physical and functional attributes (Park et al. 2014).



Taxonomy for wearables (Park et al. 2014)

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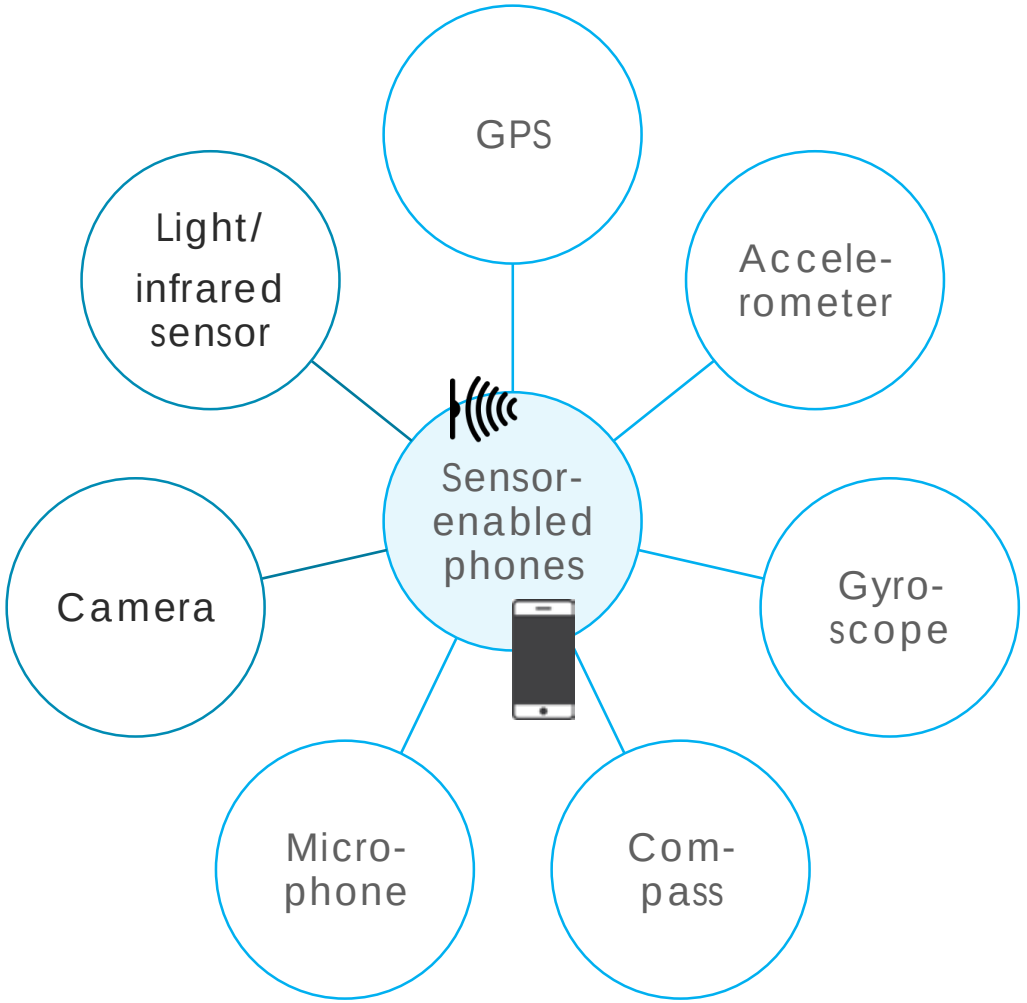
Mobile phone as a wearable sensor

- Multi-functional
- Non-invasive (?)
  - Other phone data: information as a by product of ICT services (CDR, signaling, Bluetooth, app use data)
- Wireless, etc.
- Individual → Community
- Wide, increasing use
  - Sample, spatial and temporal resolution, long term → statistics
- Use cases: mobility patterns, behavioural studies, social media use, etc.



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Focus of Mobility Lab on using mobile (sensor) data

- CDR data
- Data from mobile application (Mobility Log)

- Population statistics
  - Census
  - Migration
  - Commuting
- Central places & catchment areas
- Tourism statistics
  - Local
  - Inbound
  - Outbound
- Spatial segregation
- Accessibility
- Transport demand

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Memory files of mobile operators

- Call detail records (CDR) – location and time of call and number of respondent (user id, location, time).
- Passive mobile positioning.

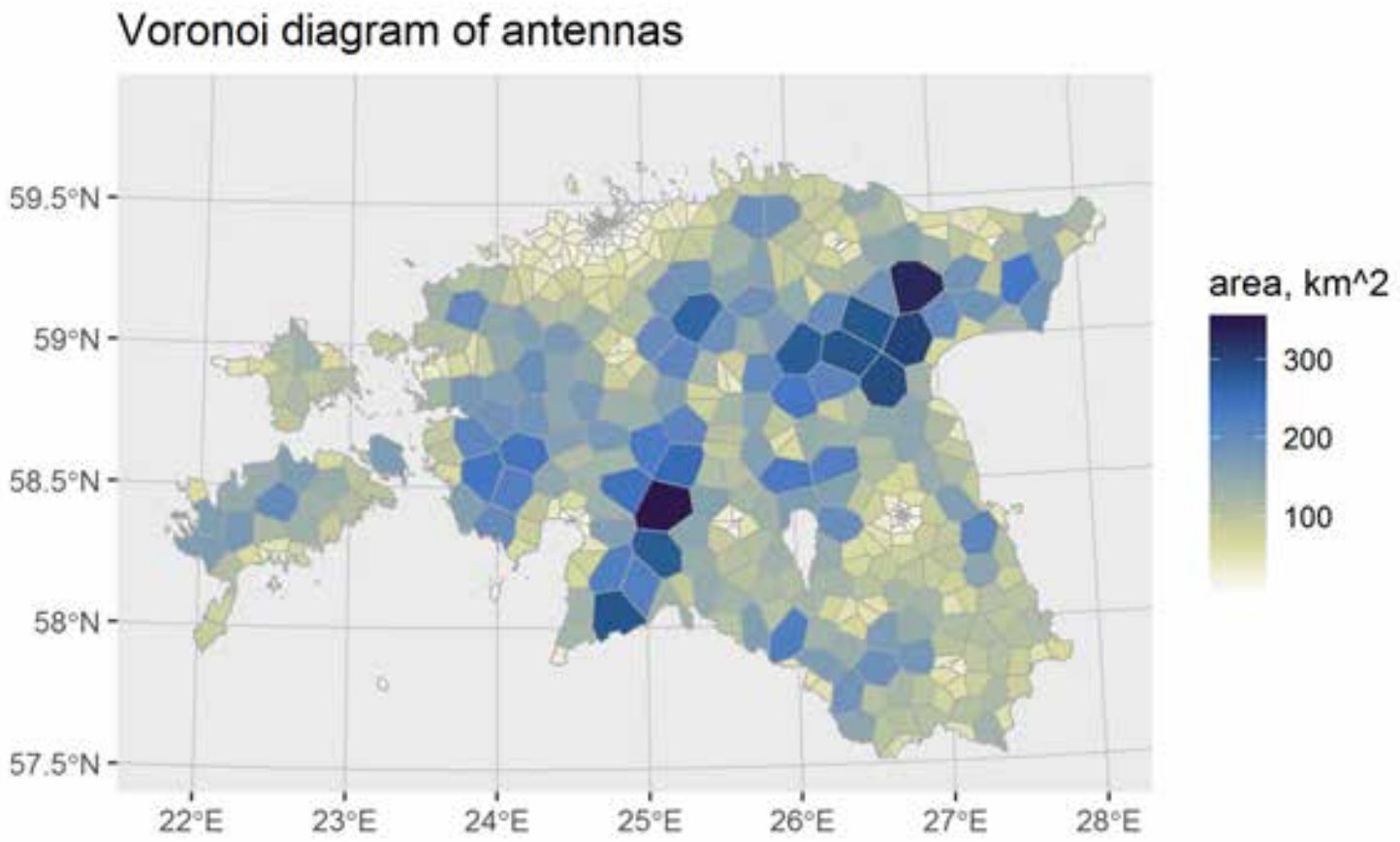
data table

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

Spatial resolution of CDR



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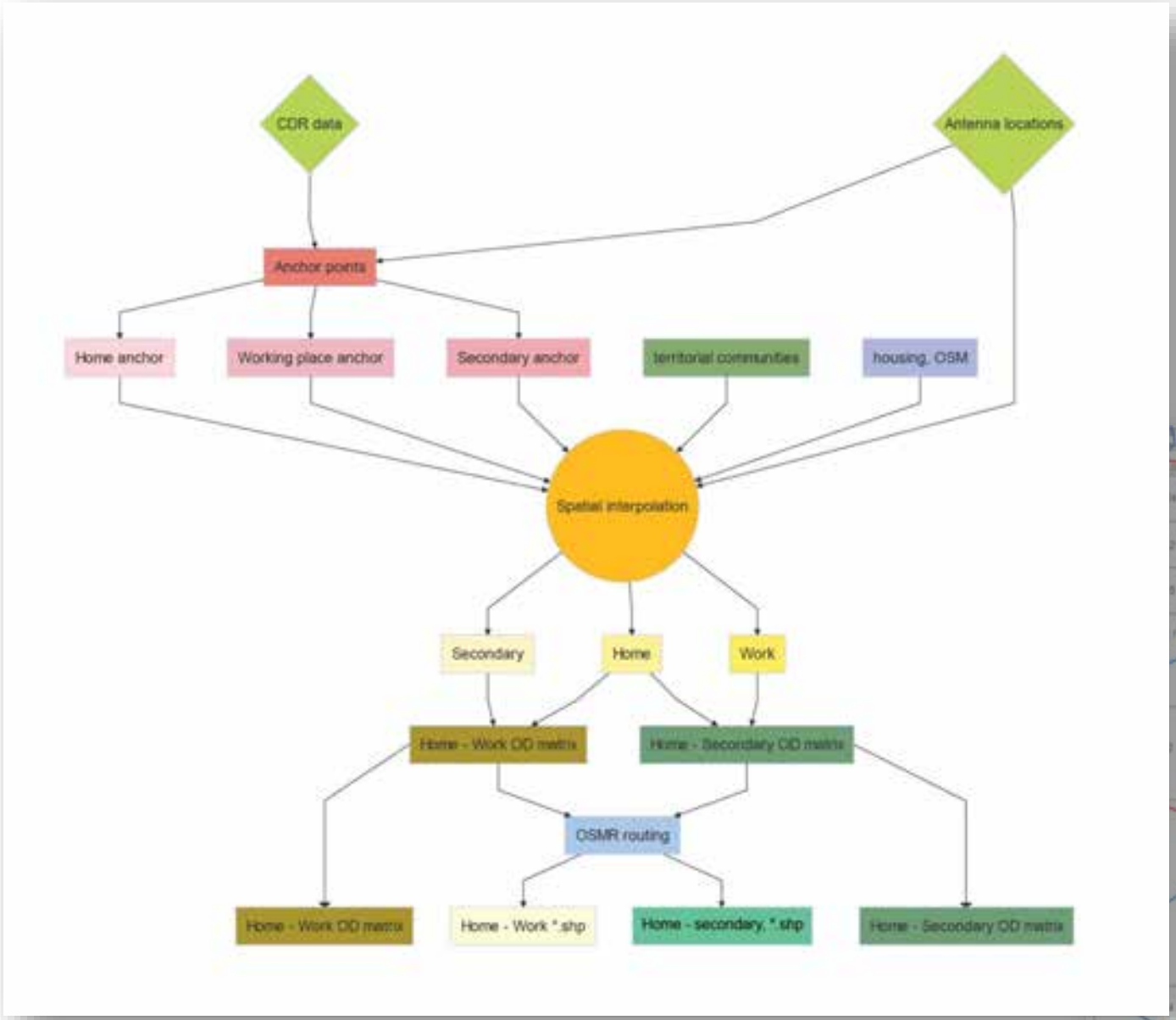
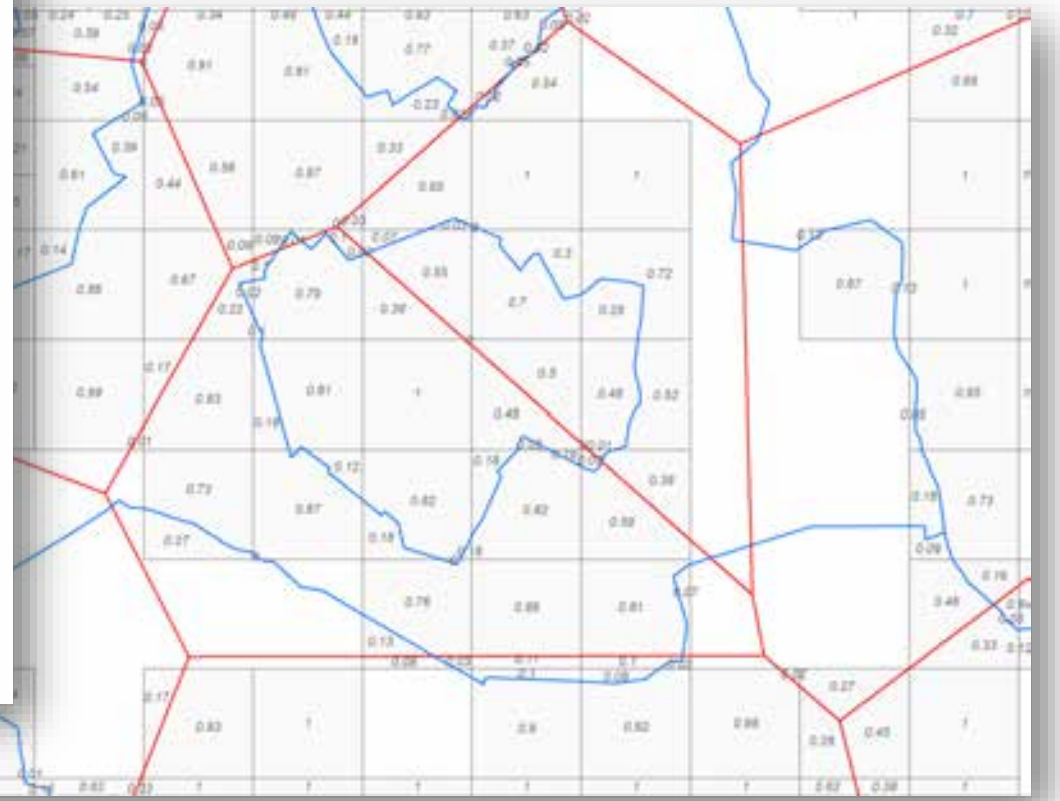
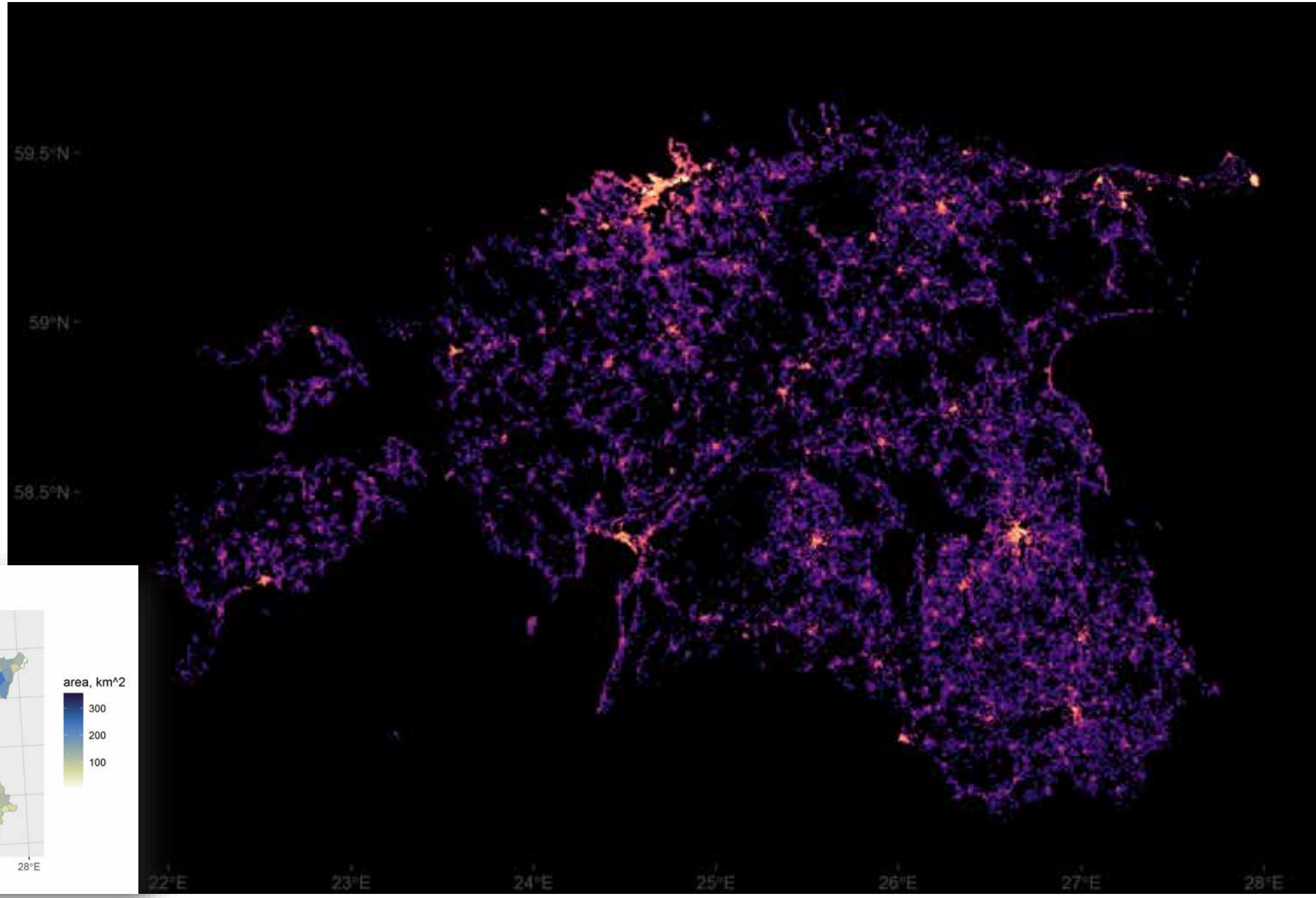
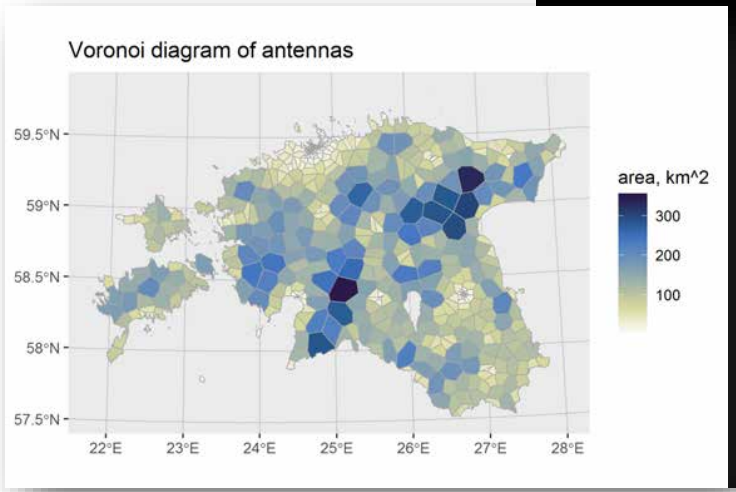




Mobile Census





Regular movement according to the mobile positioning data

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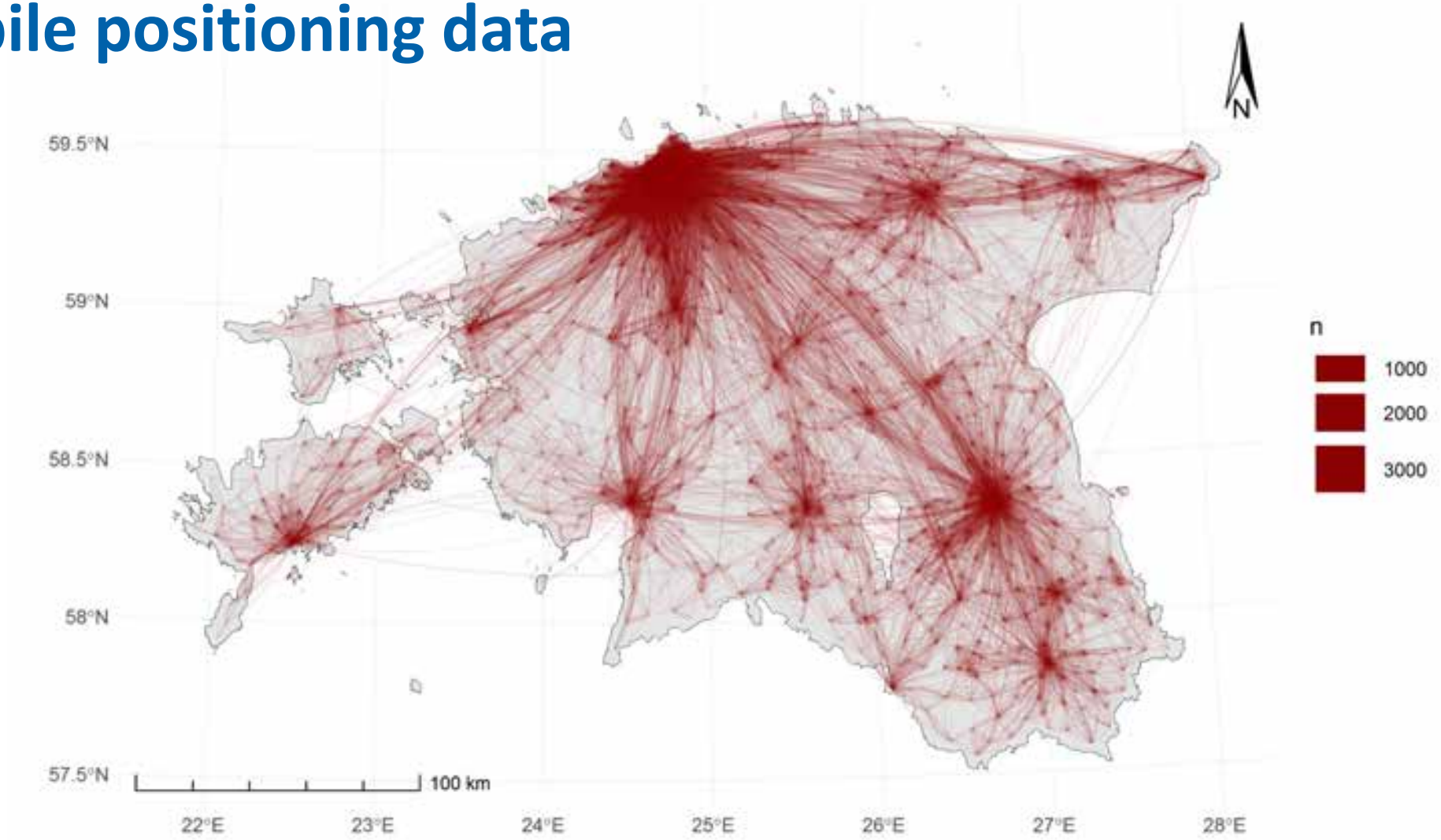
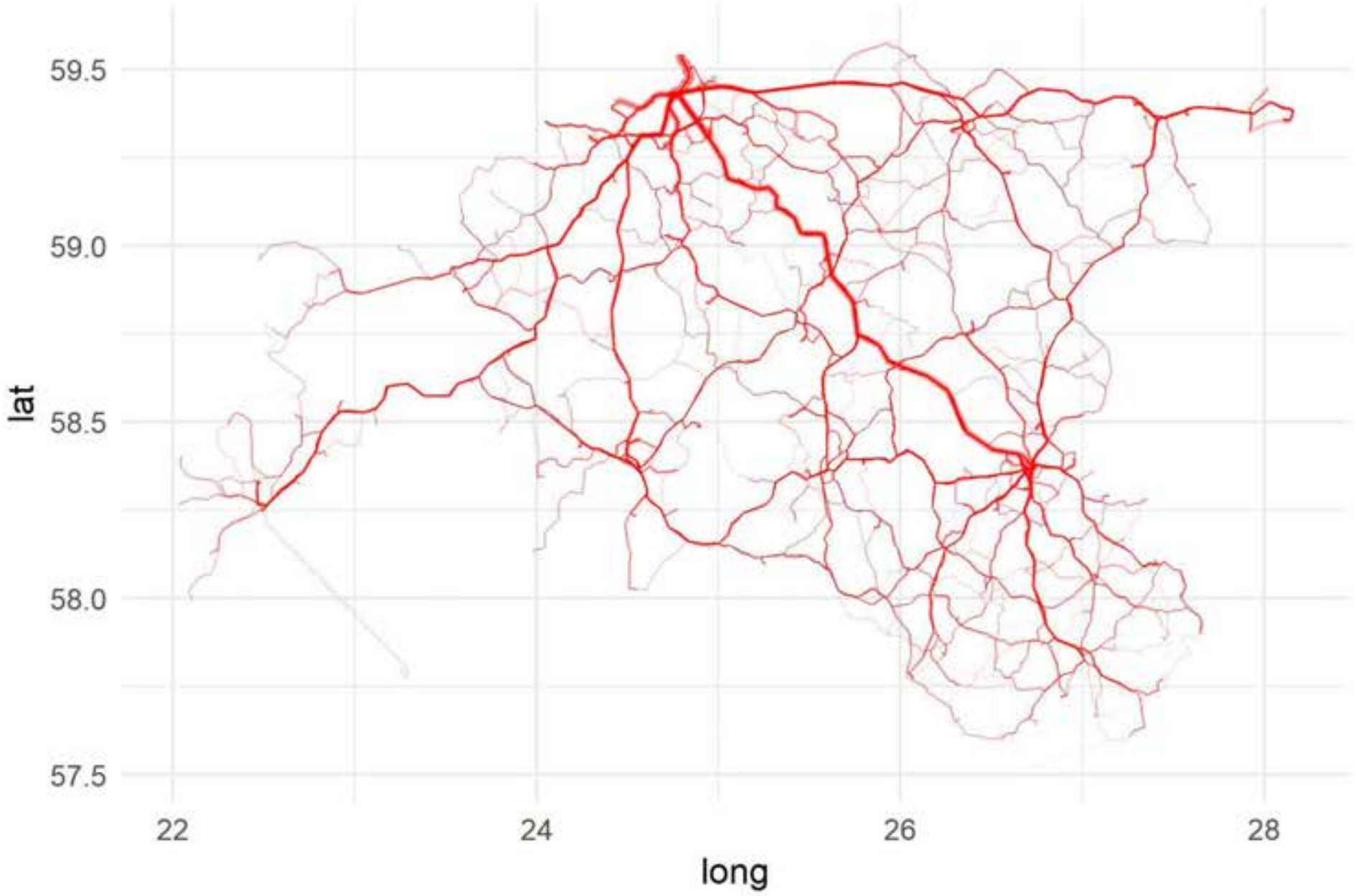


Routing,

OD-matrix



Central places & hinterlands (commuting)

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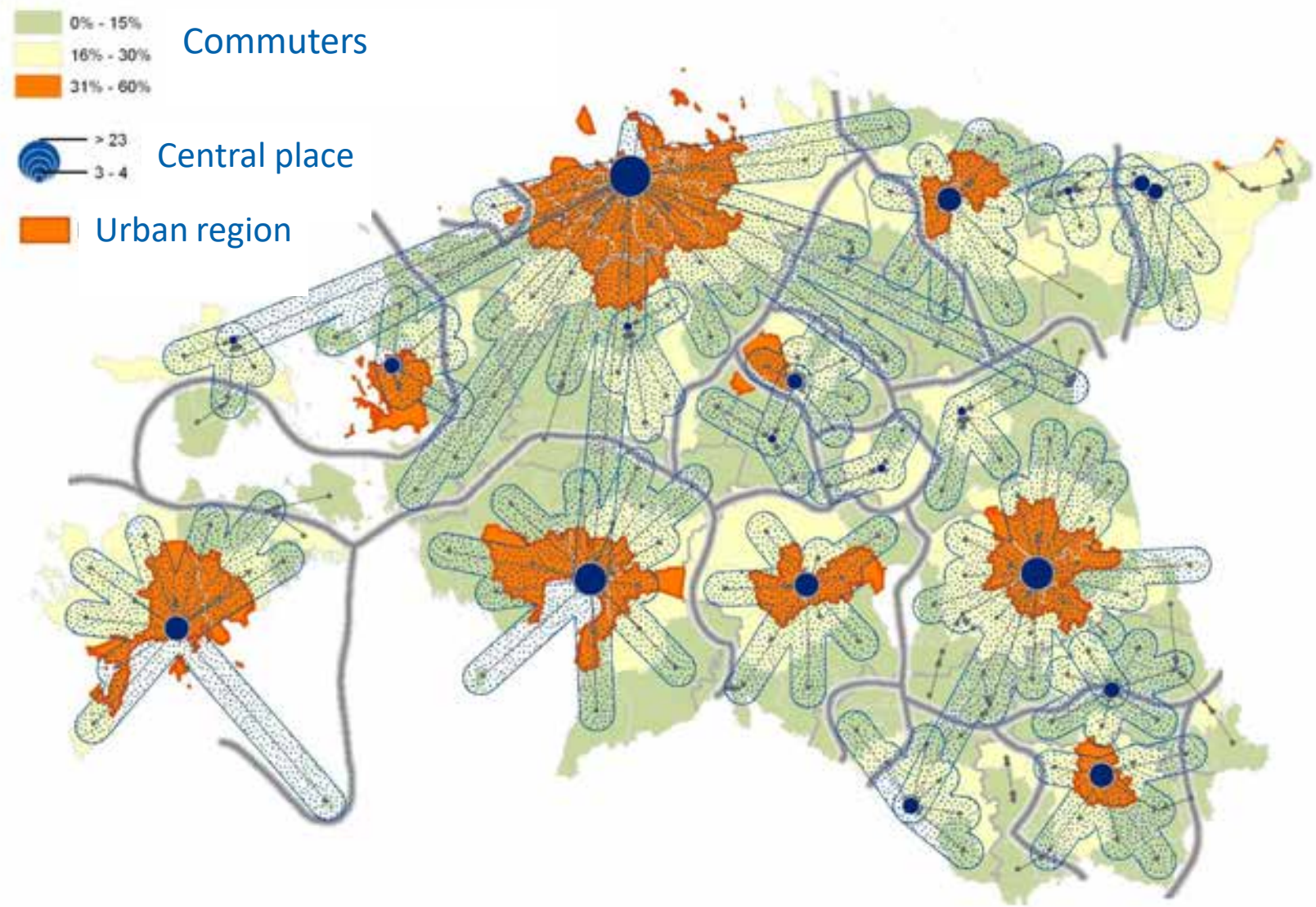

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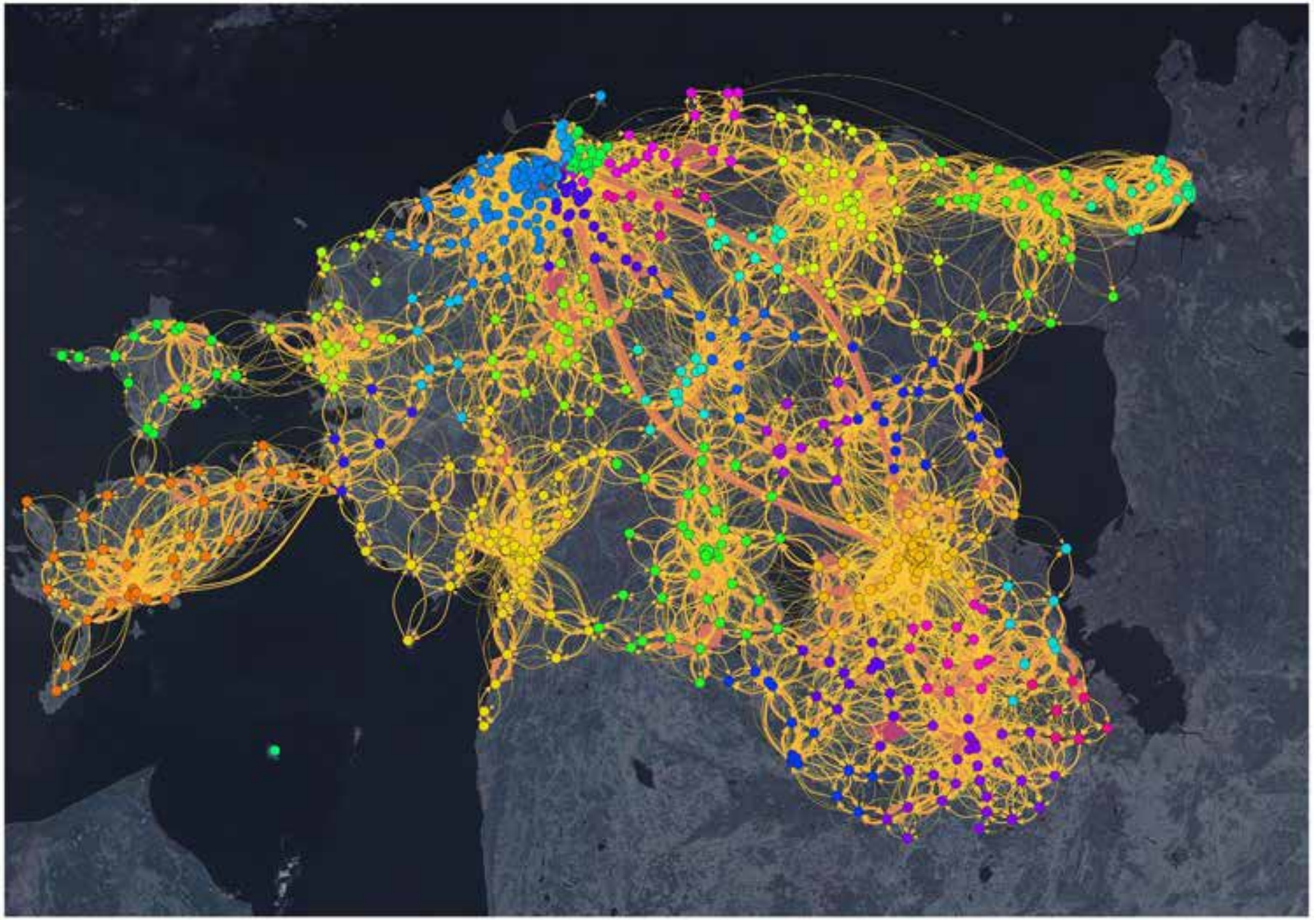
Migration

Movement during Christmas Eve



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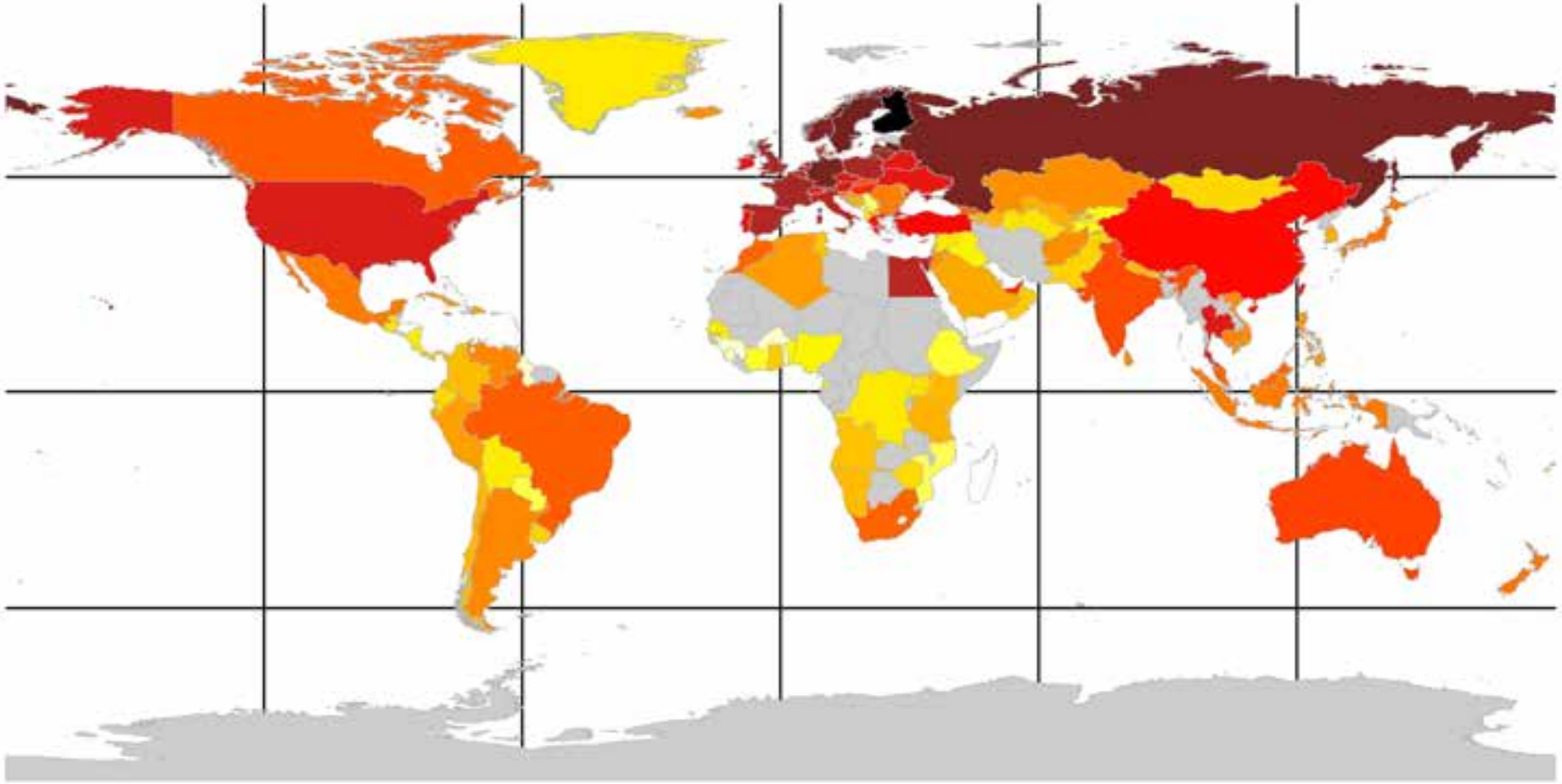
Estonians abroad



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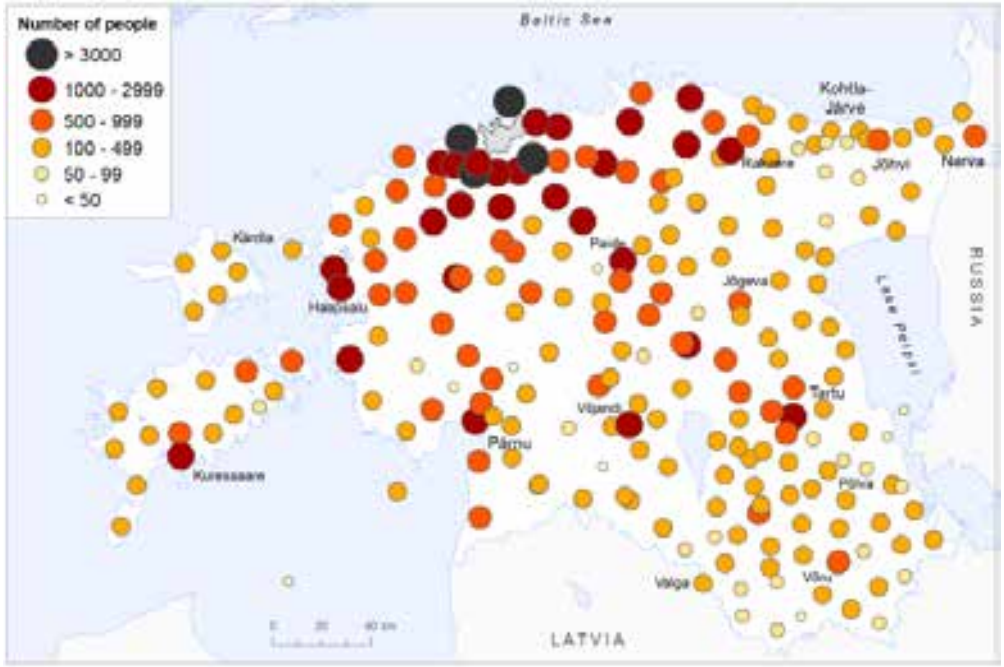
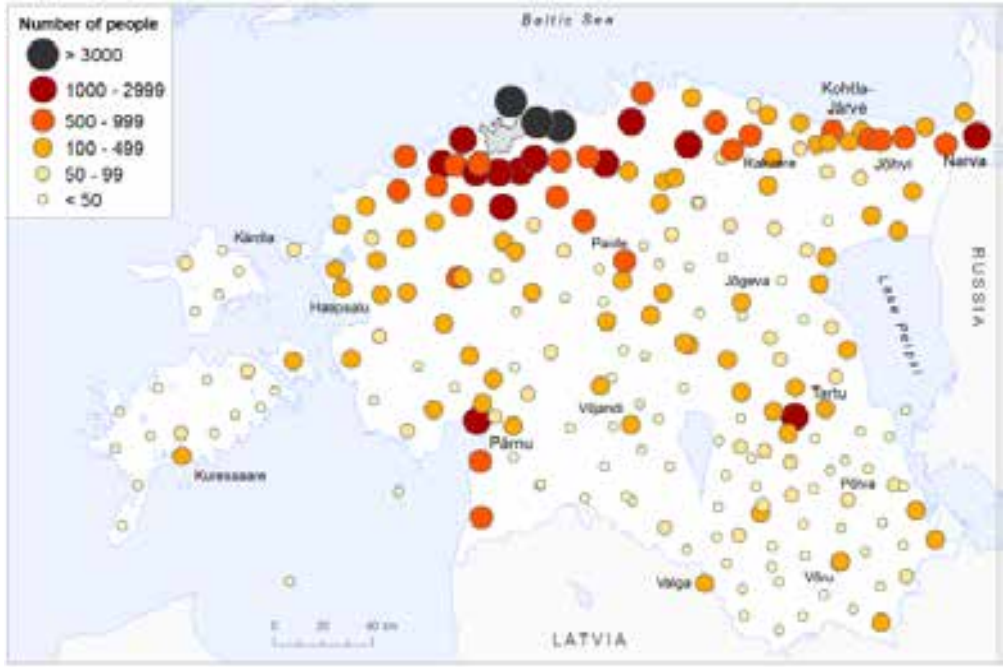
Ethnic differences in leisure-related spatial mobility





Silm, S., & Ahas, R. (2014). **Ethnic differences in activity spaces: A study of out-of-home nonemployment activities with mobile phone data**. Annals of the Association of American Geographers, 104(3), 542-559.

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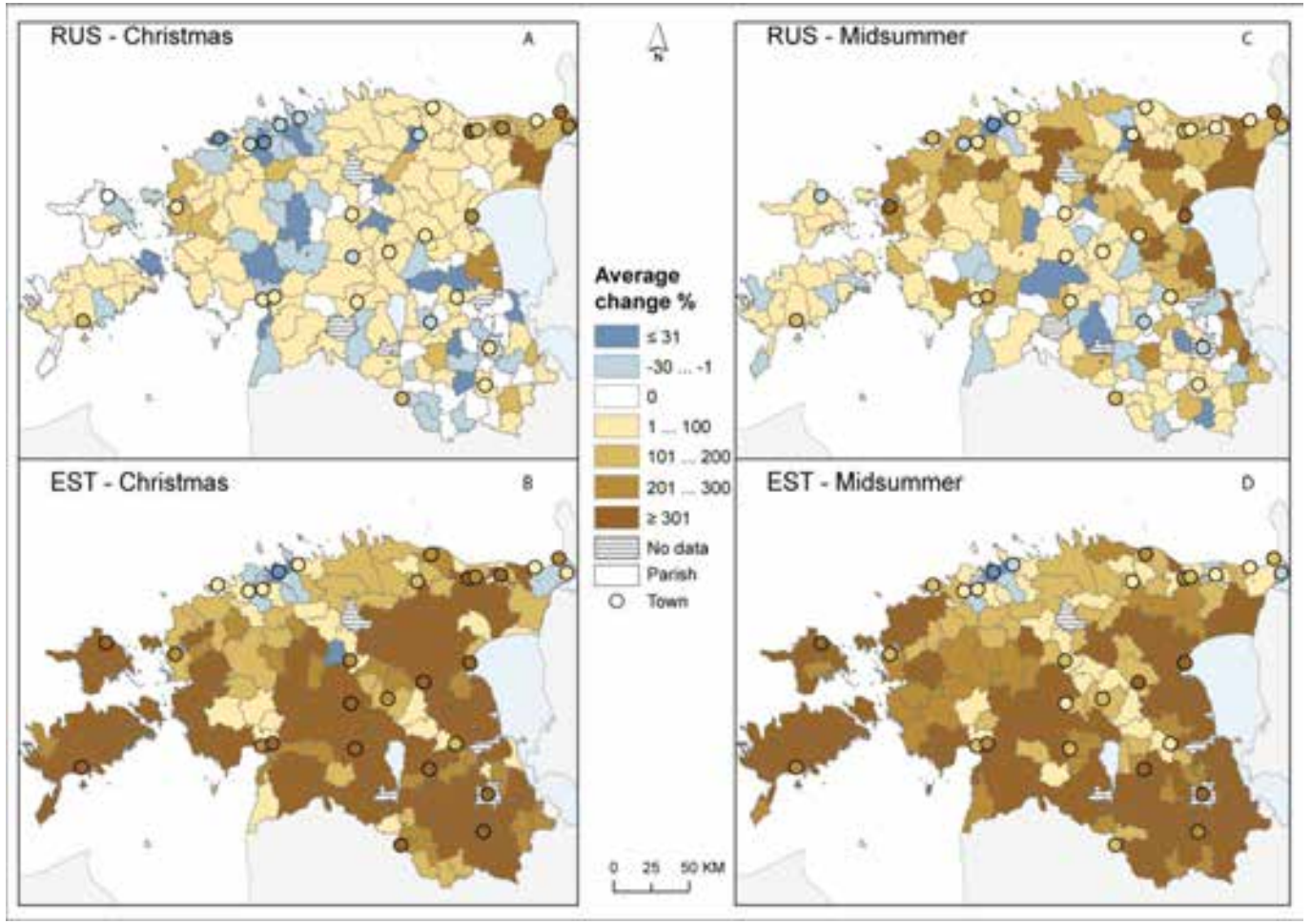
Ethnic differences in holidays



Mooses, V., Silm, S., & Ahas, R. (2016). **Ethnic segregation during public and national holidays: A study using mobile phone data**. Geografiska Annaler: Series B, Human Geography, 98(3), 205-219.

Latvian fishermen on lake Peipsi

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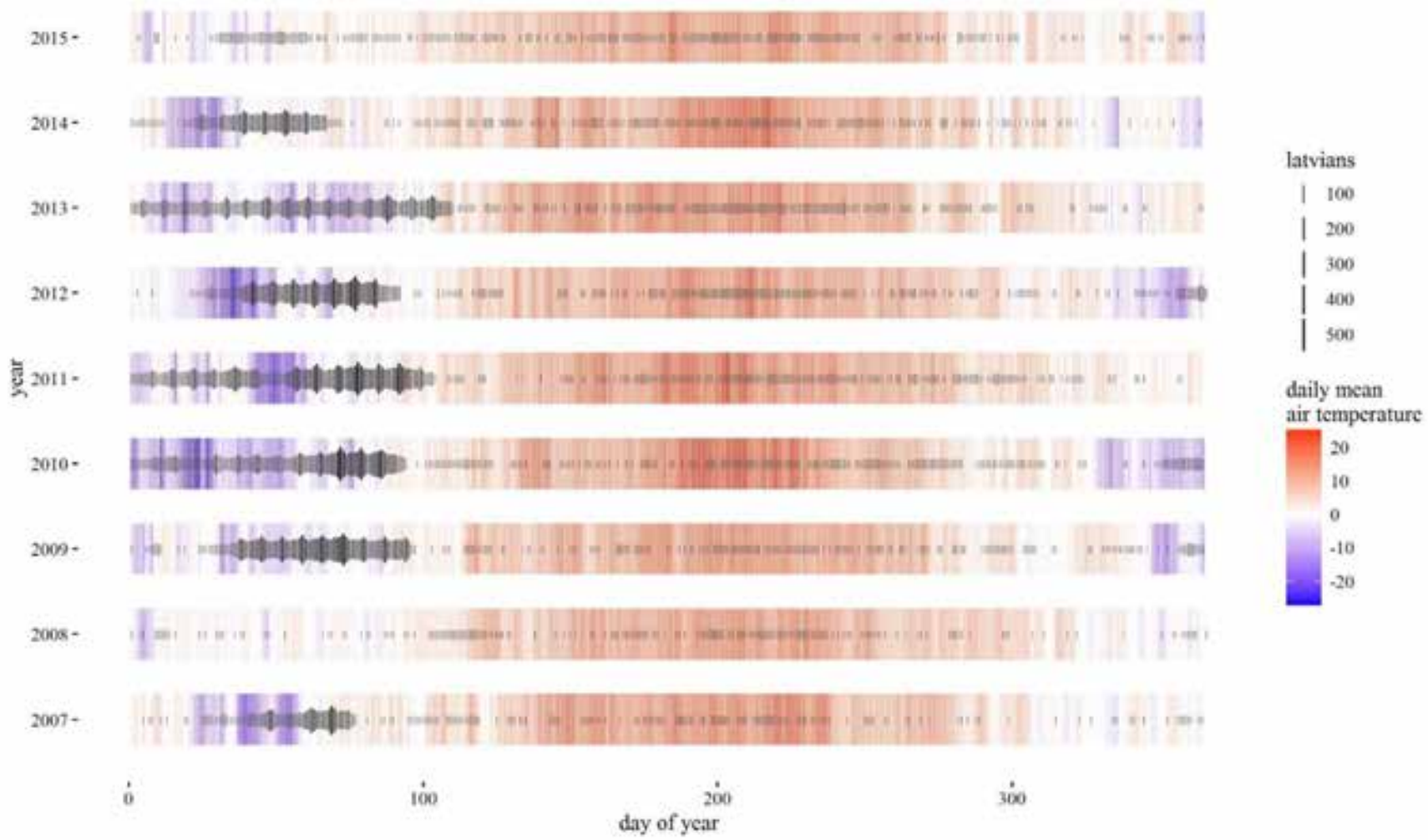

Social networks

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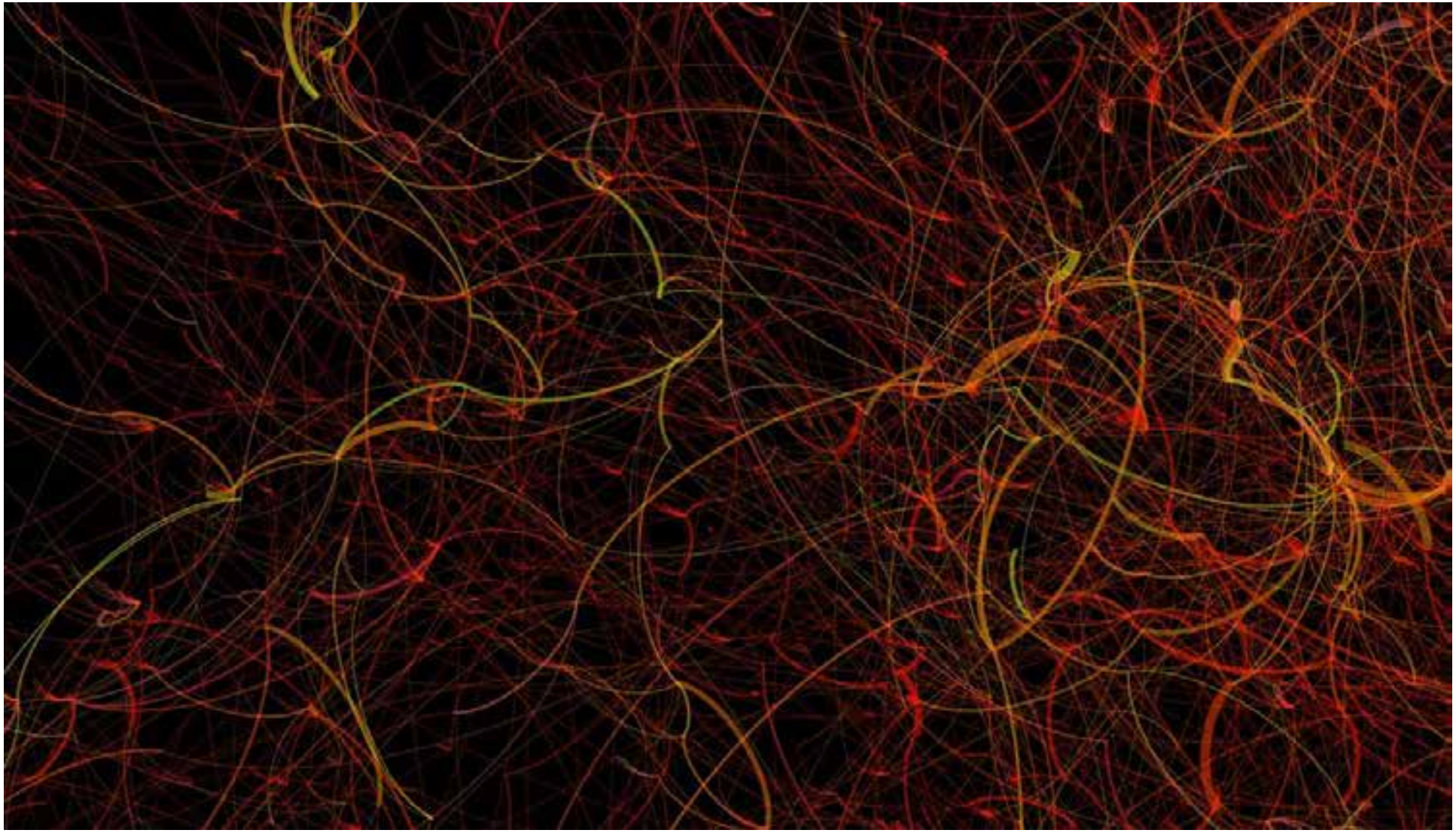

Communication between places

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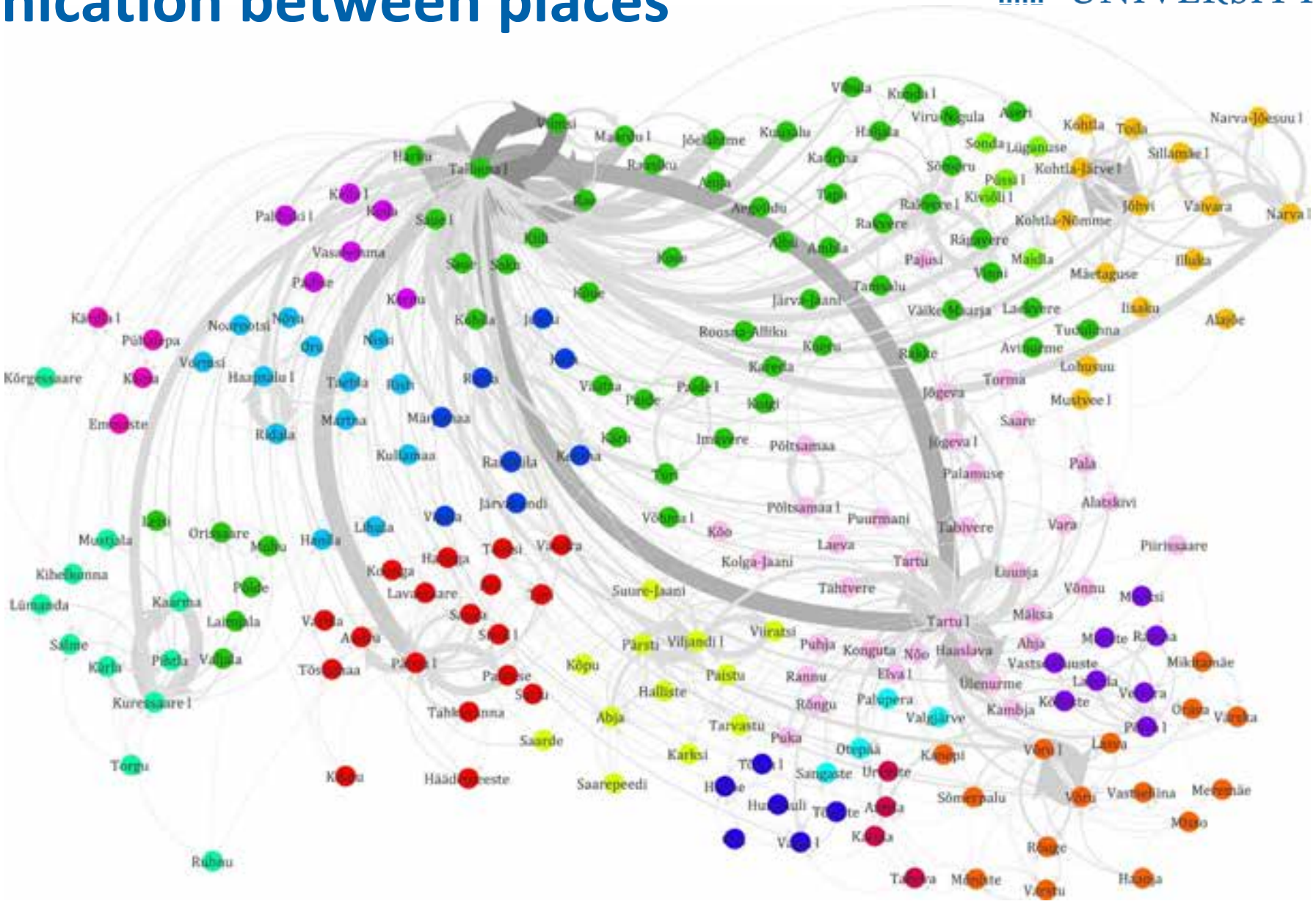

Diurnal rhythm

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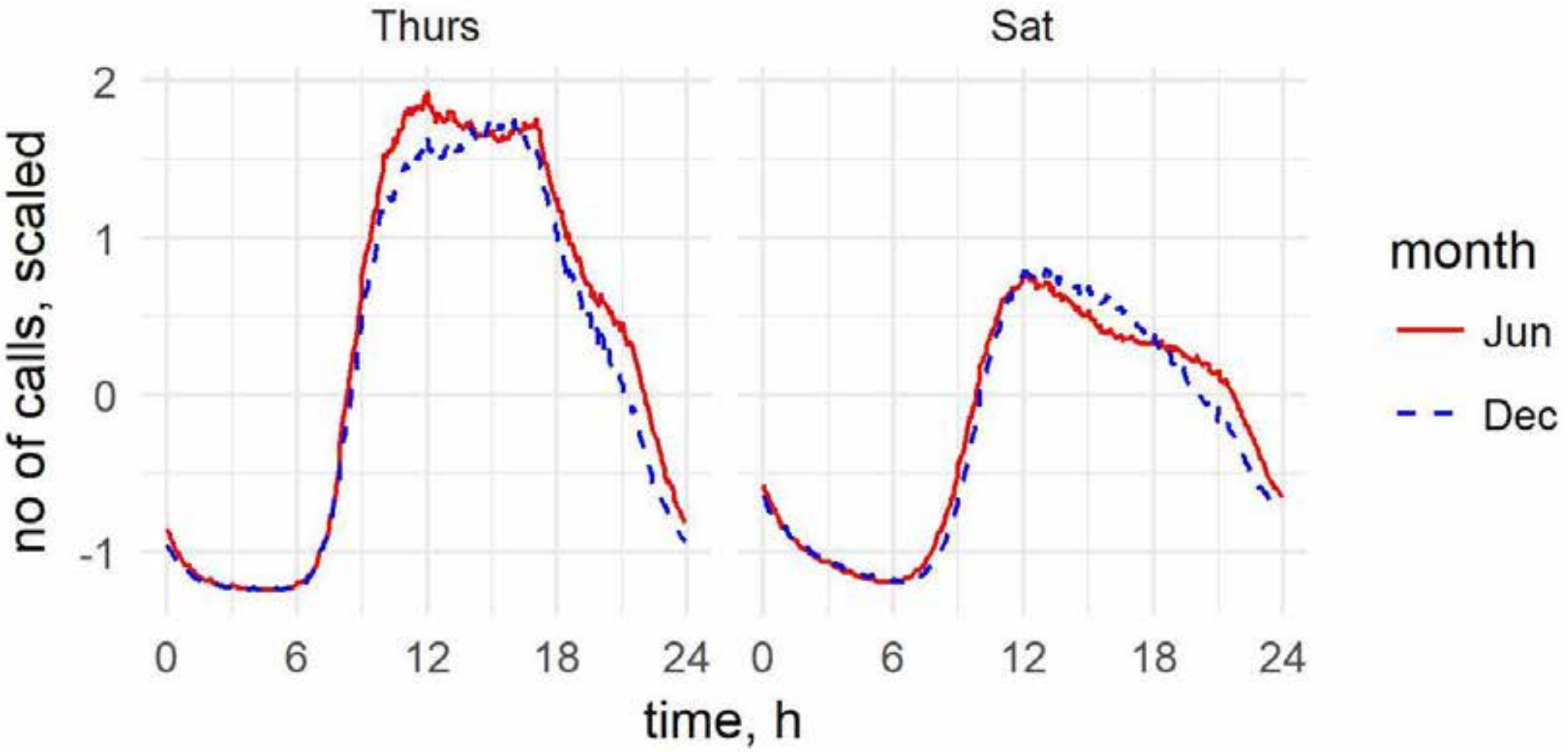

Chronotypes

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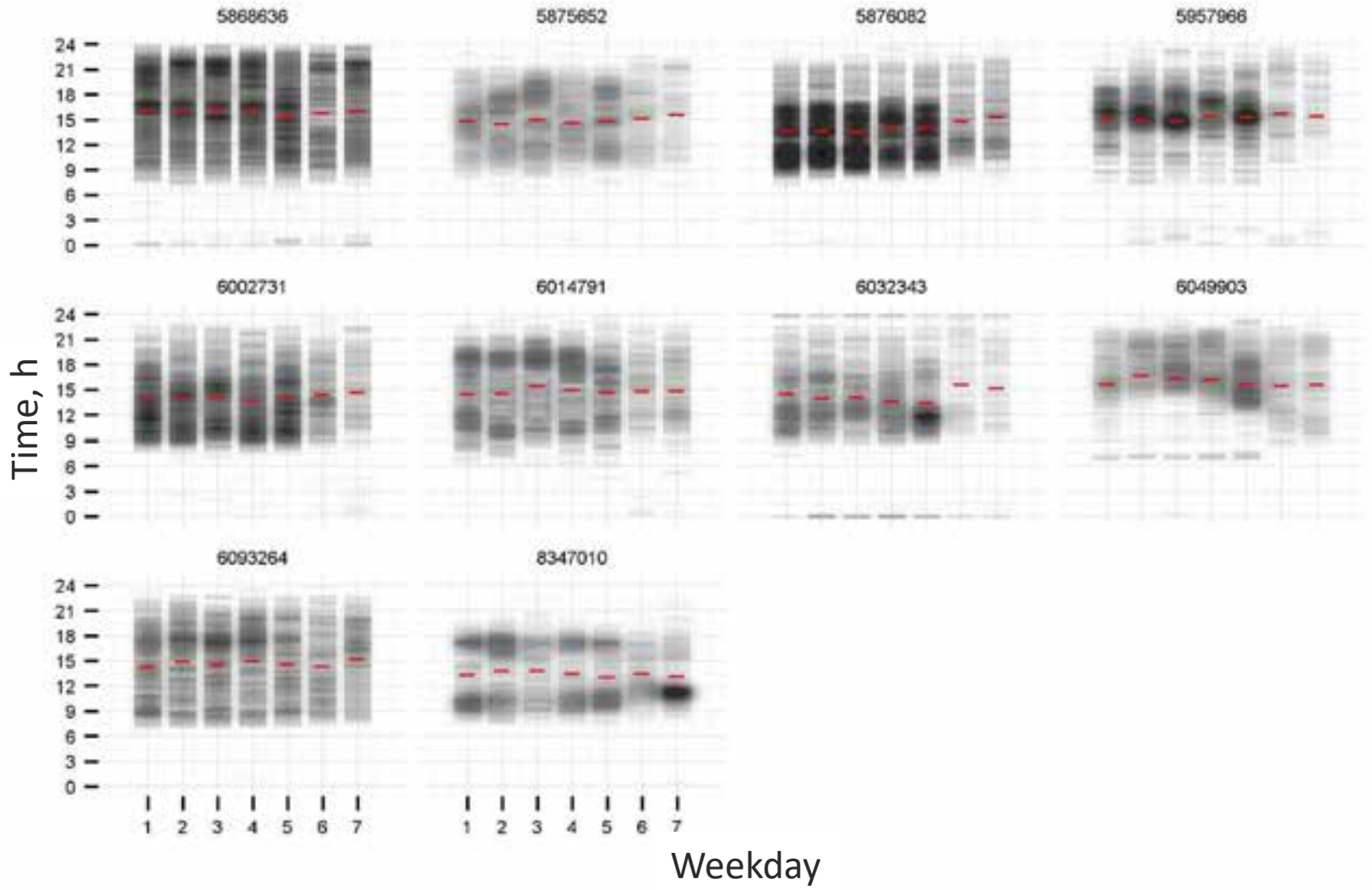
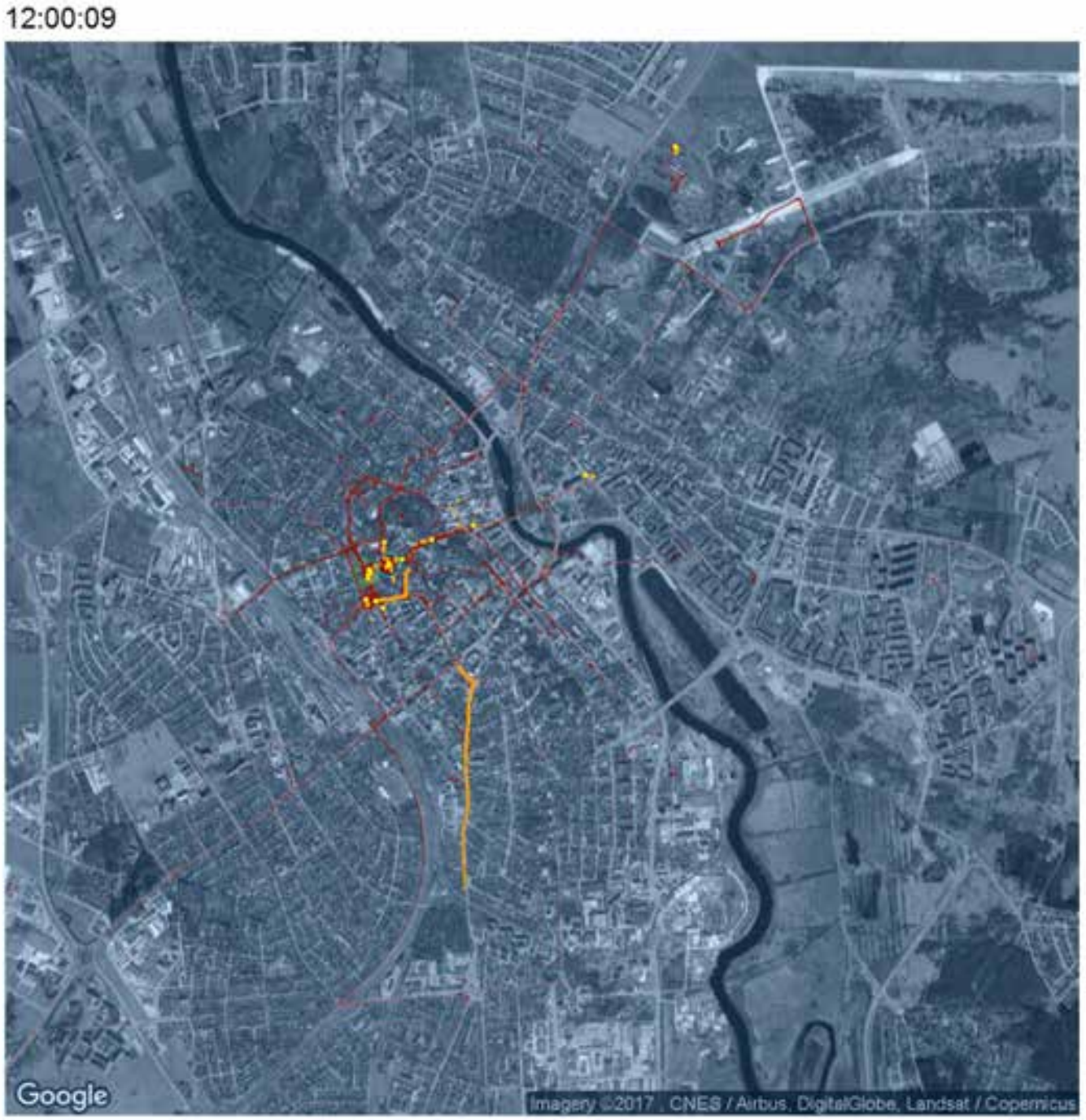


GPS



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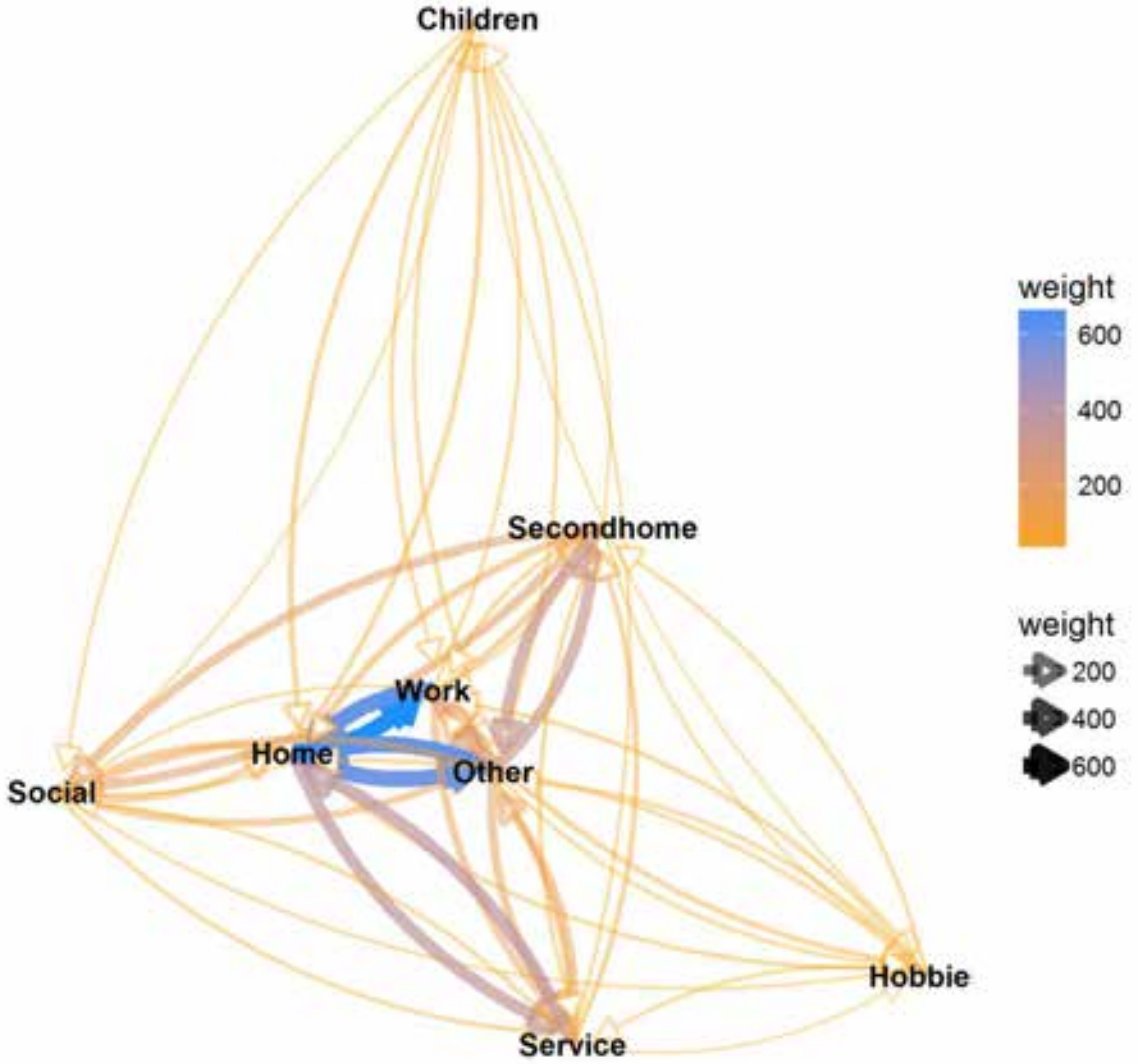
Social network



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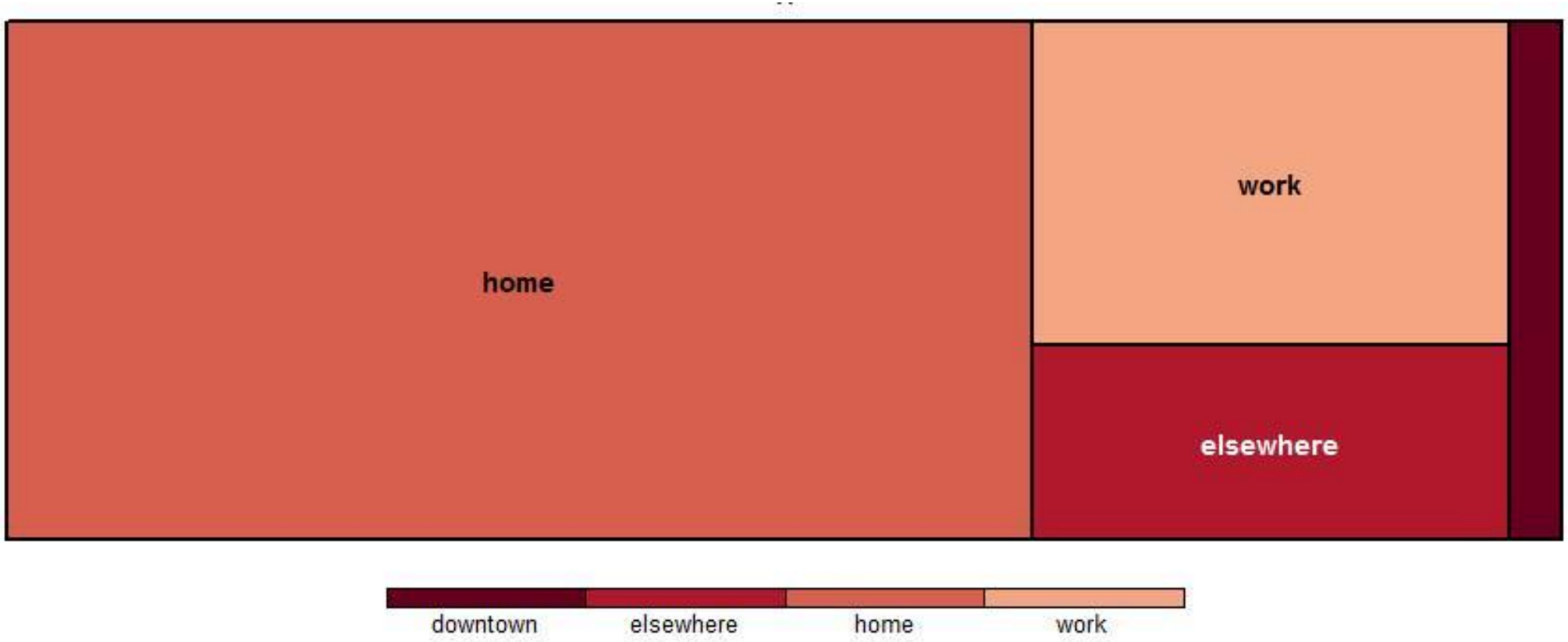
Boring life…



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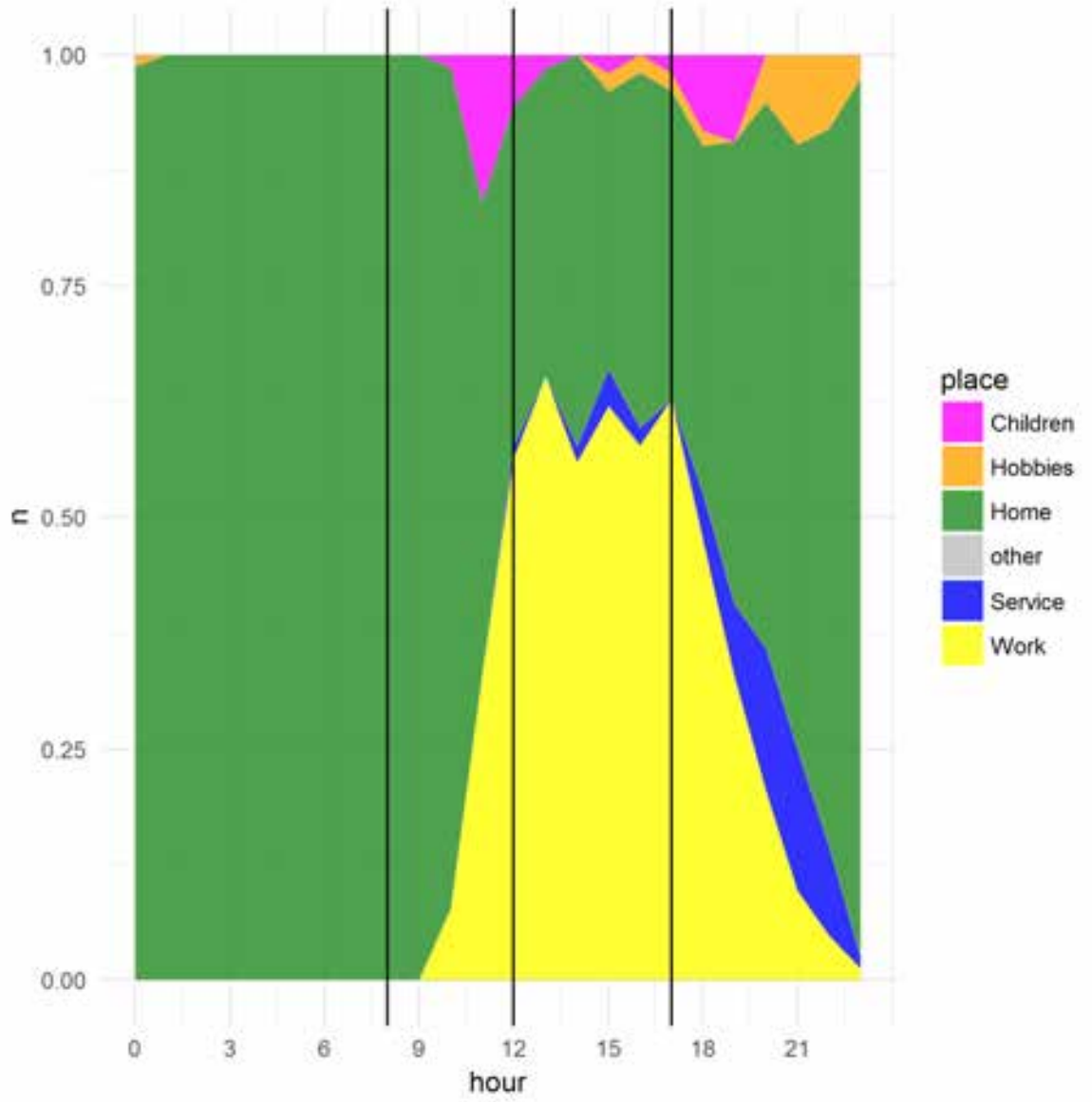
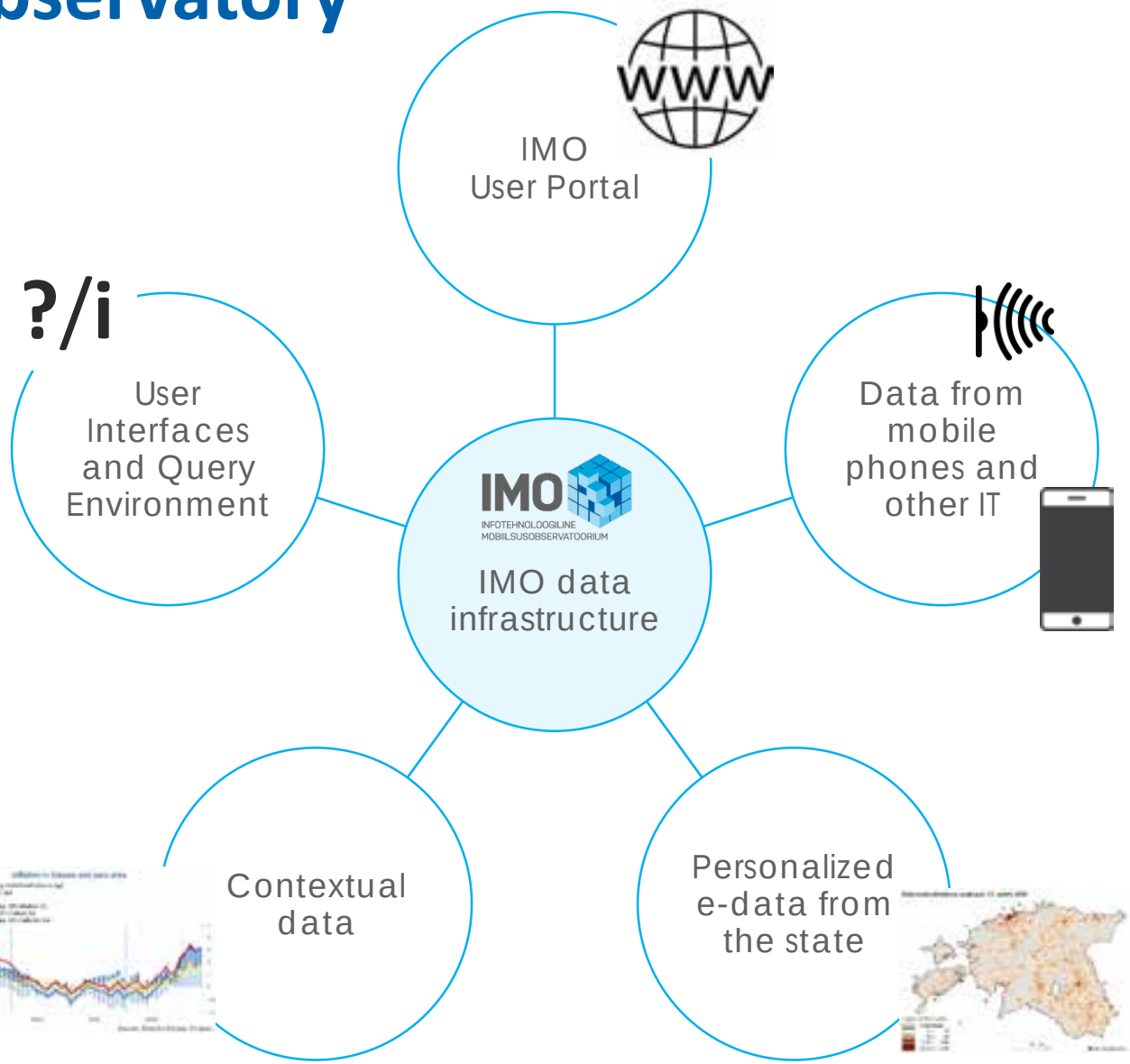
GPS:

Time budget



Infotechnological Mobility Observatory

- The aim of IMO is to develop a **data infrastructure that supports mobility studies.**
- **Integrate** different data:
  - data obtained from mobile phones and other IT tools,
  - country-specific e-data (censuses, registers, databases, etc.),
  - contextual data and descriptions (environmental information, land use functions, etc.).



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Thank you!

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Used materials

PwC (2016) The Wearable Life 2.0. Connected living in a wearable world. Consumer Intelligence Series.

Park, S., Chung, K., Jayaraman, S. (2014) Wearables: Fundamentals, Advancements, and a Roadmap for the Future. Wearable Sensors: Fundamentals, Implementation and Applications, Pages 1–23.