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quantitative research

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Tour-based freight modelling

The HARMONY Tactical Freight Simulator

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Content

Introduction

HARMONY consortium

21 partners from 9 European countries

www.harmony-h2020.eu

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HARMONY

The story of Jos..

E commerce

Road user charges

Globalisation

Internet of Things

Logistic developments

Logistic hub's

ZE vehicles

Truckplatooning

Emission zones

'Urban transport planner'

Keep the city accessible

Reduce CO2 emissions

Policy objectives

Keep the city livable

Use land efficiently

transport planning tool

www.harmony-h2020.eu

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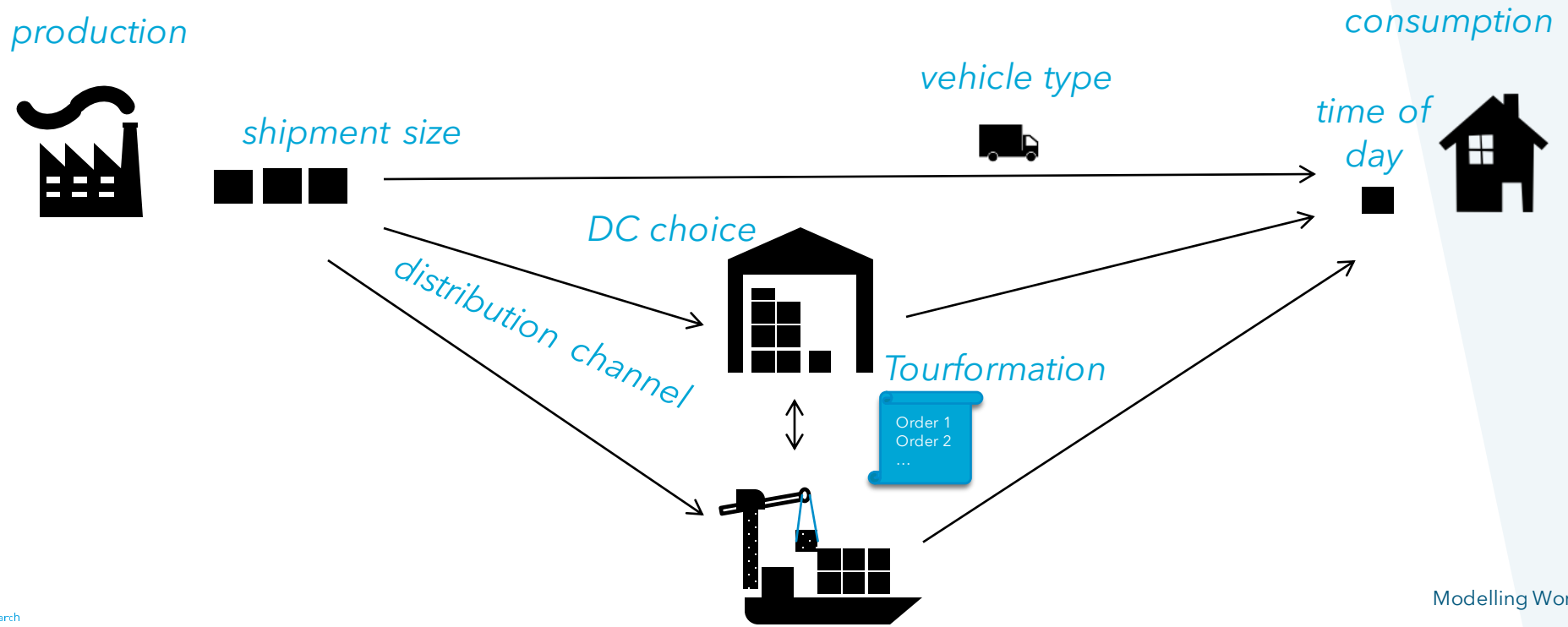
HARMONY

Conceptual model for agent- and tour based freight models

- Goods are transported as shipments between producer and consumer. Some transports are direct from P to C…..
- …but many goods are transported via distribution channels via one or more logistical node
- Different logistical choices are made, which we try to simulate as accurate as possible



The HARMONY Tactical Freight SImulator

- Overview
- Shipment synthesis
- Tourformation
- Synthesis of logistic agents
- Data used

Overview of the TFS

Simulation of logistic decision making behind urban freight transport demand

Key design principles:

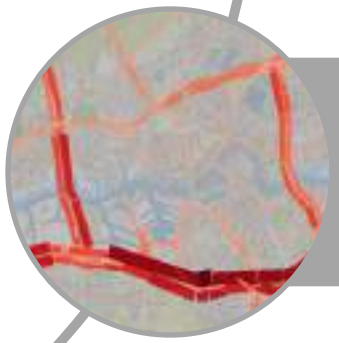
- ❖ Evidence based (data!)
- ❖ Agent-based: to represent the heterogeneity in city logistics: producers, consumers, carriers, public administrators
- ❖ Shipment-based: more behavioural realism
- ❖ Long-term and daily logistic decisions are simulated separately

Shipment & parcel demand

- Producer/supplier choice
- Shipment size & vehicle type

Scheduling

- Tourformation
- Time-of-delivery choice



Networkmodule

- Routechoice
- Emissions

Shipment module

Objective of the shipment synthesizer:

To build a set of all shipments that are transported to/from/within the study area.

Top-down simulation of mid-term tactical decisions:

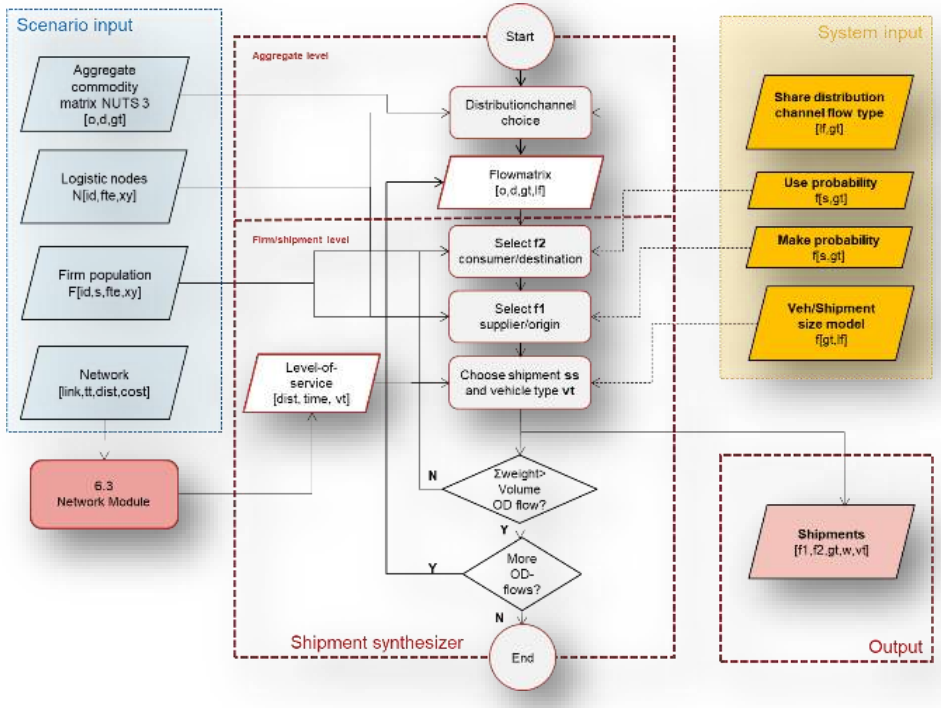
1. Allocation to distribution channel
2. Vehicle and shipment size choice
3. Selection of consumer and/or producer

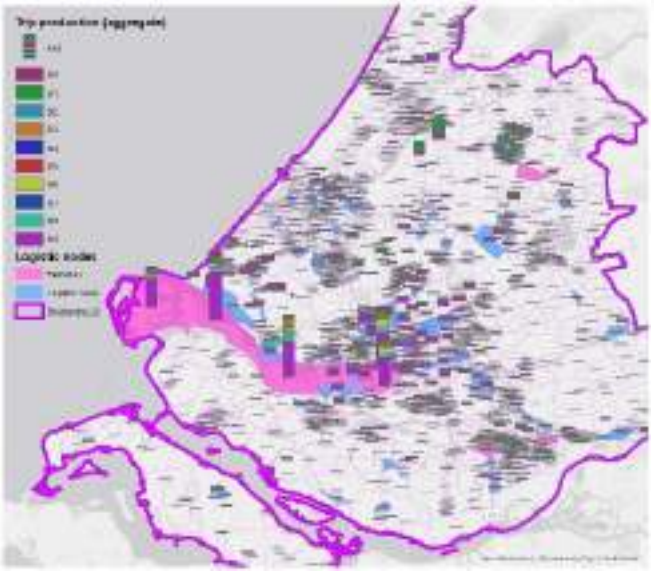
Output:

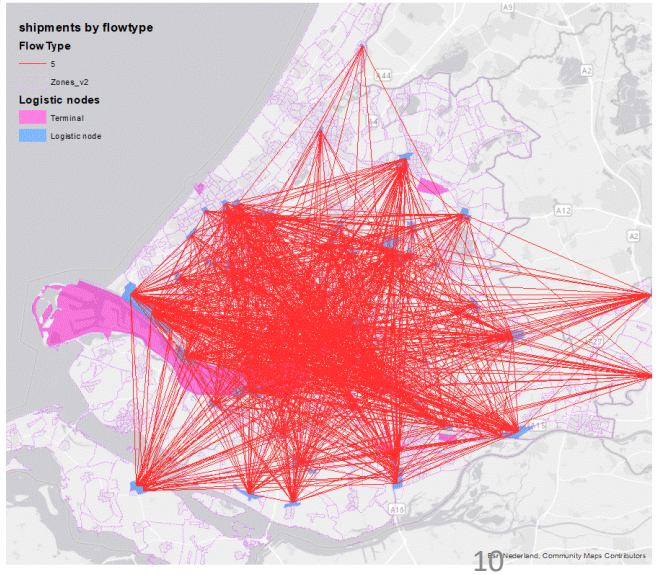
All shipments in the study area

Statistics and models based on transport data:

- ❑ Statistics Netherlands (XML microdata)
- ❑ Regional transport Model







Scheduling module

Objective of the Scheduling module:

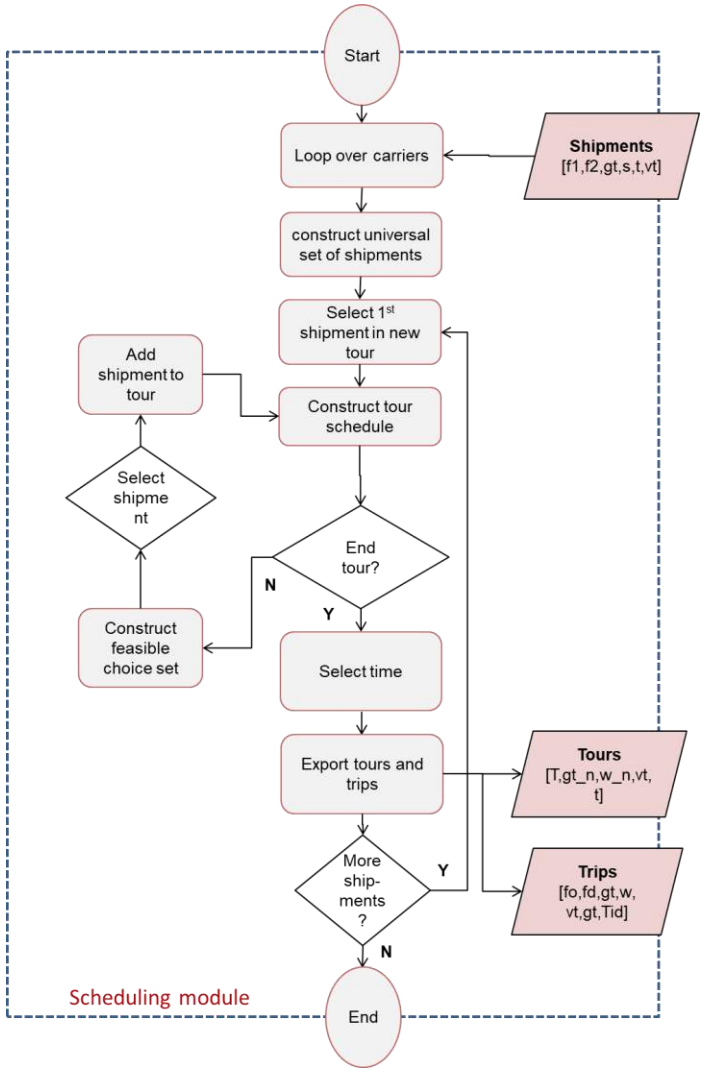
Simulate daily logistic decision making to schedule the delivery of all shipments that are transported to/from/within the study area.

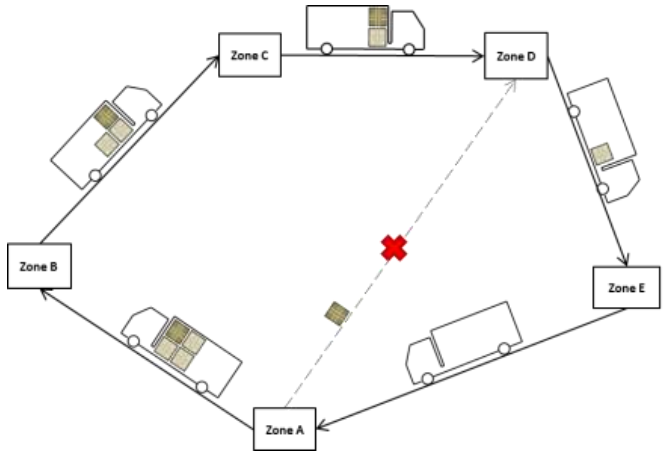
Builds tour patterns, in a step-wise procedure, simulating the following logistic processes:

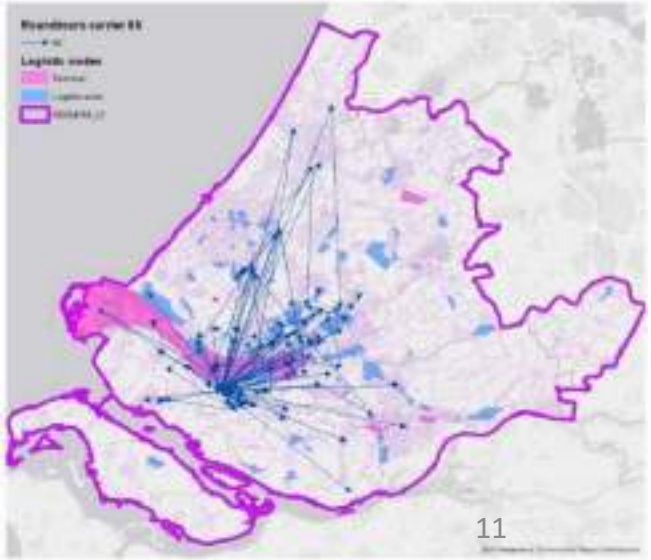
1. Tourformation
2. Delivery time

Output:

Truck round tours for the collection and delivery of all shipments in the study area



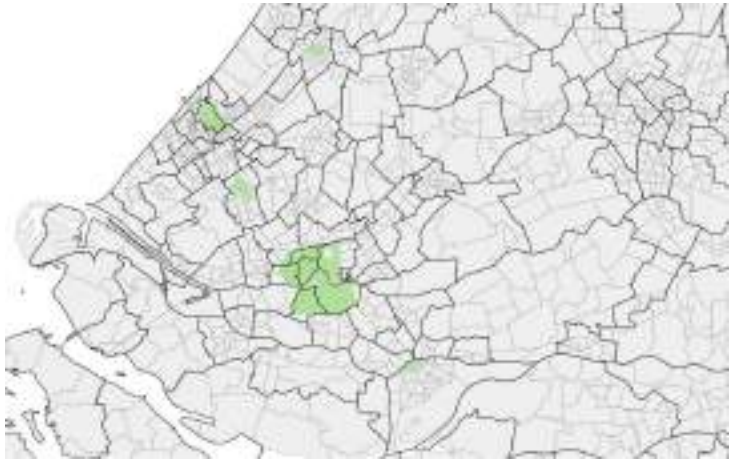


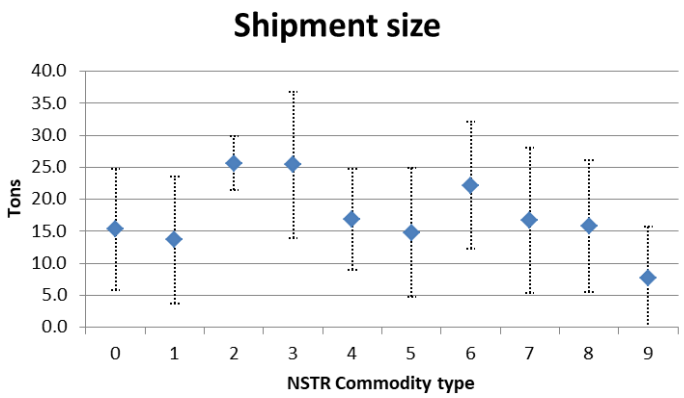


For details see:

Thoen, S, L Tavasszy, M de Bok, G Correia, R van Duin (2021) Descriptive modeling of freight tour formation: A shipment-based approach, *Transportation Research Part E*, Volume 140

Data requirements





The TFS has been designed in such a way that it uses generally available transport modelling data and statistics as primary inputs. Behavioural parameters can be calibrated, either validated, depending on local available data.

Summary of basis input data:

- Local transport model (networks, zones with socio economic data)
- Location of logistic nodes (distribution centers/transshipment terminals)
- Global firm statistics (size distribution)
- Aggregate commodity demand

Optional data for calibration:

- Detailed freight trip diaries
- Establishment surveys
- Truck counts

Modelling use cases

- Overview
- First results

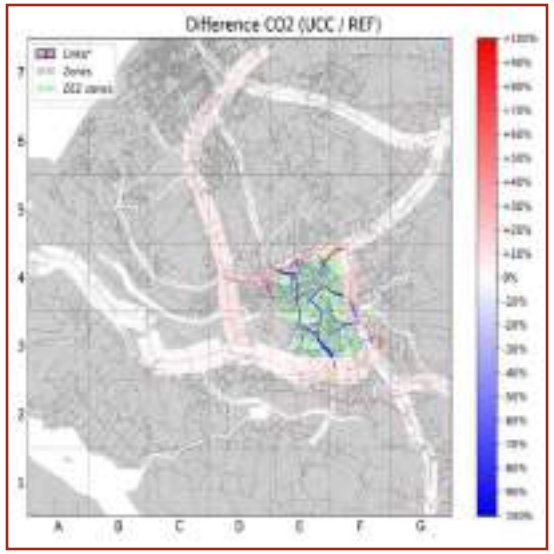
Use cases: simulation results

The TFS is aimed at city logistic analysis in general. In HARMONY several relevant use cases are developed and tested during the project:

- ☑ Zero –emission zone
- ☑ Heatmaps and carbon footprinting
- ☑ Crowd-shipping
- ☑ Micro-hubs and cargo bikes (with microsimulator)
- ☐ Land use planning of logistic and industrial sites

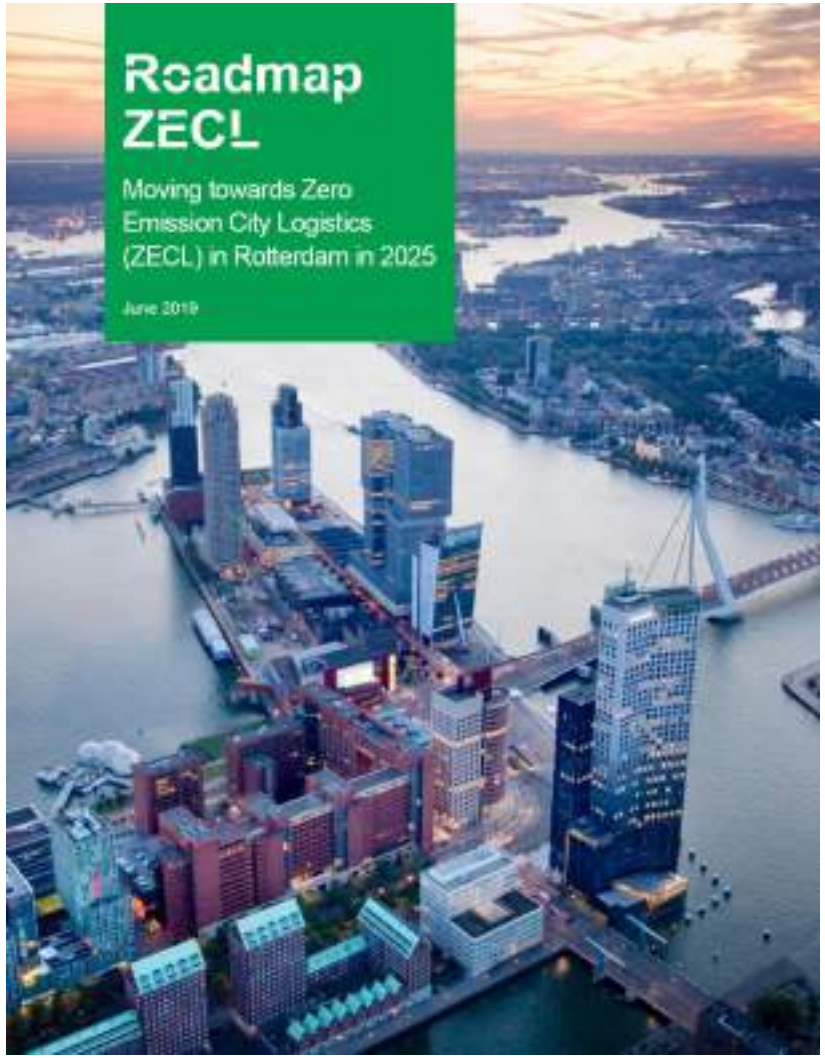
City logistic outlooks

New logistic services



Impact assessment

Zero emission zone for Rotterdam



Jan Boeve, Director of TLN:

"As soon as possible, the City of Rotterdam must communicate where the zero emission zone for city logistics will be from 2025, so that transport business owners know where they stand and can prepare their business model accordingly."

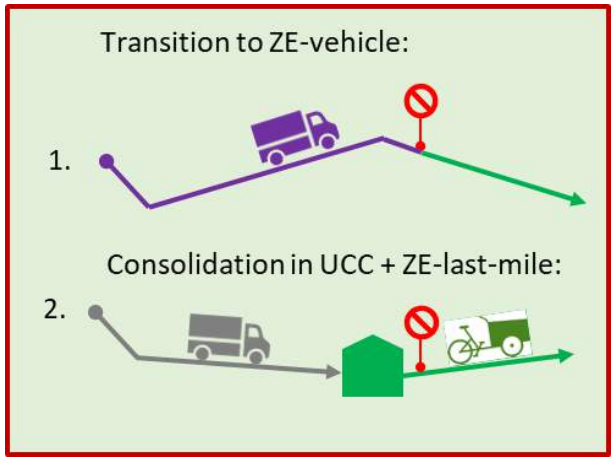
Best Research Paper award @TRB !

Paper "*Application of the HARMONY tactical freight simulator to a case study for zero emission zones in Rotterdam*", presented at TRB conference jan 2021, and published in TRR (open access)

Zero emission scenario: geography

Assumptions:

- ❖ Only ZE vehicles may enter the zero emission zone
- ❖ A proportion of shipments are redistributed via 7 UCC's
- ❖ Delivery and collection from the UCC takes place with dedicated ZE vehicles
- ❖ Analysis based on transitions scenario's for each logistic segment



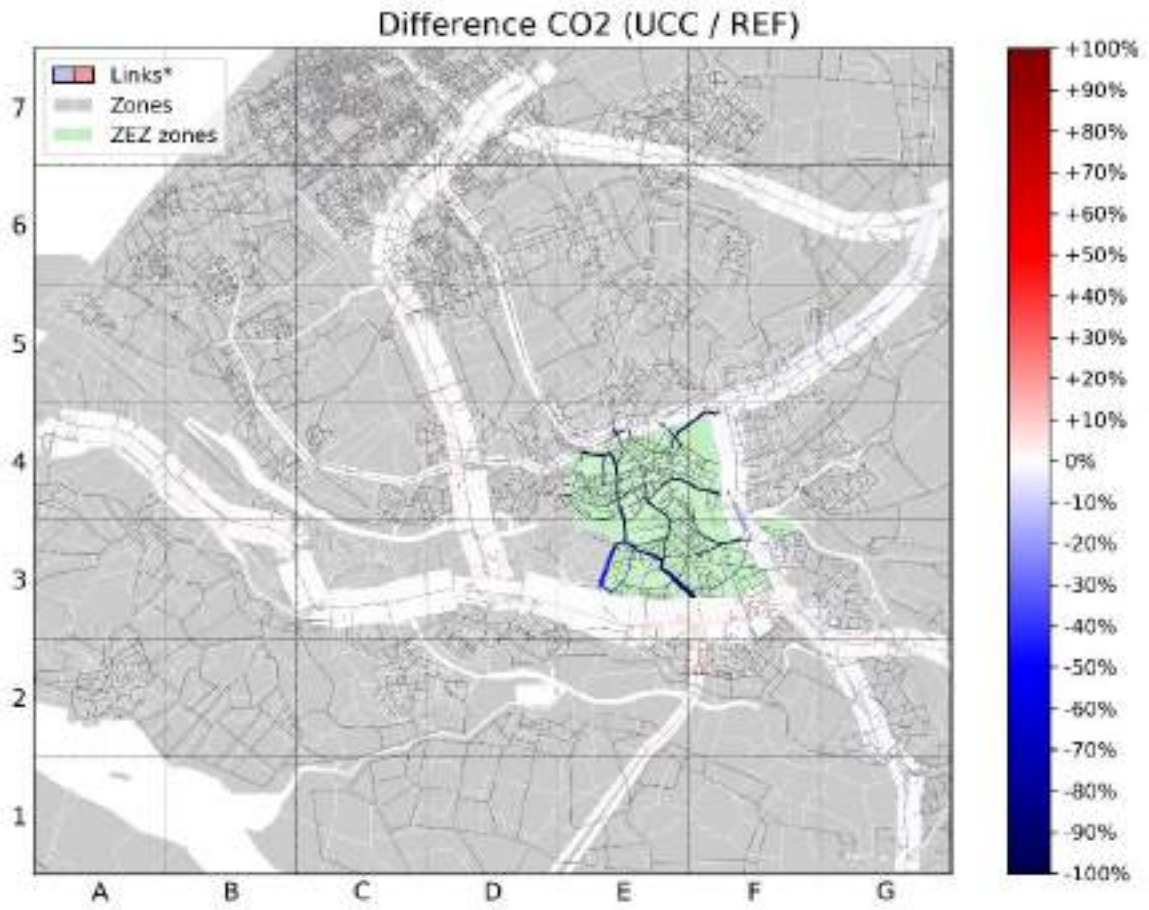
Possible configuration of the zero-emission zone, and 7 Urban Consolidation Centers

Results: impact on emissions at network level

- Emissions of all vehicle movements are calculated using the vehicle type, link speeds, and load of the vehicles.
- Reduction in total emissions within the municipality of Rotterdam: ca. 8%. This includes all the freight traffic to and from the port area.

Type	Inside the ZEZ	City of Rotterdam	Study area (prov. South Holland)
CO2	-91%	-8%	-1%
SO2	-91%	-8%	-1%
PM	-89%	-8%	-1%
NOX	-91%	-9%	-1%

- Rerouting of shipments to the hubs also leads to small increases of emissions in the surrounding area.



* Linkwidth is shown proportial to traffic intensity REF (max. = 42317 freight vehicles/day)

Use case: ‘Heatmaps’

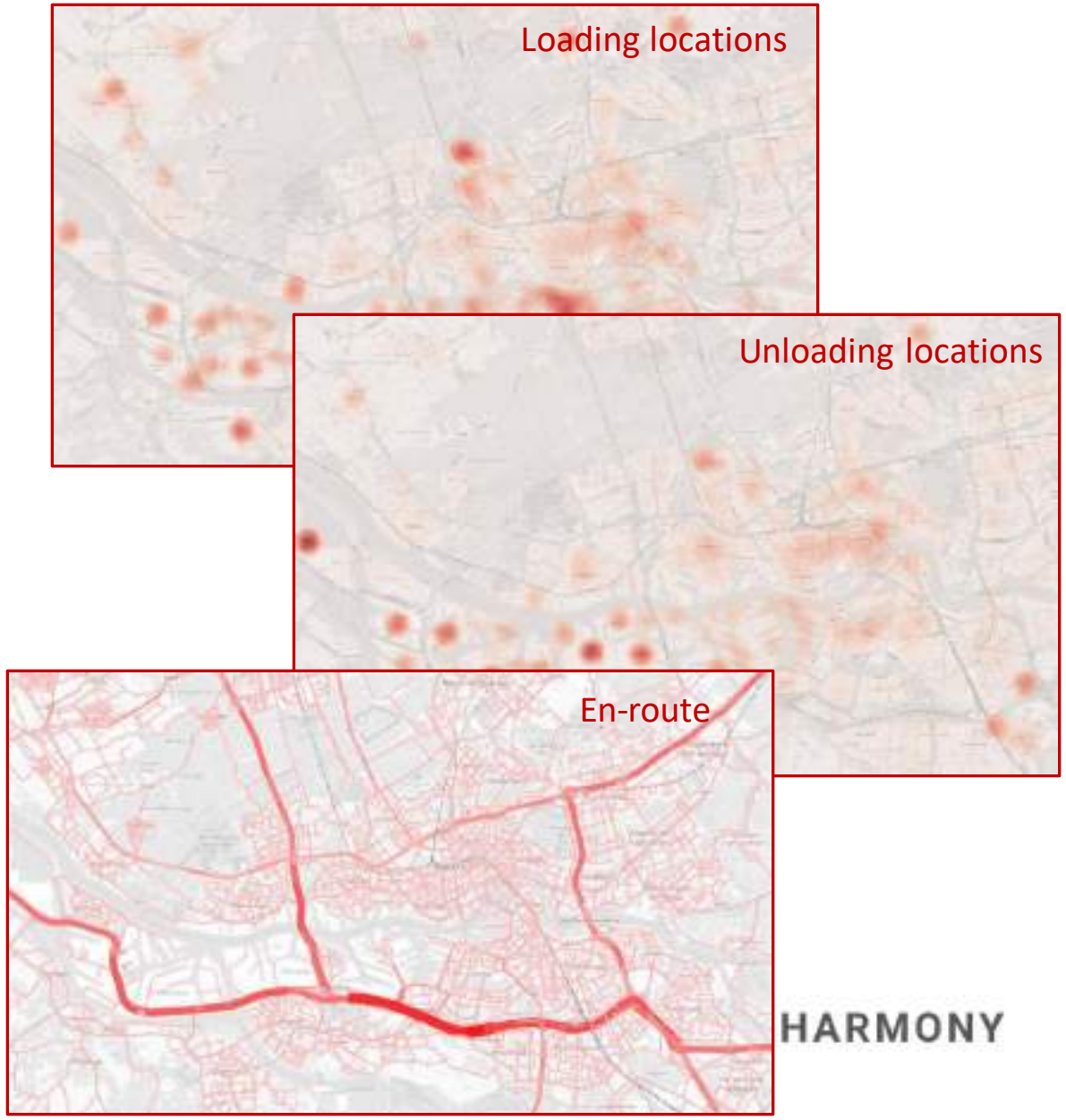
Objective: to provide KPI to identify optimal locations for **charging infrastructure** for electric/hybrid HGV

Approach: outputs from the TFS (vehicle patterns and stoplocations) are used to calculate **Heatmaps** of energy demand, either at Loading locations, Unloading locations or en-route.

Further development:

- Segregation to **logistic segments**.
- Where available use ‘**real-data**’ from logistic stakeholders in the area.
- **Overlay** with other **GIS layers** to make multi criteria selection of potential sites (e.g. electricity network, petrol stations).
- Include passenger vehicles

First visualisations:

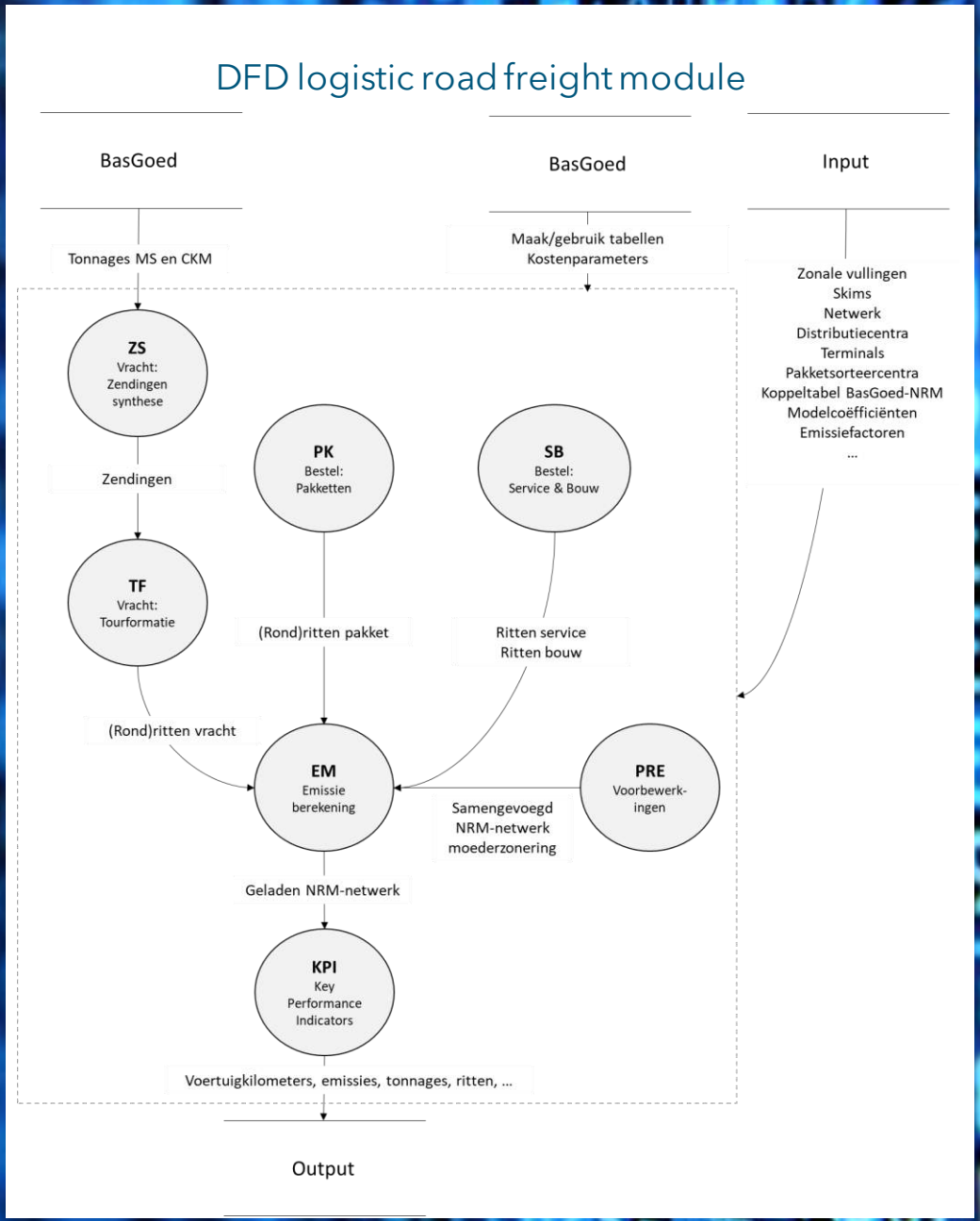


Other applications of tour based models

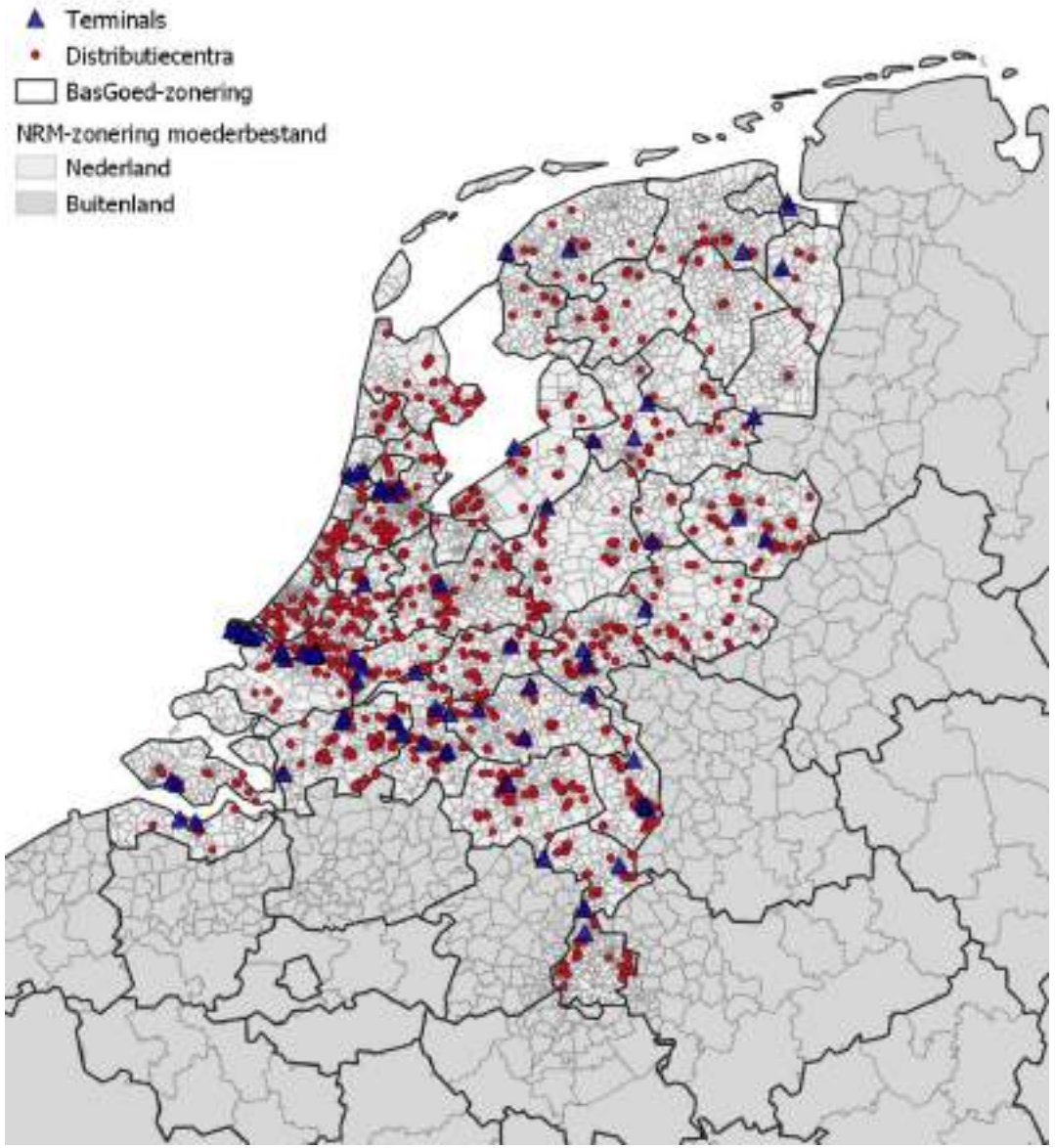
Dutch National Freight model Basgoed

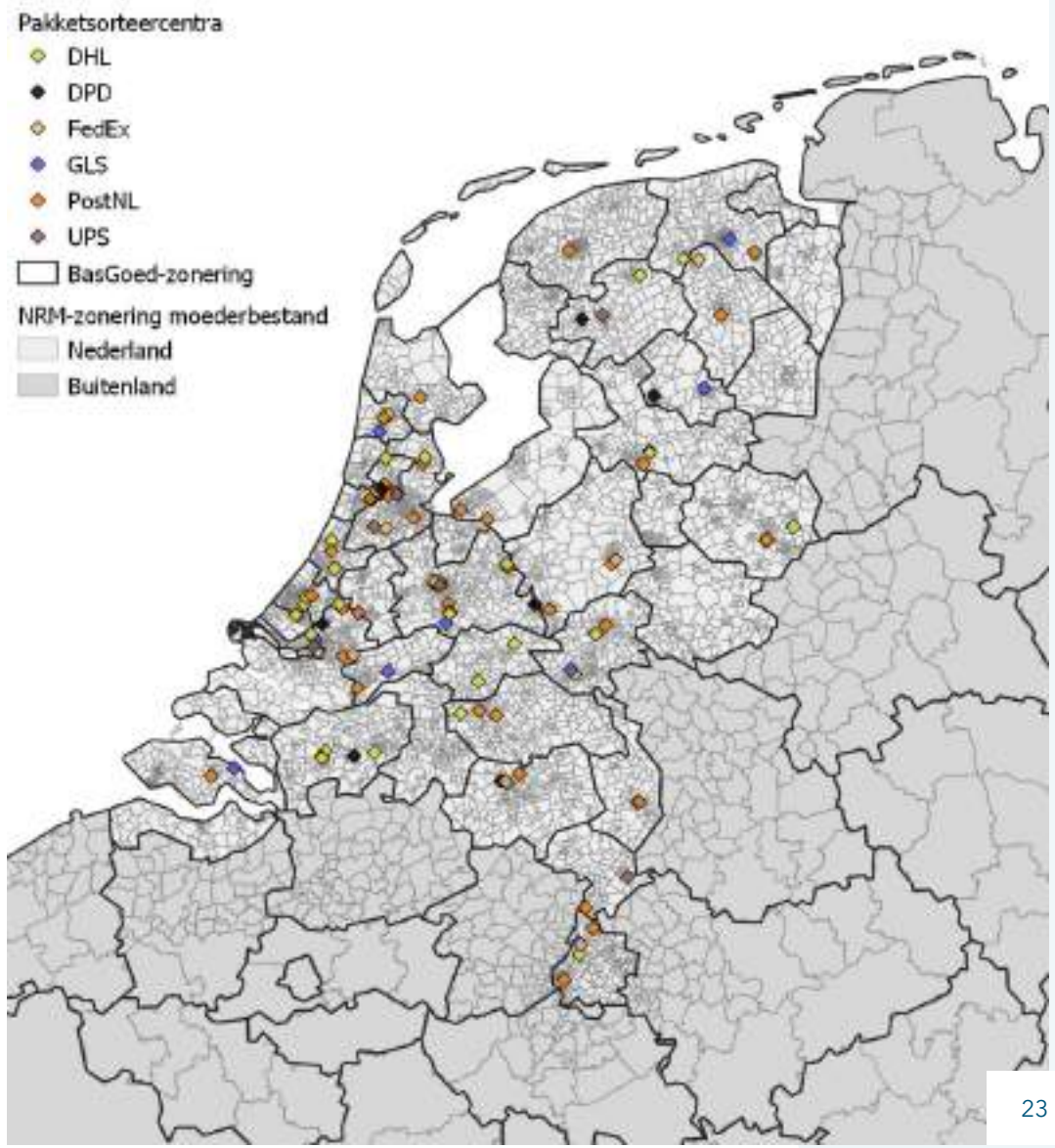
Overview of project:

- The TFS is used as a donor model for a new logistic road freight transport module in Basgoed
- Tour- and shipment based
- Instead of agents, zonal employment is used for demand estimation (6930 zones) (*not agent-based*)
- Module interacts with mode choice models; output is used for traffic assignment (HGV, LCV)
- Module distinguishes 3 road freight segments:
  - Commodities
  - Parcel delivery
  - LCV service trips

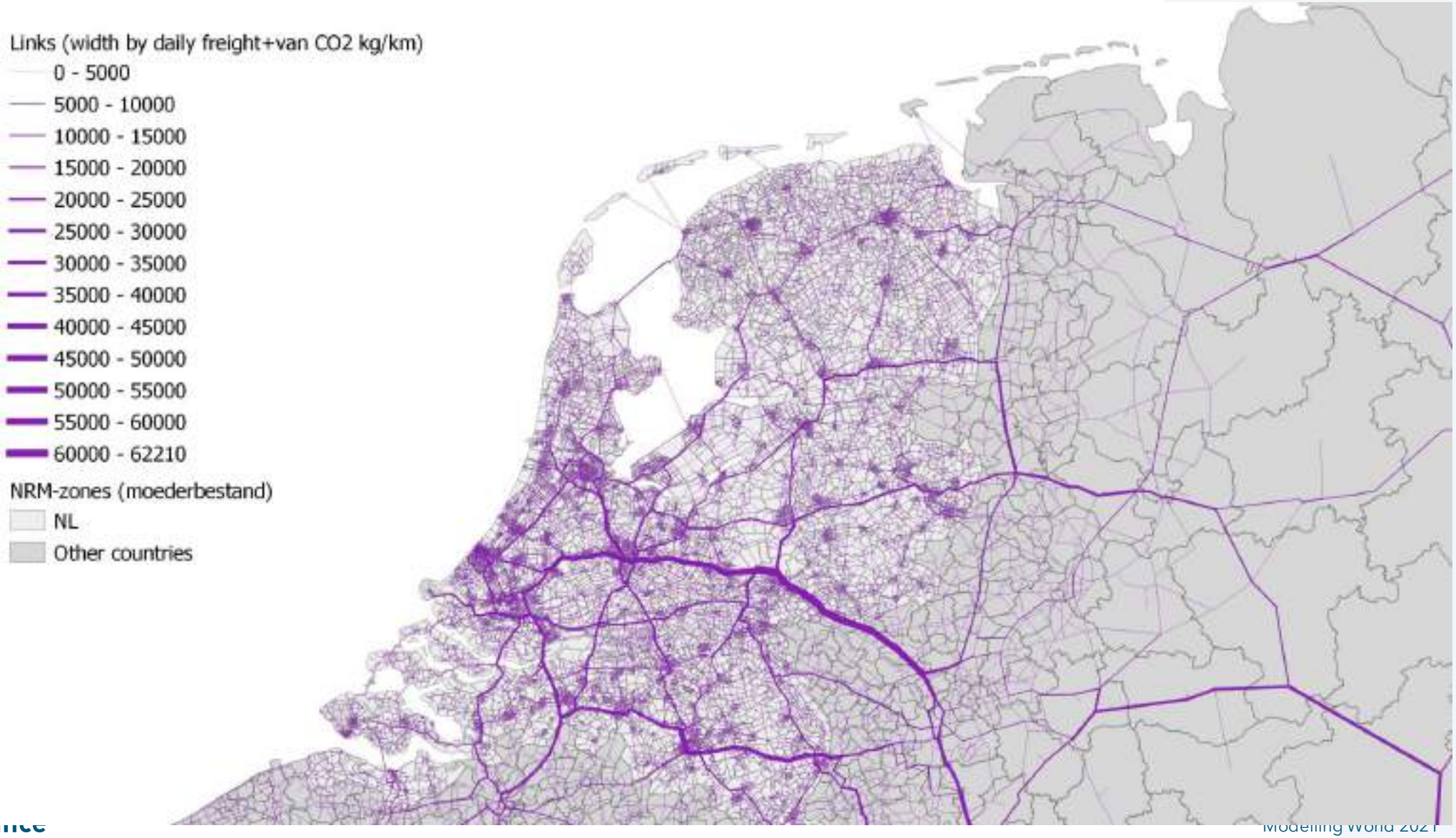


Basgoed Road Freight Module: data collection (logistic nodes)





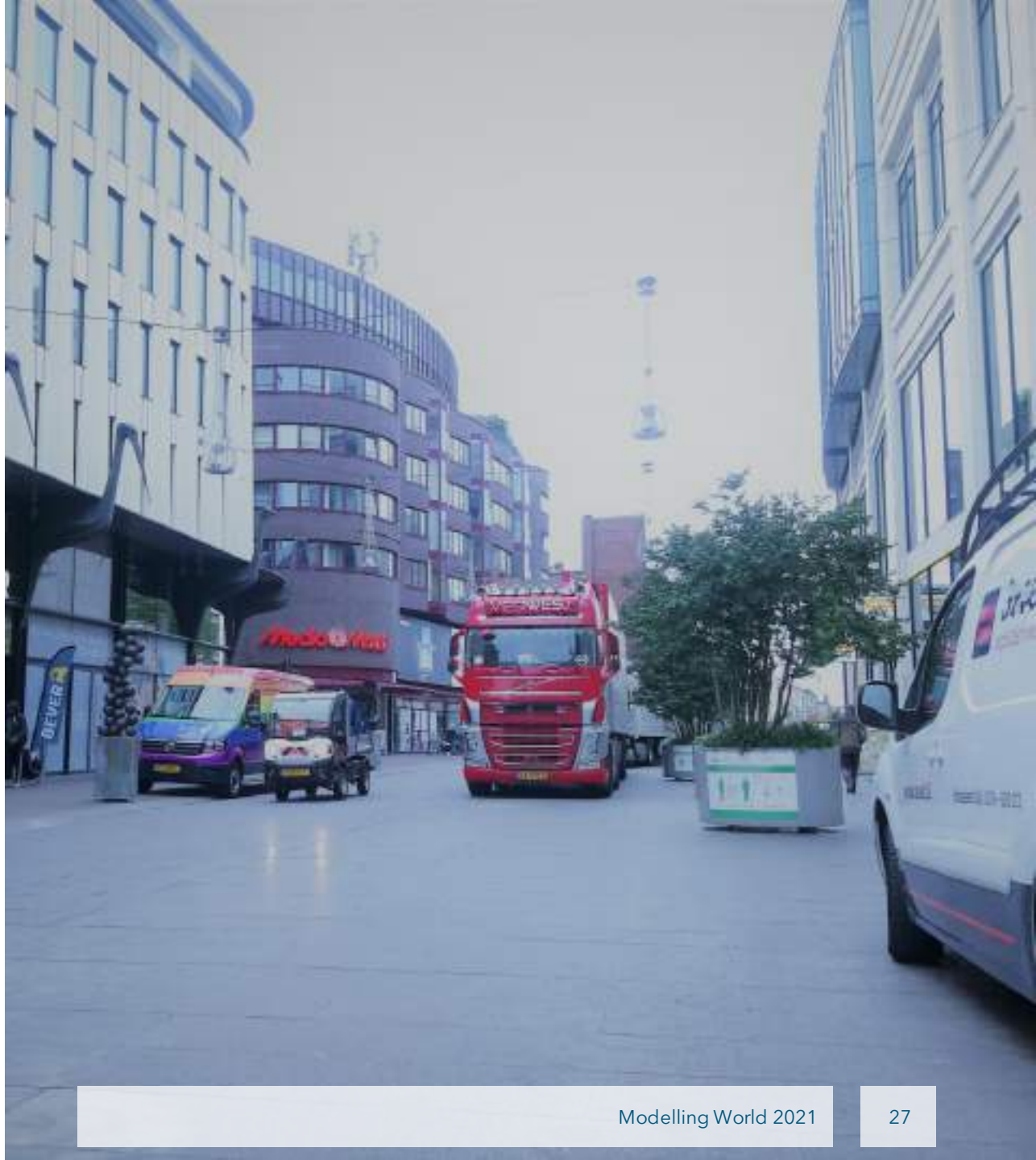
Basgoed Road Freight Module: first results



Conclusions and discussion

Conclusion and discussion

- A balanced design of the TFS allows 'easy' transfer of tour-based approach to other modelling systems
- Wider application to (city) logistic use cases will contribute to the further utilization of the possibilities of agent-based simulation
- Tour-based demand modelling, also asks for tour-based traffic count calibration



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