

UNECE Working Party on Transport Statistics

Time series of OD matrices and travel time matrices based on FCD

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Online, 15.06.2022

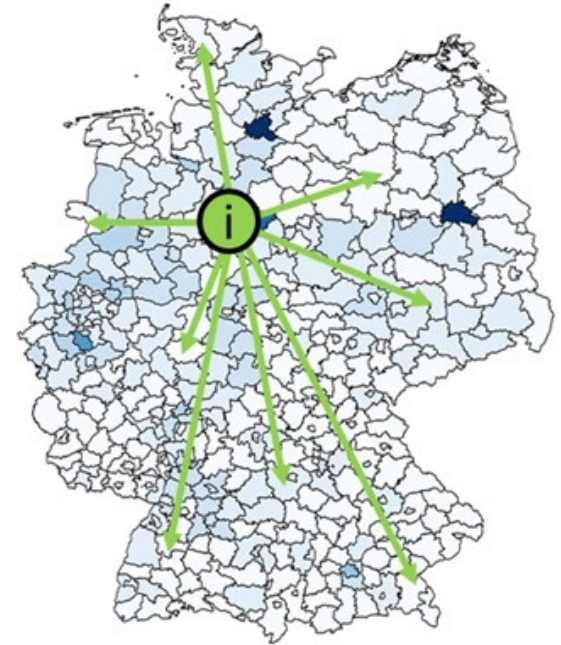
The project

Using FCD to estimate nationwide OD matrices

- of car and truck traffic
- based on NUTS3 areas (Germany and neighbours)
- for a time series 2017 - 2019 [trips/a]

Third step:

- ➔ Evaluation of methods and data: Is it possible to produce stable time series of nationwide OD matrices?
- ➔ Measuring travel times in road networks (cars and trucks)



Data source

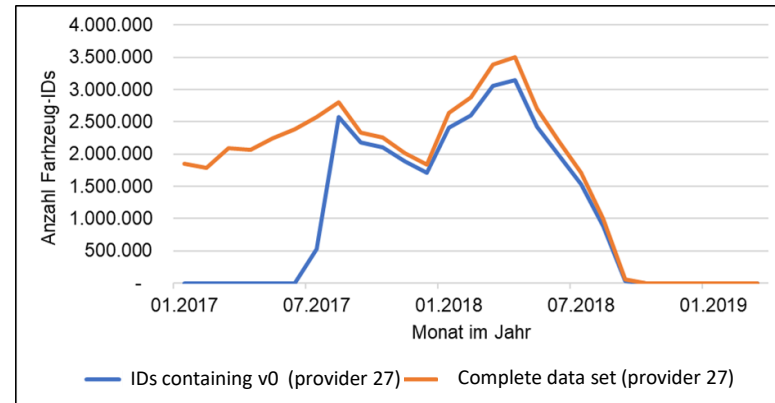
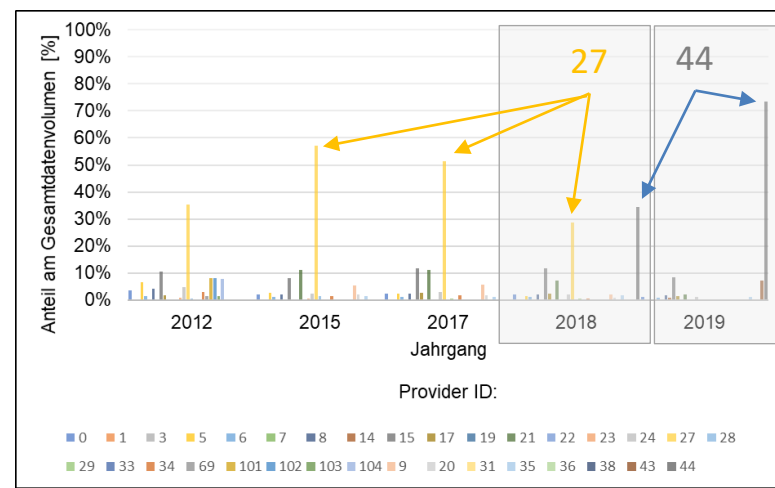
Floating Car Data (FCD) collected by German Automobile Club ADAC:

- covering Germany and neighboured countries
 - primarily used to generate real time traffic flow information
 - no data quality control regarding a representative sample (spatial, time-related, trip purpose-related) → „raw FCD“
 - heterogeneous – and changing - data structure due to several different FCD providers (only cars/trucks, mixed vehicles)
 - Per provider: different data transmitting frequencies (important für data interpretation)
 - Data privacy: anonymisation of vehicle-ID every 24 h
- ➔ Influence of data sources on calculation of nationwide OD matrices
- ➔ Outlook: Using Artificial Intelligence (AI) to forecast OD matrices

Some aspects of changing data sources:

- FCD data provider 44 appeared for the first time in data set 2018 and replaced provider 27 step by step
 - FCD with v=0 km/h were originally deleted in data sets, but appeared temporarily in provider 27 data source
 - Fluctuation in shares and spatial distribution of foreign cars
- ➔ Evaluating representativeness of the complete data sets

Land	Change in data volume [%] 2017-2019	
	[%]	abs.
Österreich	-298,8%	-347.006
Belgien	-688,5%	-253.421
Schweiz	-82,2%	513.093
Tschechien	-742,5%	-151.348
Deutschland	11,1%	44.359.238
Dänemark	-350,7%	-29.144
Frankreich	15,8%	1.962.408
Kroatien	5,6%	116.408
Italien	-147,5%	85.938
Luxemburg	-347,9%	-36.812
Niederlande	-400,4%	-191.454
Polen	-30,9%	171.523
Slowenien	-40,5%	20.361



Overview – comparison of matrices 2017/2018/2019

Jahrgang	2017	2018	2019
Anzahl unbesetzter Relationen	19.103	12.949	3.280
Anteil unbesetzter Relationen	11%	8%	2%

Declining number and share of OD-relations without trips due to rising data volume

Is 2% a realistic estimation for this item in population?

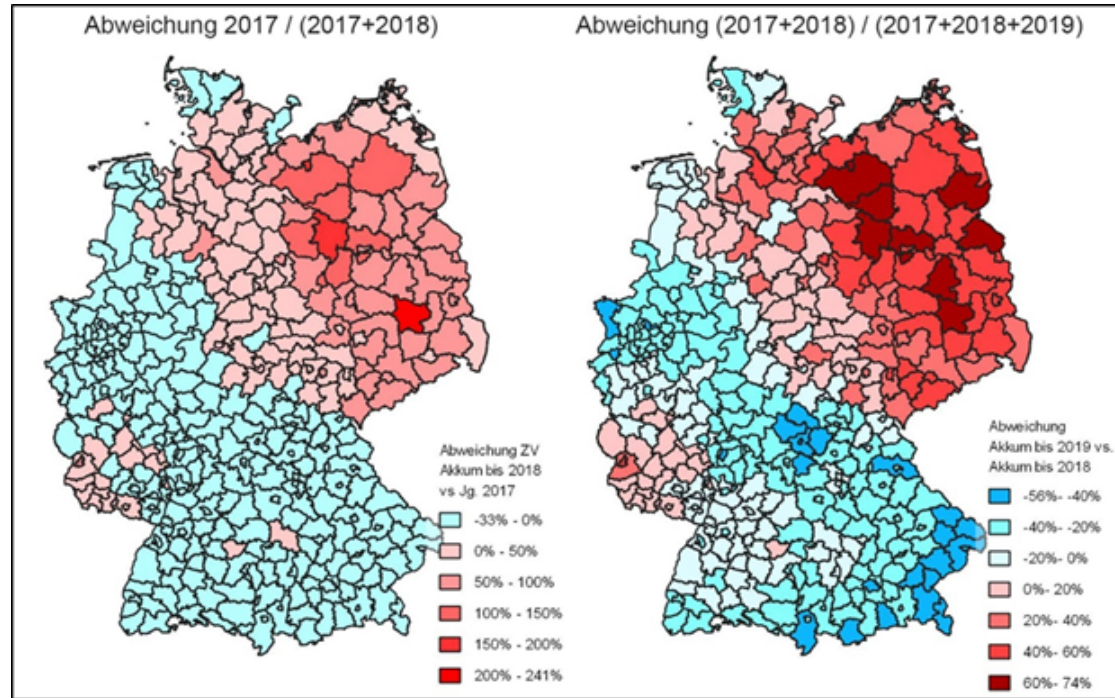
Jahrgang	2017	2018	2019
Gesamtfahrleistung aus FCD	653 Mrd. Fz-km	646 Mrd. Fz-km	657 Mrd. Fz-km

Total vehicle distance: declining (2018) and rising (2019) volume due to varying distance of trips inside the 9 distance classes which were used to expand the FCD trip sample

Merging FCD data bases of 2 or 3 years – better results?

Number of relations with 0 trips declines when merging FCD data sets.

Expanding the original FCD based trip matrix by using the number of inhabitants in starting zones (origin) leads to rising traffic attraction of destination zones, when FCD data sets of several years are merged.



Calculation of Travel Time Matrices – 2 methods

Trip based

OD matrix



Travel time per trip (several different routes)



Average/median travel time of all trips between 2 territorial units

Trajectory based

Road network, separated into ≈ 100 m sections
(> 3 mio sections in nationwide network)



Match FCD data to sections
(for different time slots such as 3 – 7 p.m.)



Calculate median speed (v_{50}) per section



define central point for each LAU and link it to network

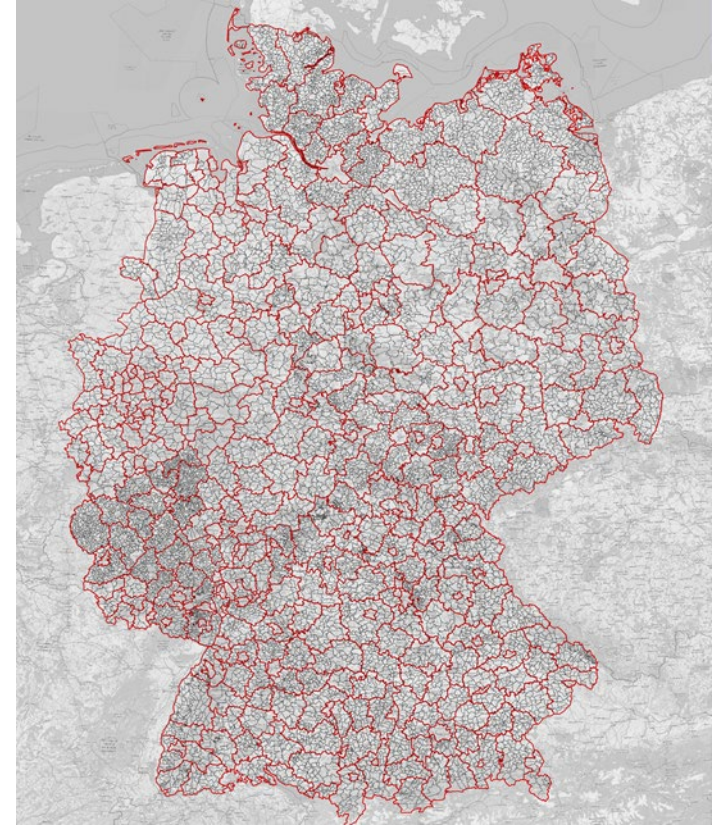


Routing: Find fastest route for all OD relations

Advantages of trajectory based method

- Travel time calculation is possible for arbitrary and even very small territorial units (NUTS3, LAU, grids)
- Much higher FCD sample on sections compared to sample of relations → travel time matrices can be generated for different time slots and day types (working day, sunday, ...)

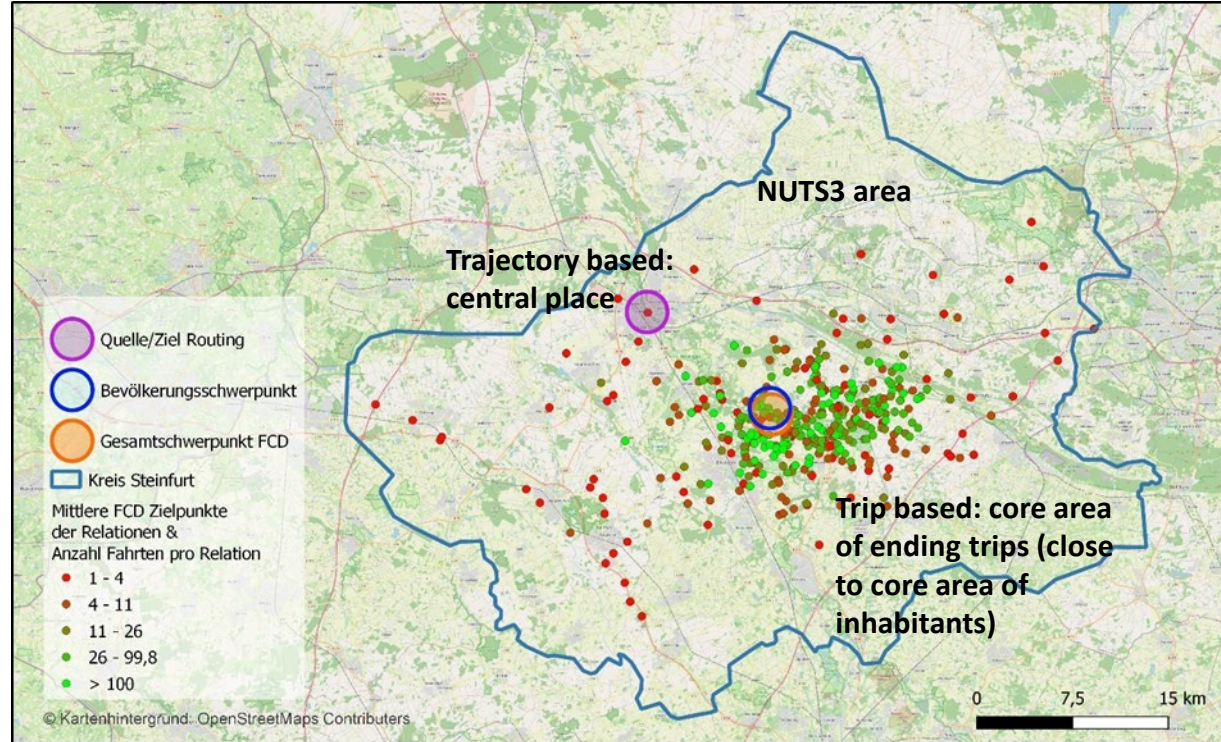
≈ 440 NUTS3 (red) and
> 11.000 LAU areas in
Germany



Trip based and trajectory based calculation of travel time matrices

Differences in origin and destination coordinates

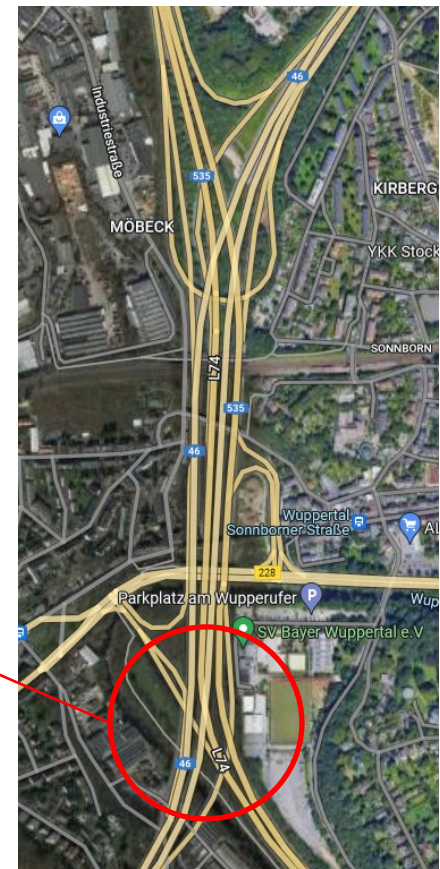
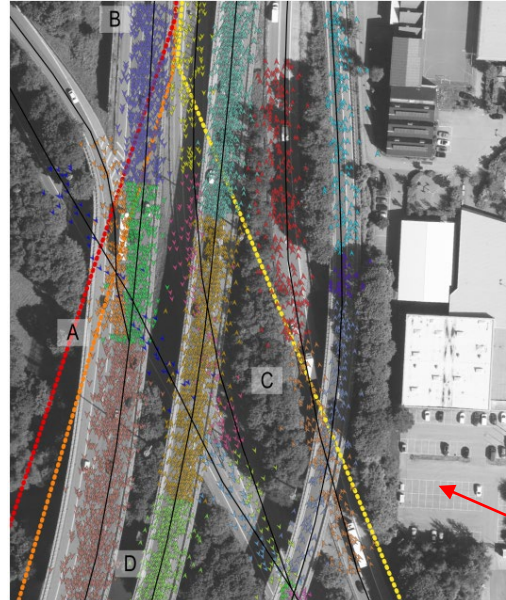
Trajectory based method allows to set the trip origin and destination coordinates, while trip based method sets them in core area of starting/ending trips.



Disadvantages:

High effort and complexity of map matching: It is not satisfactory to assign a FCD data spot to nearest road axis. Instead the assignment algorithm has to follow each data spot of a vehicle step by step. This causes long calculation times.

Implicit assumption of constant traffic flow quality during a complete trip doesn't fit for long trips (demand for dynamic routing)

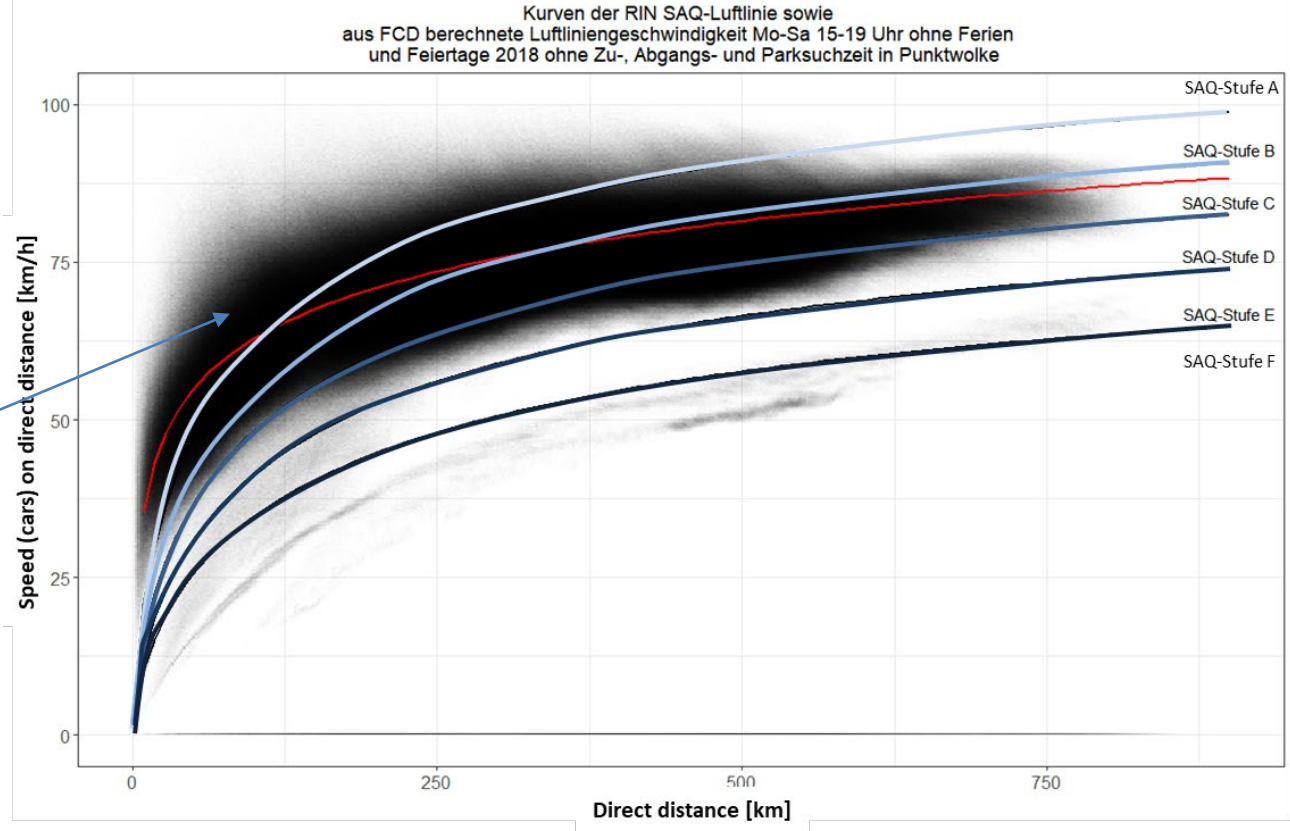


Evaluation of accessibility:

Trajectory based method can generate travel times for an arbitrary amount of relations

This data set (speed related to direct distance) can be used to define levels of service of accessibility

➔ Used for network planning



Use cases:

- Accessibility standards for transport networks (car and truck transport)
- Monitoring accessibility of central places, urban and rural regions
- Validation/calibration of network assignment models
- Calculating the effects of general speed limits on motorways (only Germany)

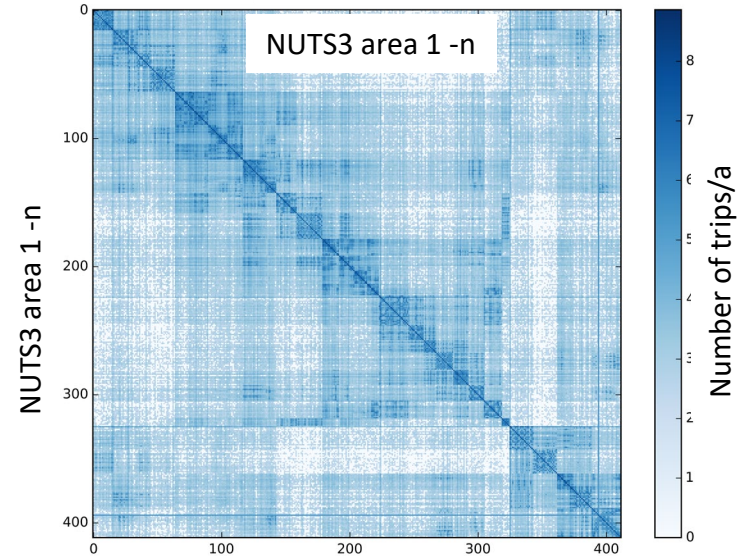
Thank You for Your Attention!



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Challenges:

- ≈ 170.000 OD links in Germany (NUTS3 level)
- less than 10 trips/d on $> 85\%$ of all links
- no empirically proved „ground truth“ about spatial distribution of trips
- FCD sample covers 1-2% of daily trips
- FCD sample 2017 > 12 billion data sets (developing fast algorithms)



Visualisation of German-wide OD matrix (NUTS3-level):
Intensity of color represents amount of trips