Modeling of Krasnoyarsk Public Transportation Network in a "Smart" City

[1]Michael G. Sadovsky

in cooperation with E.Bukharoiva, A.Tokarev & O.Yakubailik

[1]Institute of computational modeling SB RAS

September 27, 2018

Out-line

“Hydraulic” models

These model stipulate that

- streets, lanes and roads (SLRN) is a kind of a pipeline web;
- transport traffic is a liquid flow in the pipeline;
- a web might be rather complicated.

"Hydrodynamic" models

These models are similar to those mentioned above, while the transportation flows are described by hydrodynamics eautions (PDEs, mainly).

Crucial disadvantages of HD models

- incompressability of transport flow;
- continuity of flow;
- strong correlations in microfluxes, as compared to hydrodynamics.

Graph models

These are simulation models where

- SLRN is presented by a graph (very smart presentation);
- traffic is simulated as a "walking" of randomly moving particles;
- a lot can be retrieved and understood over a graph pattern, before any simulation.

Current models have serious disadvantage: a single-particle approximation is implemented (= deliberate rejection of an interaction implementation) of the "particles" in transportation flow.

Specific area of SLRN

Specific area of SLRN $\langle SS \rangle$ is the **area** of all streets, lanes, roads determined *per capita* in a city.

Specific area of SLRN in some cities

- New York is the champion: $\langle S \rangle = 135\,\mathrm{m}^2$;
- Paris is suspected to have some problems: $\langle S \rangle = 36{,}6\,\mathrm{m}^2$;
- Hong Kong is the leader in South-East Asia, $\langle S \rangle = 47\,\mathrm{m}^2$;

Specific area of SLRN

Specific area of SLRN $\langle SS \rangle$ is the **area** of all streets, lanes, roads determined *per capita* in a city.

Specific area of SLRN in some cities

- New York is the champion: $\langle S \rangle = 135\,\mathrm{m}^2$;
- Paris is suspected to have some problems: $\langle S \rangle = 36{,}6\,\mathrm{m}^2$;
- Hong Kong is the leader in South-East Asia, $\langle S \rangle = 47\,\mathrm{m}^2$;
- Moscow – just feel the difference! $\langle S \rangle = 5{,}7\,\mathrm{m}^2$;
- Krasnoyarsk (my estimation): $\langle S \rangle = 11 \div 14\,\mathrm{m}^2$.

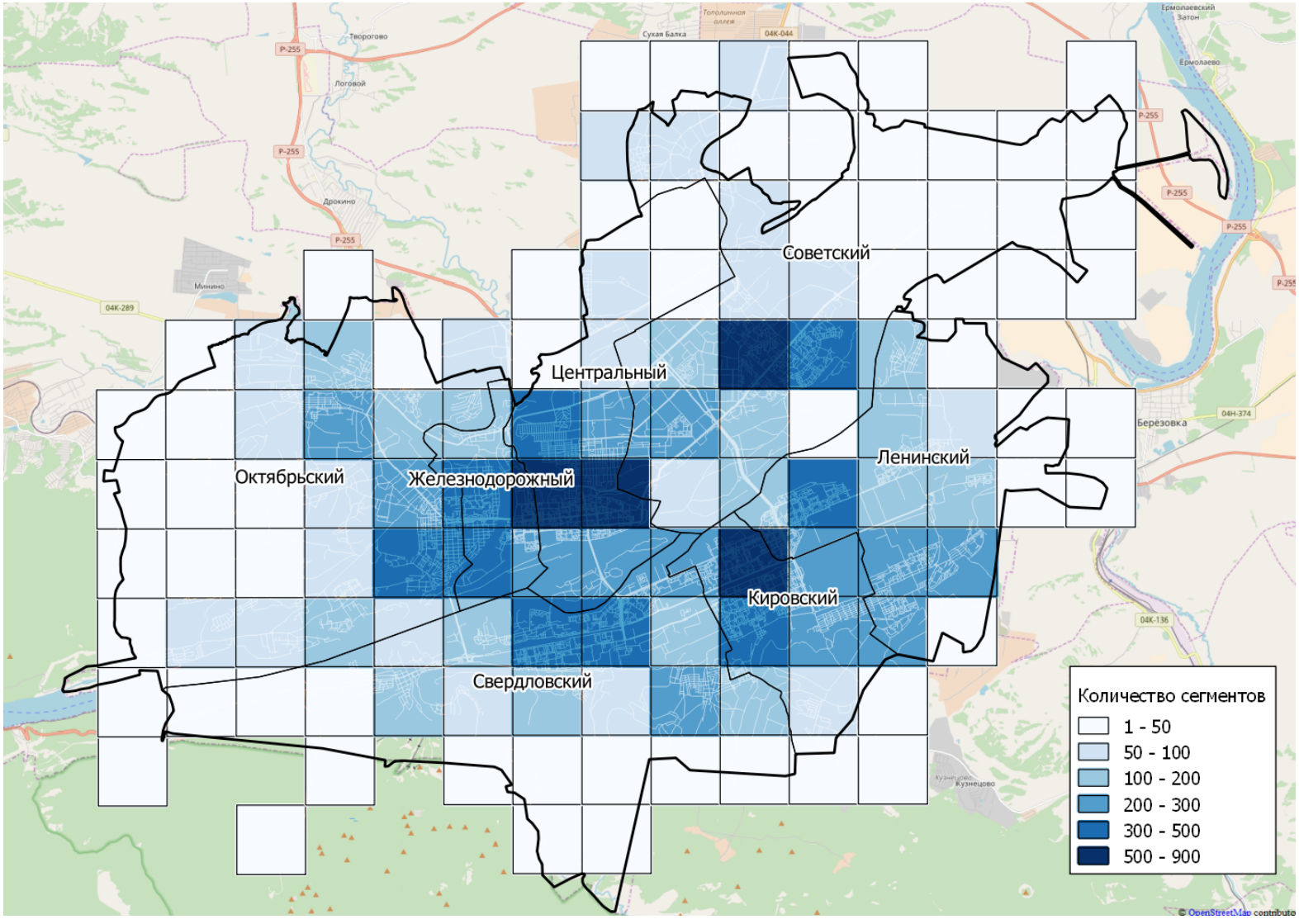
Connectivity of SLRN

For our purposes, the connectivity of SLRN is the necessity to visit some specific node (or an edge) of SLRN graph when driving from point A to point B.

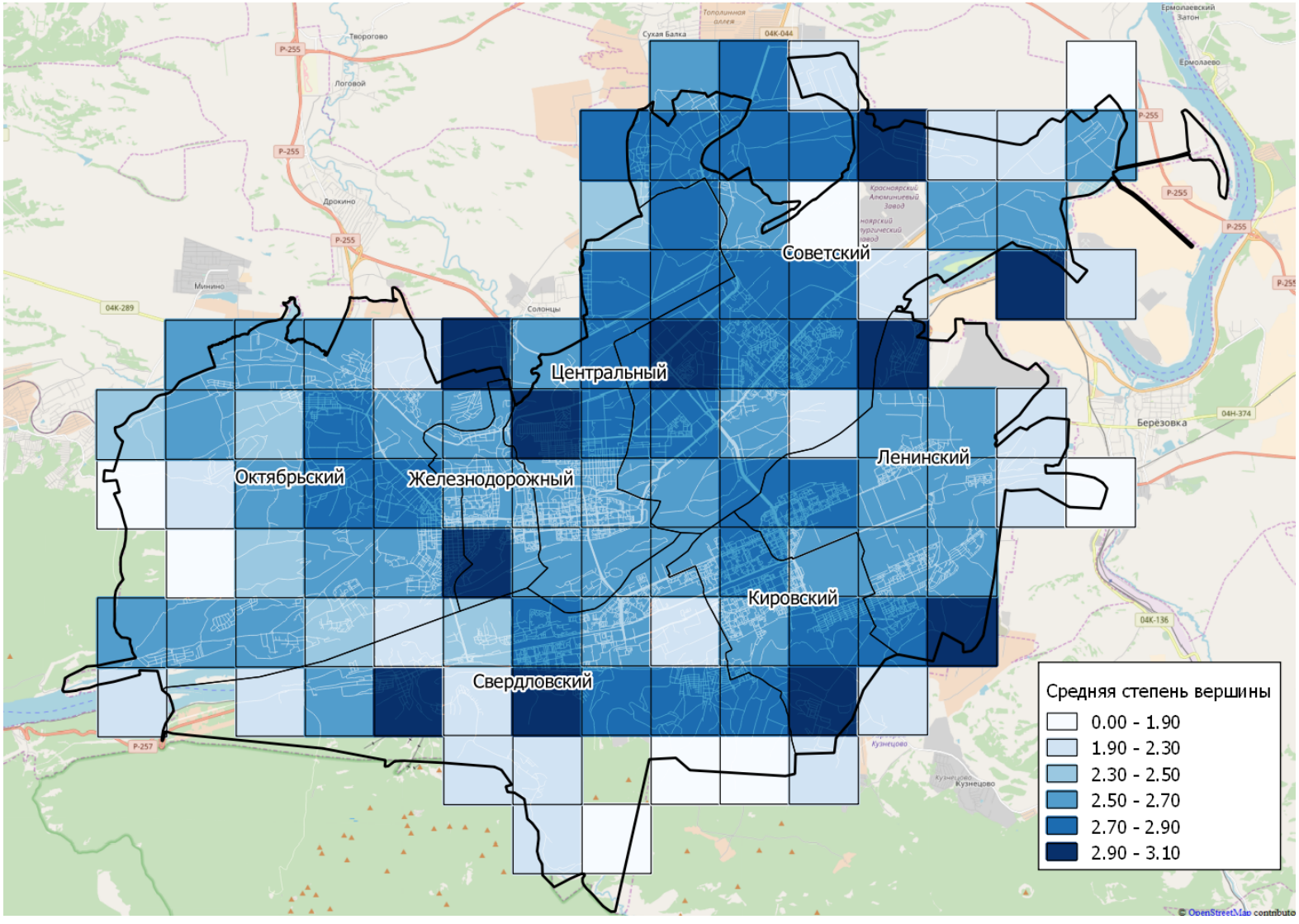
Krasnoyarsk SLRN has very low global connectivity: there are three bridges over Enisey and three traffic junctions with railway, on both sides of the city.

There are a lot of other “bottlenecks” in the city SLRN.

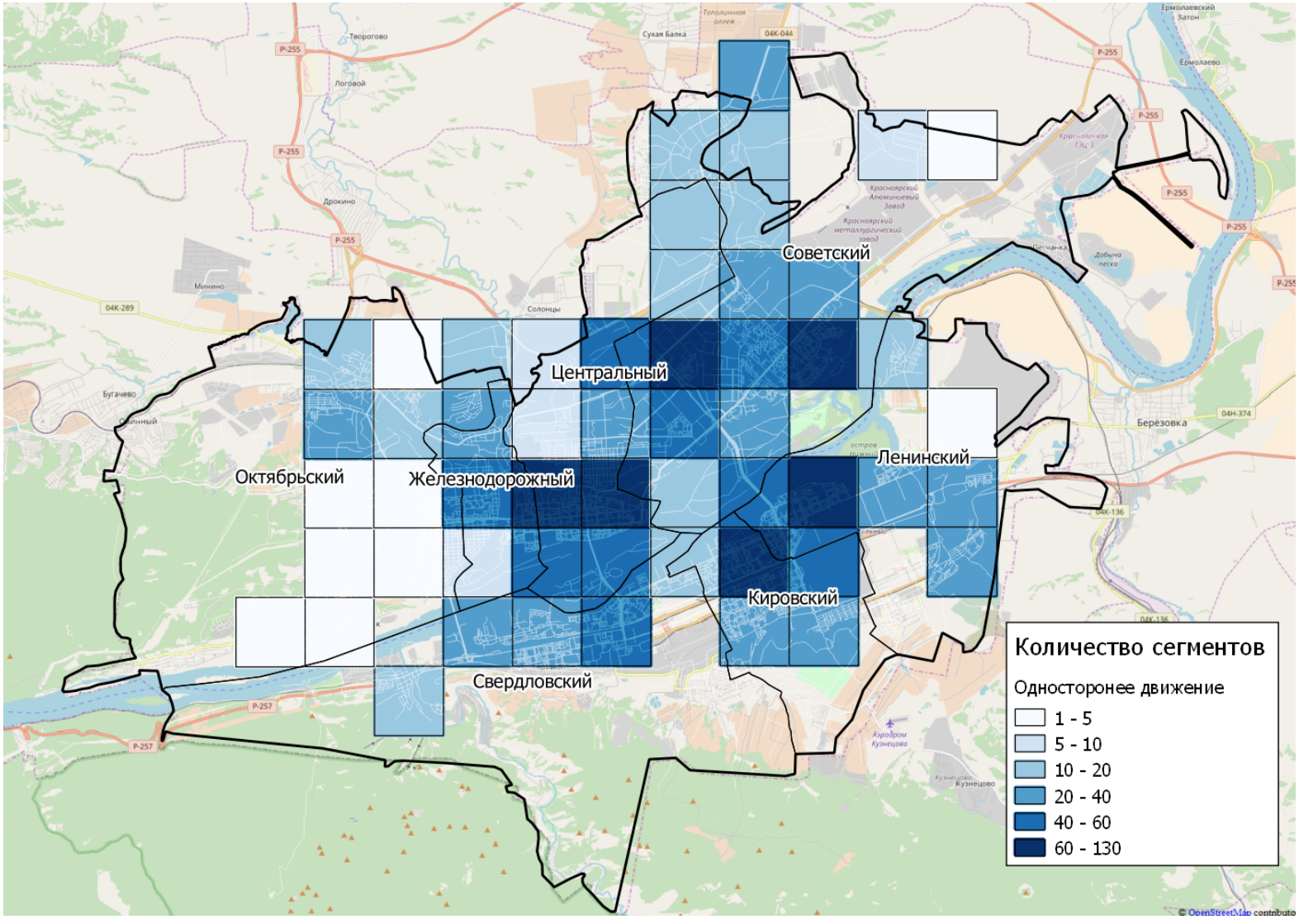
Distribution of road junctions number in the city, 2×2 km grid



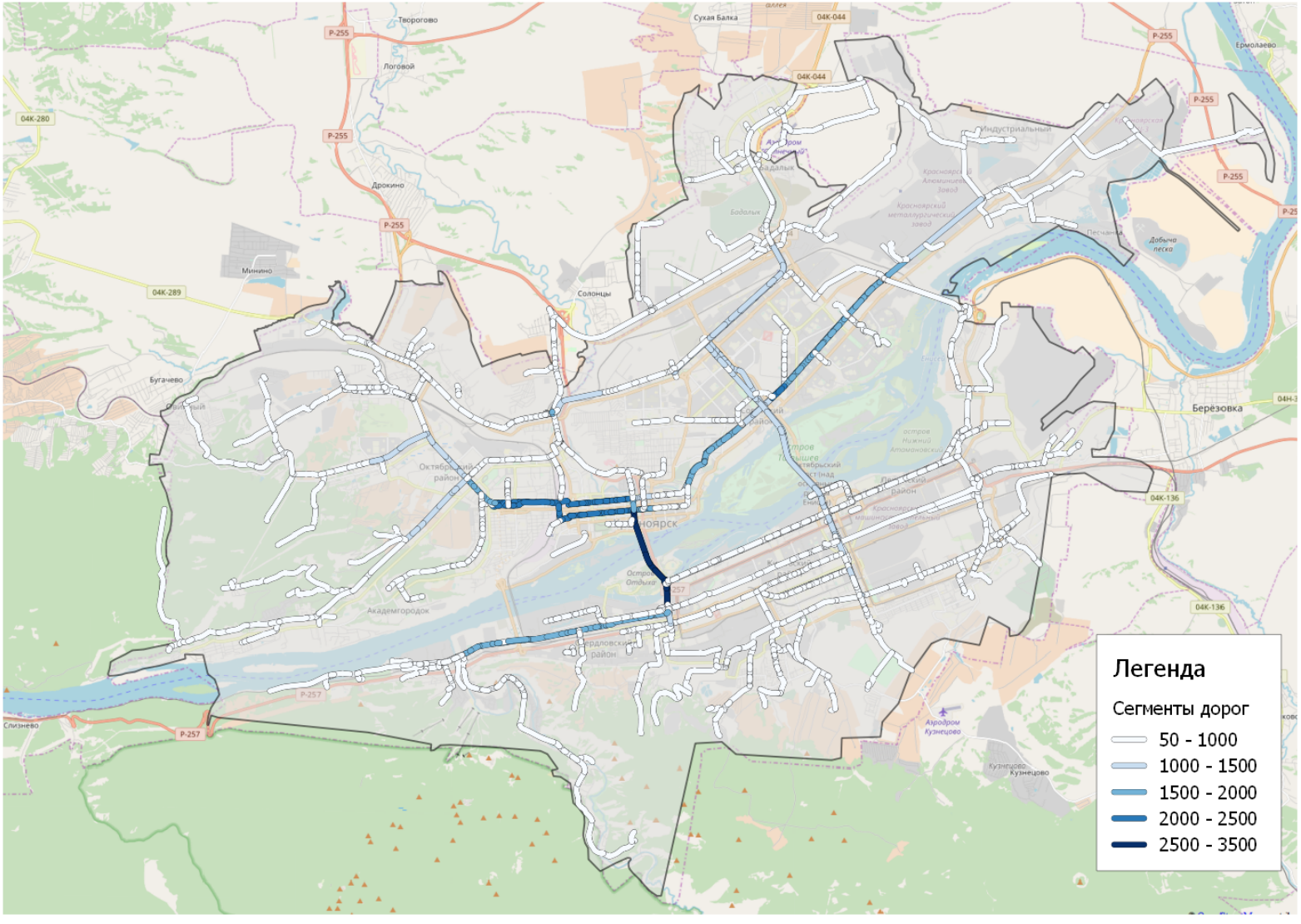
Distribution of average SLRN graph node power, over 2×2 km grid



Average number of one-way roads in the city SLRN



Distribution of random routs longer than 10 km



What we need for effective modeling

1. Actualized SLRN map.
2. Data records on "microscopic" moving features (= local fluxes in junctions and along the streets).
3. Knowledge of transportation behaviour of the city residents driving a vehicle: this is the terrible shortage!
4. Data records on passengers flows in public transportation.
5. Data records on diurnal migration of the residents: where to, where from, when and how many users of city transport network run over SLRN.

. . . and the most essential is:

- One may pursue a fundamental studies in transportation modeling with obvious out-come: SCOPUS, Hirsch, etc.
- Any applied research requires **exact** and **comprehensive** project description.

Thank you for your attention!

Thanks a lot

and questions, if we still have some time!