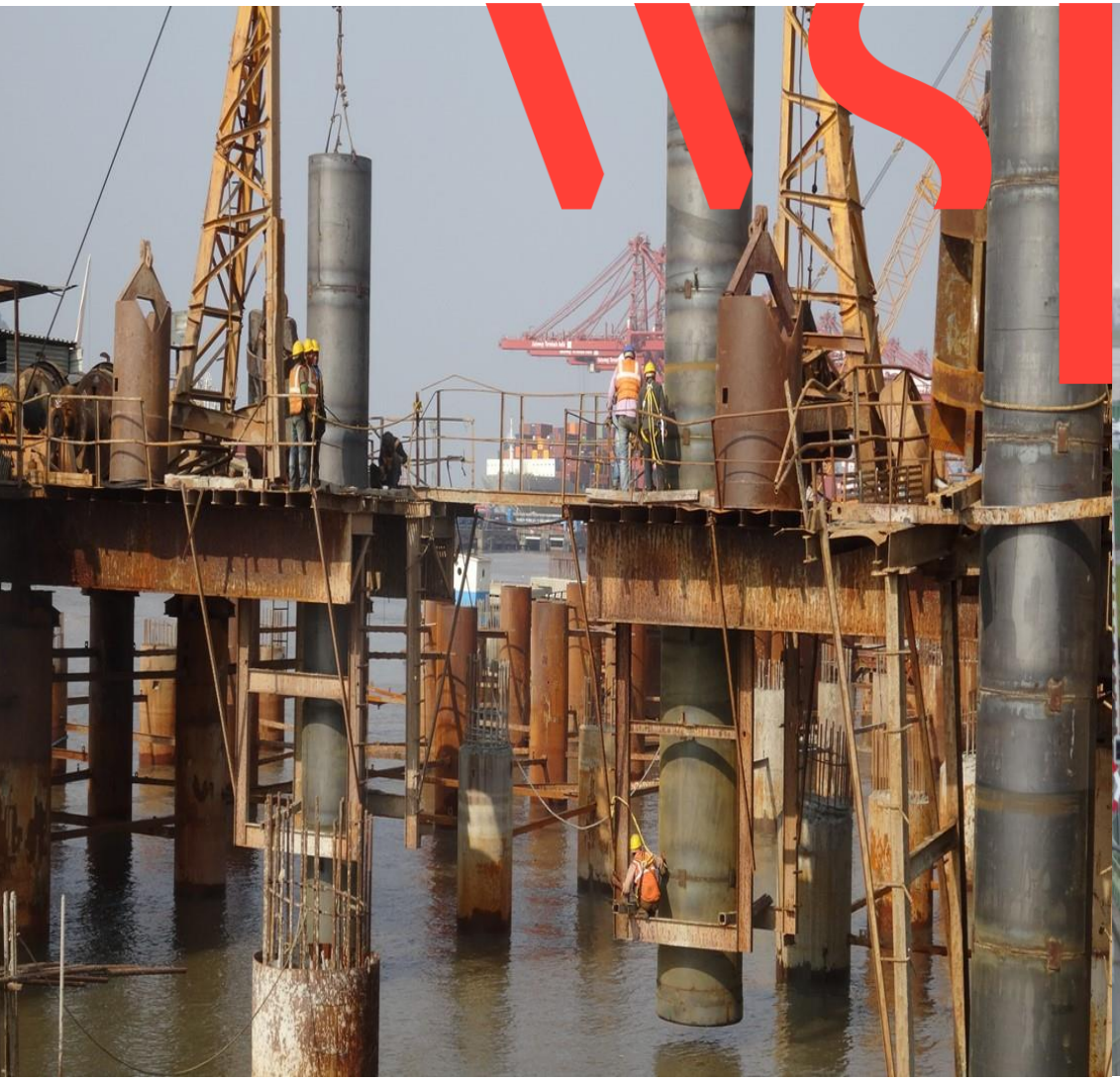
June 3, 2019

YRD Workshop onTransport-related Air Pollution Control
Shanghai, China
May 30-31, 2019



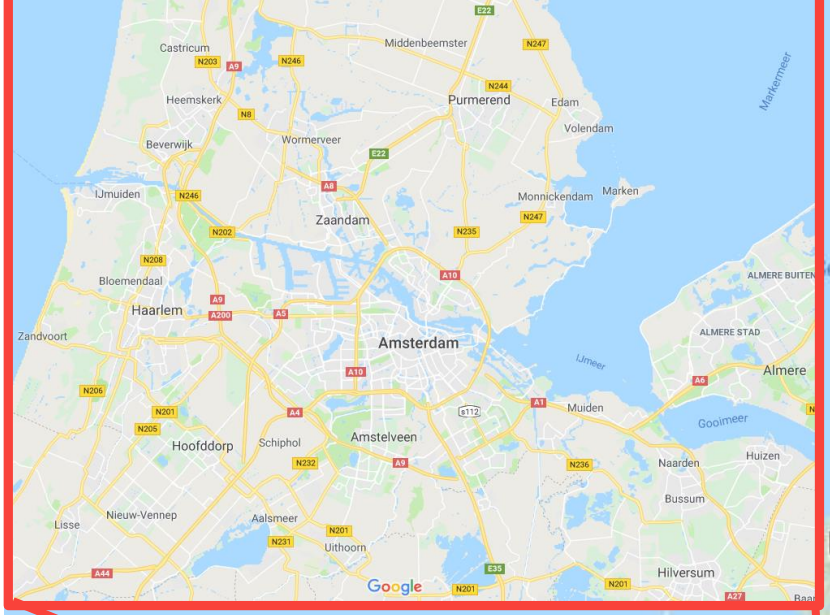
Amsterdam: Transport Modal Shift and Impacts on Air Quality

Dr Bethan Tuckett-Jones

Day 1, 30th May 2019

Content

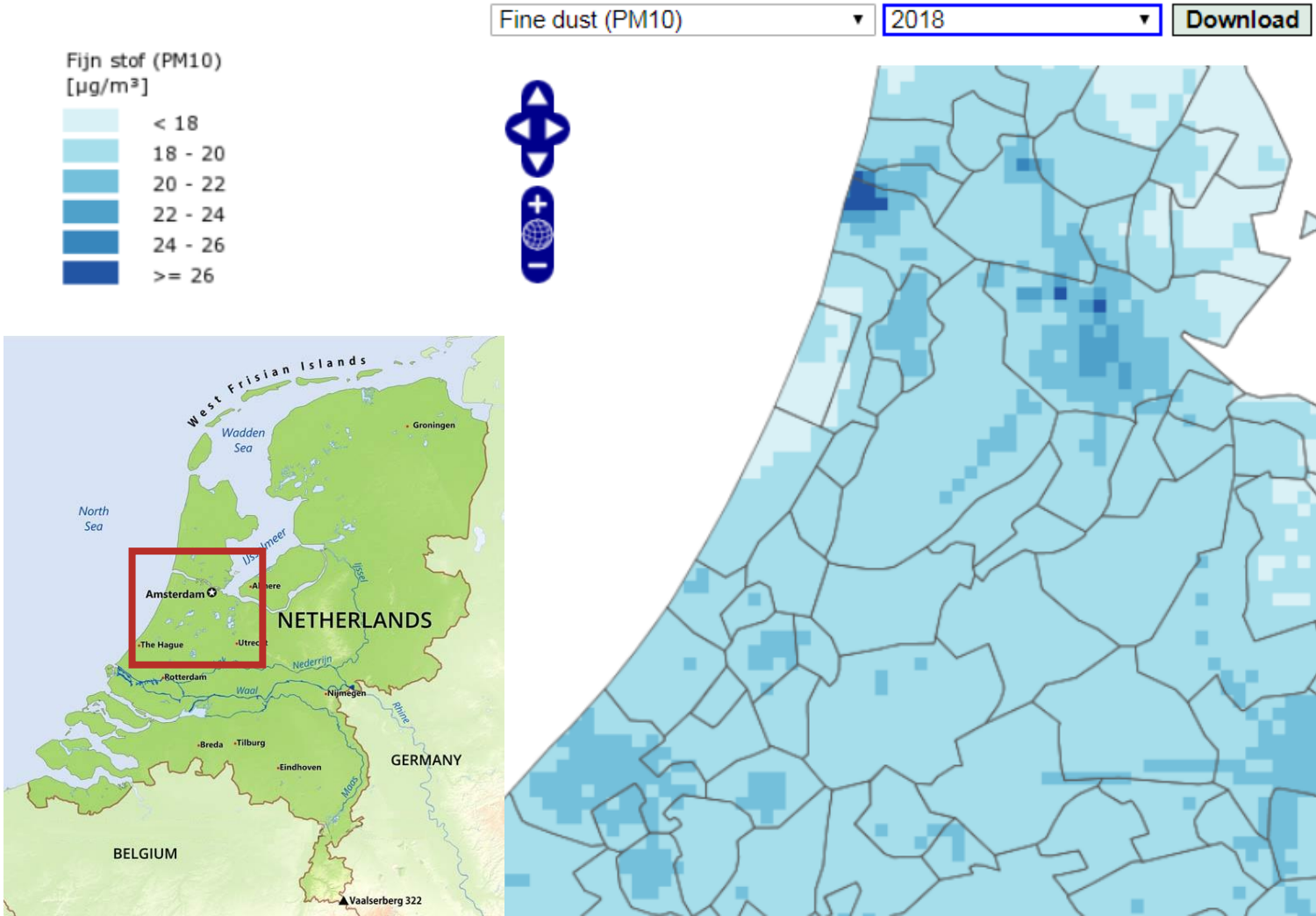
1. Air Quality in Amsterdam



1. Air Quality in Amsterdam

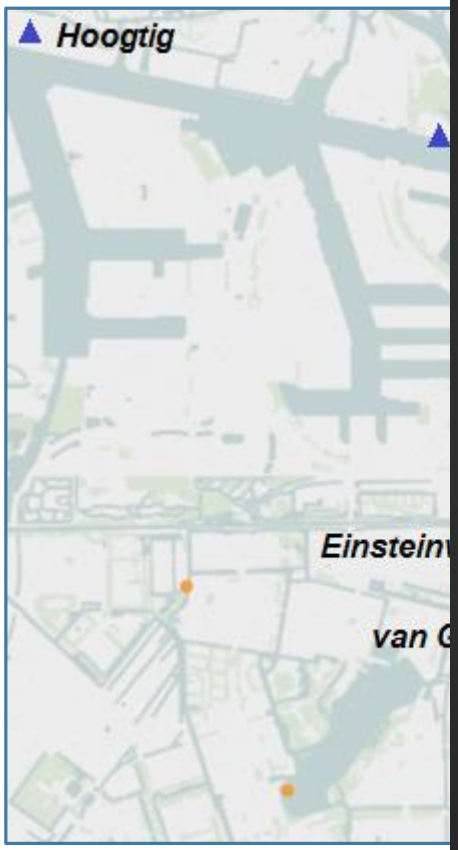
1km x 1km average concentrations

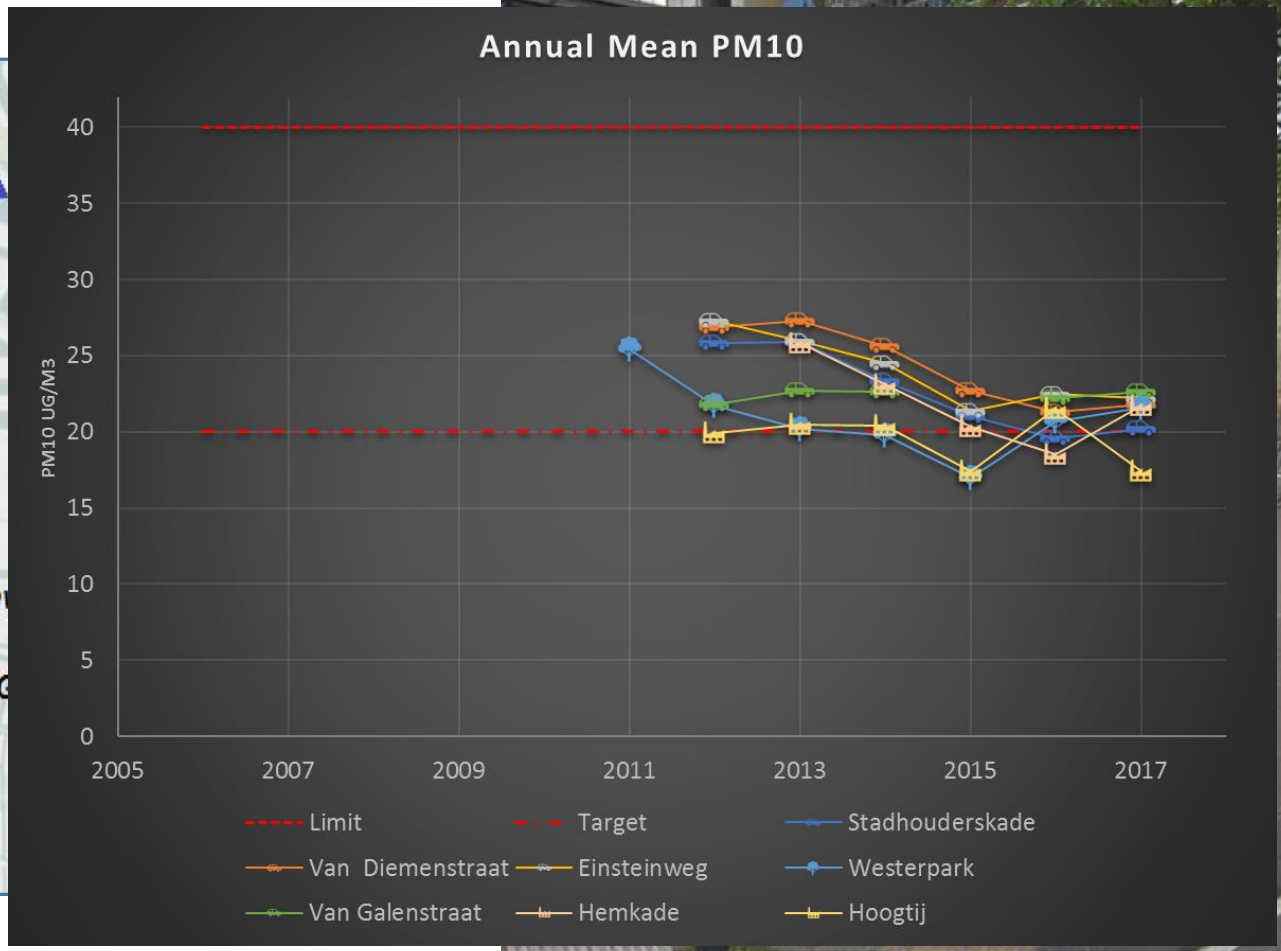
(Data from Rijkinstituut voor Volksgezondheid en Milieu, geodata.rivm.nl)



1. Air Quality in Amsterdam

Pollution Concentration Trends

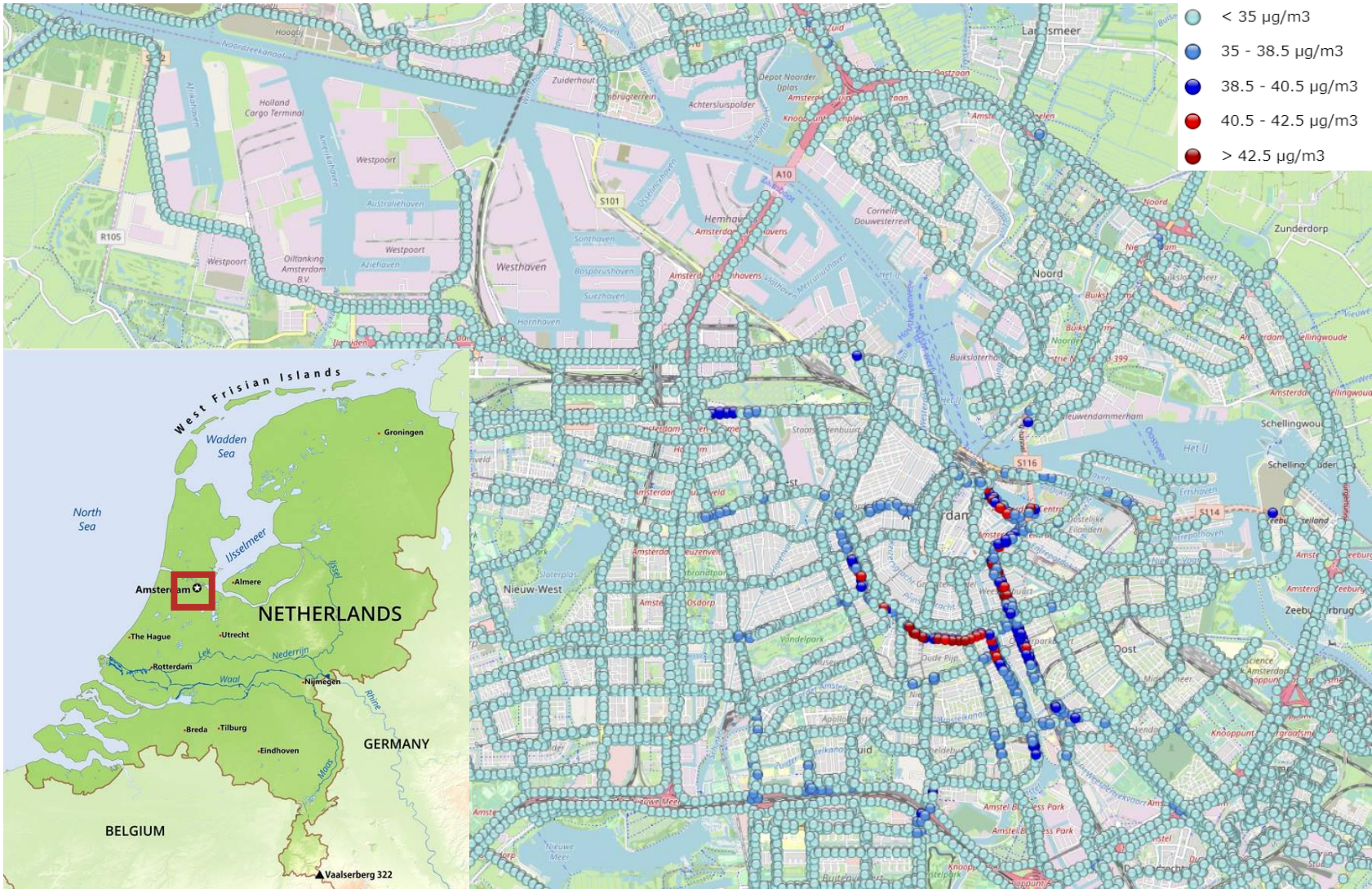




Data from European Environment Agency

1. Air Quality in Amsterdam

Detailed modelling at roadside property facades (2017 NO_2)



1. Air Quality in Amsterdam

Clean Air Plan
Zero Emissions by 2030

2. Modal Shift and Air Quality

Modal Shift

Shift

Road → Rail

Road → Shipping (Inland)

Improve

All models → Increased carrying capacity

All models → Reduced emissions

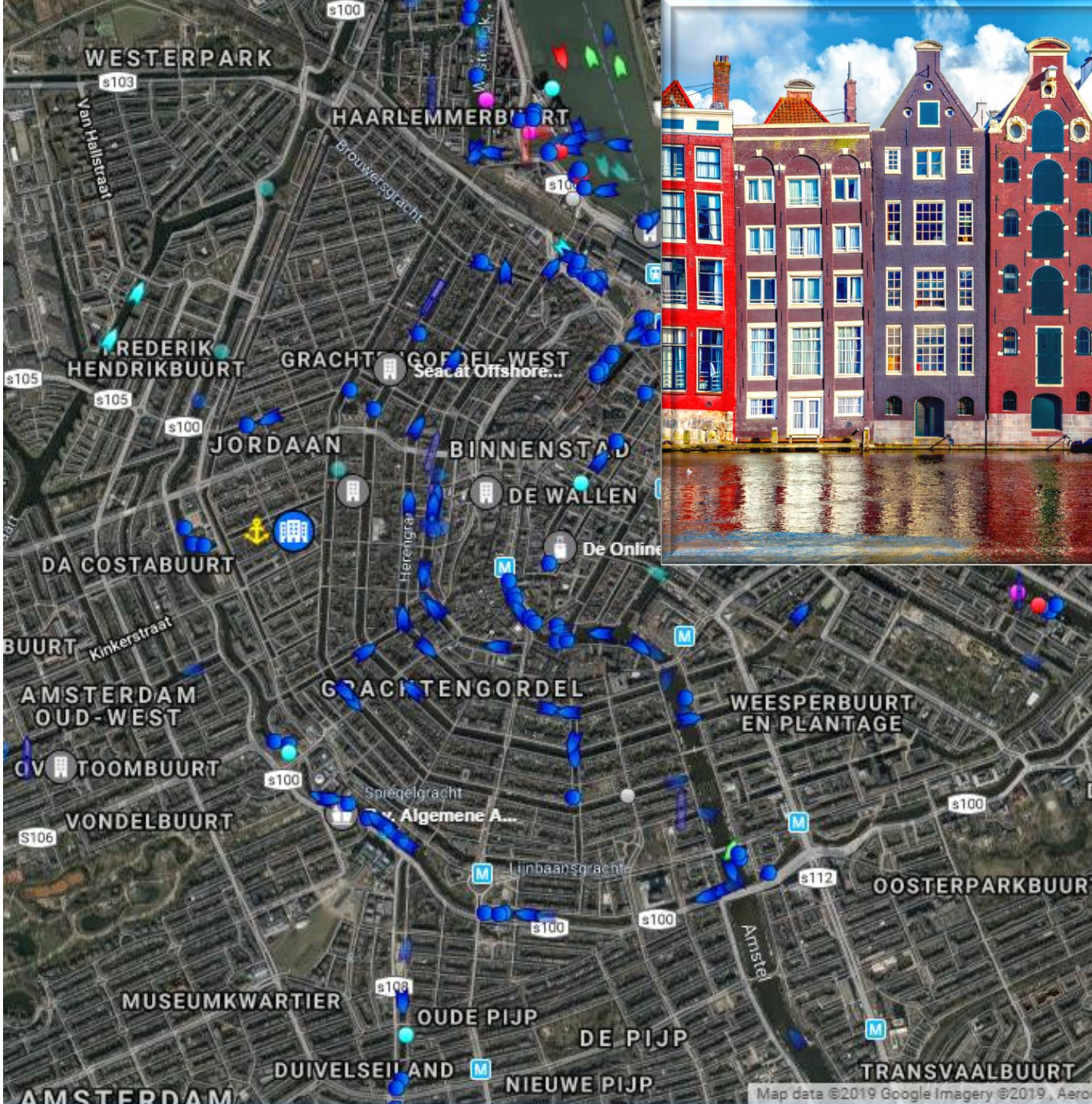
Amsterdam - A regional opportunity

Modal shift from road to inland waterways

Waterway type	Waterway class		Designation	L(m)	B (m)	T (t)		L(m)	B (m)	T (t)	Symbol on maps
of regional importance	west of Elbe à l'Ouest de l'Elbe к западу от Эльбы	I	Barge - Péniche - Баржа	38.50	5.05	250-400					
		II	Kampine - Campinois - 'Кампин'	50-55	6.60	400-650					
		III	Gustav Kœnigs - 'Густав Кёнигс'	67-80	8.20	650-1000					
of international importance	IV		Johann Welker - 'Йоганн Велкер'	80-85	9.50	1000-1500		85	9.50 [5]	1250-1450	
	Va		Large Rhine vessels-Grands rhénans-большие рейнские	95-110	11.40	1500-3000		95-110 [1]	11.40	1600-3000	
	Vb							172-185 [1]	11.40	3200-6000	
	VIa							95-110 [1]	22.80	3200-6000	
	VIb		[3]	140.00	15.00			185-195 [1]	22.80	6400-12000	

Amsterdam - A unique local opportunity

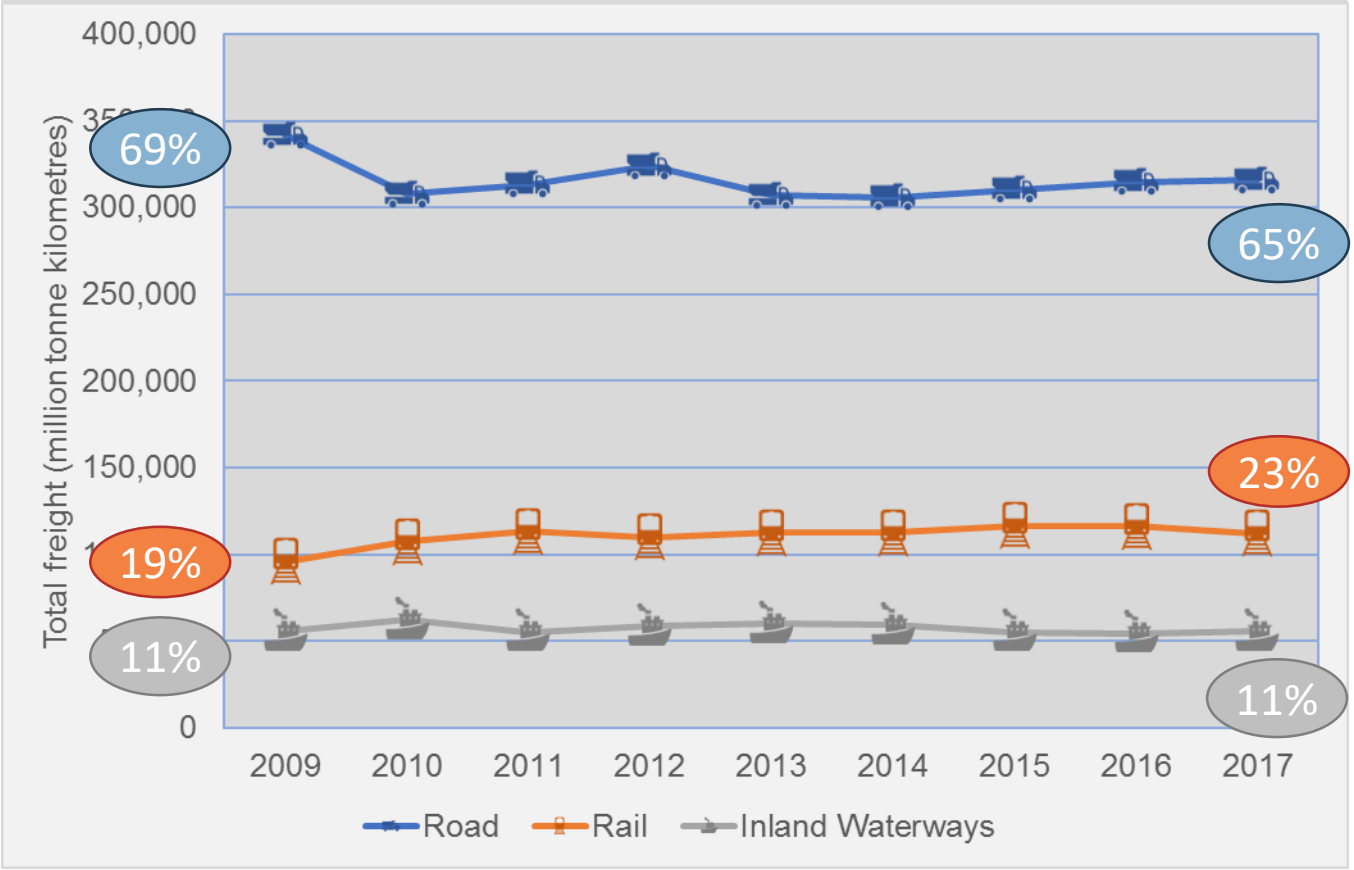
Modal shift from road to canal barge



2. Modal Shift and Air Quality

Freight in Europe

Germany



2. Modal Shift and Air Quality

Emission Factors

Emissions per tonne-kilometre (g/tkm) = Emissions for Trip (g)/ (Weight transported (t) x Distance travelled (km))

where Emissions for Trip = loaded & unloaded legs;
Distance travelled = loaded distance travelled

Can consider:

Tank-to-wheel: Emissions from exhaust

Well-to-wheel: Exhaust emissions plus power generation etc. * typically for GHG

Wear & tear: tyres, wires etc (PM only)

Report: STREAM Freight Transport 2016, Delft January 2017

2. Modal Shift and Air Quality

Emission Influences - Fleet Mix & Standards

- ***Road:***

Since 2013 new heavy duty diesel engines must satisfy the Euro VI standard. No further standards proposed for heavy goods vehicles. Since 2015-16 new light goods vehicles must satisfy Euro 6 standard. Tightened testing regime proposed.
[Euro VI = 0.4g/kWh NOx; 0.01g/kWh PM]

- ***Rail:***

Since 2012 new rail locomotives must satisfy Stage IIIB standards. Phase V standards are planned for 2021.
[Stage IIIB = 2.0g/kWh NOx; 0.025g/kWh PM]

- ***Inland Shipping:***

Since 2007-09 inland shipping must satisfy Stage IIIA standards. Phase V standards are planned for 2019-21.
[Stage IIIA = 7.5 – 11.0g/kWh HC+NOx; 0.2 – 0.5g/kWh PM; equivalent to CCRN2]

2. Modal Shift and Air Quality

Emission Influences - Load

- ***Load***

Road – increases linearly with energy consumption e.g. Truck 10 – 20t = NOx 8.6 (empty) – 8.9 (100%) g/km (2014)

Rail – energy consumption (and hence emissions) vary non-linearly with weight e.g. Medium length train with containers = NOx 141 (light) – 163 (heavy) g/km

Inland Waterways – non-linear based on waterway, vessel, load, operational parameters and upstream/downstream movement

- ***Load Type***

Bulk Cargo or Container

Light, Medium Heavy Weight

2. Modal Shift and Air Quality

Emission Influences – Vessel Type

- ***Results Consolidated with reference to typical Netherlands transport vehicle/vessel sizes:***

Road –

Large Van
Truck
Tractor with Semi Trailer*

Rail –

Diesel
Electric*

Inland Waterways -

Rhine-Herne canal vessel
Large Rhine vessel

2. Modal Shift and Air Quality

Emission Factors

Bulk Cargo

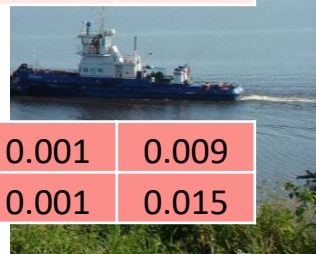
Mode	Vehicle/Vessel	Type of freight	Tonn-age	PM_c+ PM_w	NOx
Road	Large Van	Med. weight	1.2	0.218	5.03
	Truck, medium-size	Med. weight	7.5	0.037	1.75
	Tractor-semitrailer	Med. weight	29.2	0.007	0.29
Rail	Electric, medium length	Heavy	1914	0.005	0
	Diesel, medium length	Heavy	1914	0.010	0.19
Inland Shipping	Rhine-Herne canal vessel	Heavy	1537	0.017	0.46
	Large Rhine vessel	Heavy	3013	0.008	0.23

Containers

Mode	Vehicle/Vessel	Type of freight	Tonn-age	PM_c+ PM_w	NOx
Road	Tractor-semitrailer	Med. Weight	29.2	0.004	0.36
Rail	Electric, long length	Med. Weight	90	0.008	0
	Diesel, long length	Med. weight	90	0.016	0.31
Inland Shipping	Rhine-Herne canal vessel	Med. weight	96	0.019	0.53
	Large Rhine vessel	Med. weight	208	0.009	0.26

Upstream

Bulk Cargo - Rail	Electric, medium length	Heavy	1914	0.001	0.009
Container - Rail	Electric, long	Medium	90	0.001	0.015

2. Modal Shift and Air Quality

Netherlands-Wide Estimates

- ***Ongoing 1% shift from Road to Inland Waterways.***

Equates to 1250 million tkm per year shift

Emissions Savings Calculation Assumes:

a) ***Shift is led by ports, with 22% containerised freight***

b) ***75% tractor semi-trailer; 25% medium truck***

c) ***Rail is 30% diesel***

d) ***Inland Waterway split 50/50 RHC / Large Rhine***

2. Modal Shift and Air Quality

Netherlands-Wide Estimates

- ***Result:***

NOx benefit of 330 tonnes per year (~0.4% of emissions from road transport)

PM10 disbenefit of 2.9 tonnes per year (~0.1% of emissions from road transport)

Significant influence of assumption regarding 75% road tkm using tractor – semitrailer

- ***Targeting shift at medium trucks could increase savings to 1270 tonnes (~1.6%) NOx and 19.5 tonnes (~1.0%) PM10***

2. Modal Shift and Air Quality

Netherlands-Wide Estimates

- *Switching to Rail is better (not targeted)*

NOx benefit of 679 tonnes per year (~0.9% of emissions from road transport in Netherlands)

PM10 benefit of 3.7 tonnes per year (~0.2% of emissions from road transport)

Savings not significantly affected by power generation emissions:

NOx benefit 671 tonnes per year

PM10 benefit 3.5 tonnes per year

2. Modal Shift and Air Quality

Regional Conclusions

But – this calculation is indicative only

Primarily because it does not take into account 'final mile' transport and actual transport distances which tend to be longer for rail and inland waterway than road

2. Modal Shift and Air Quality

CE Delft Case Study

Amsterdam – (Regensburg) Munich

Transport of Steel

Mode 1: *Tractor-semi trailer, 832km*

Mode 2: *Long Train, electric, 868km*

Mode 3: *Short Train, diesel, 868km*

Mode 4: *Rhine-Herne canal vessel, 1047km*

plus 141 km by tractor-semi trailer

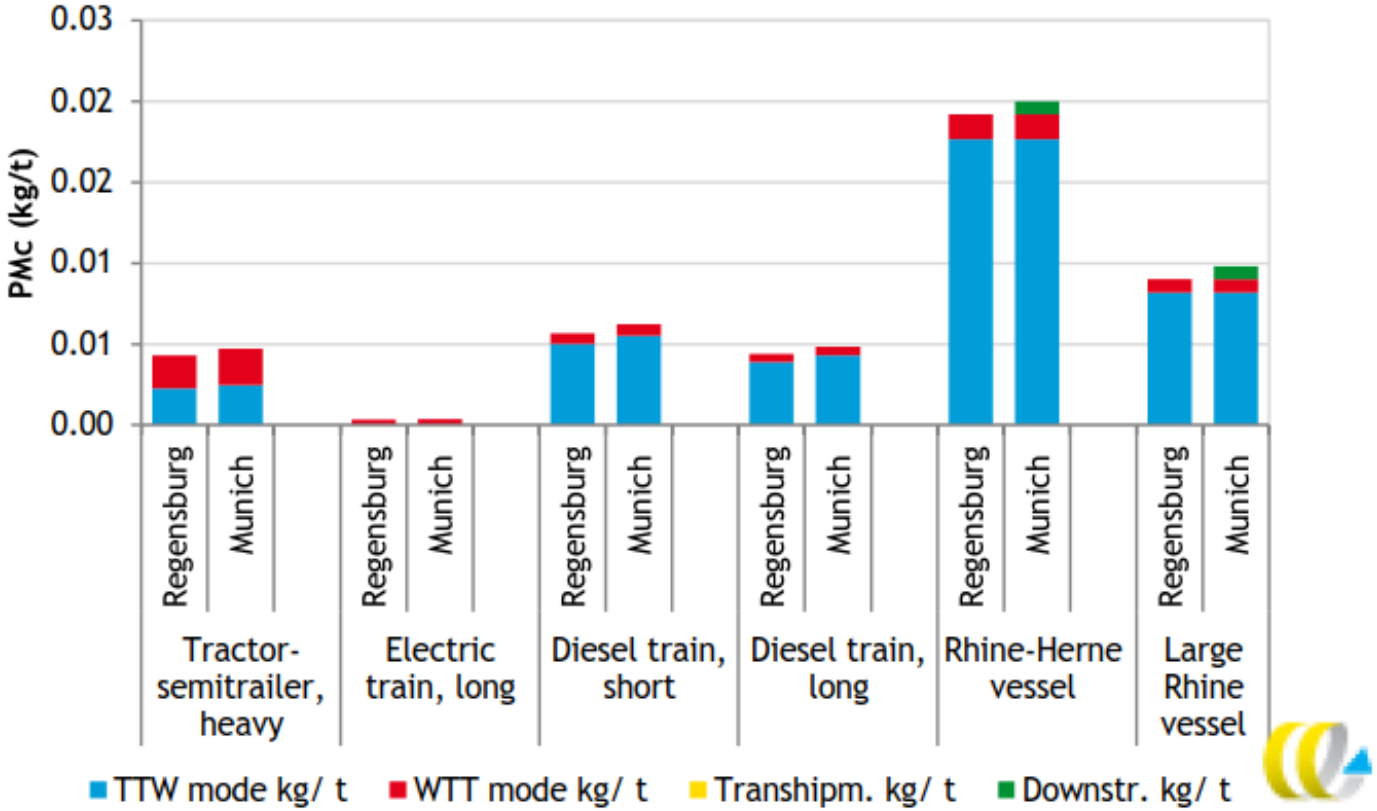
Mode 5: *Large Rhine vessel, 1047km*

plus 141 km by tractor-semi trailer

****Road = 100% motorway in Mode 1, 99% motorway + 1% rural in Mode 4&5***

2. Modal Shift and Air Quality

CE Delft Case Study



Taken from Report: STREAM Freight Transport 2016, Delft January 2017

2. Modal Shift and Air Quality

Inner City

- ***Potentially significant gains to be made with switch to zero emission barges****
- ***Applies to both passenger & cargo barges***
- ***Requirement under Clean Air Plan***

2. Modal Shift and Air Quality

Inner City

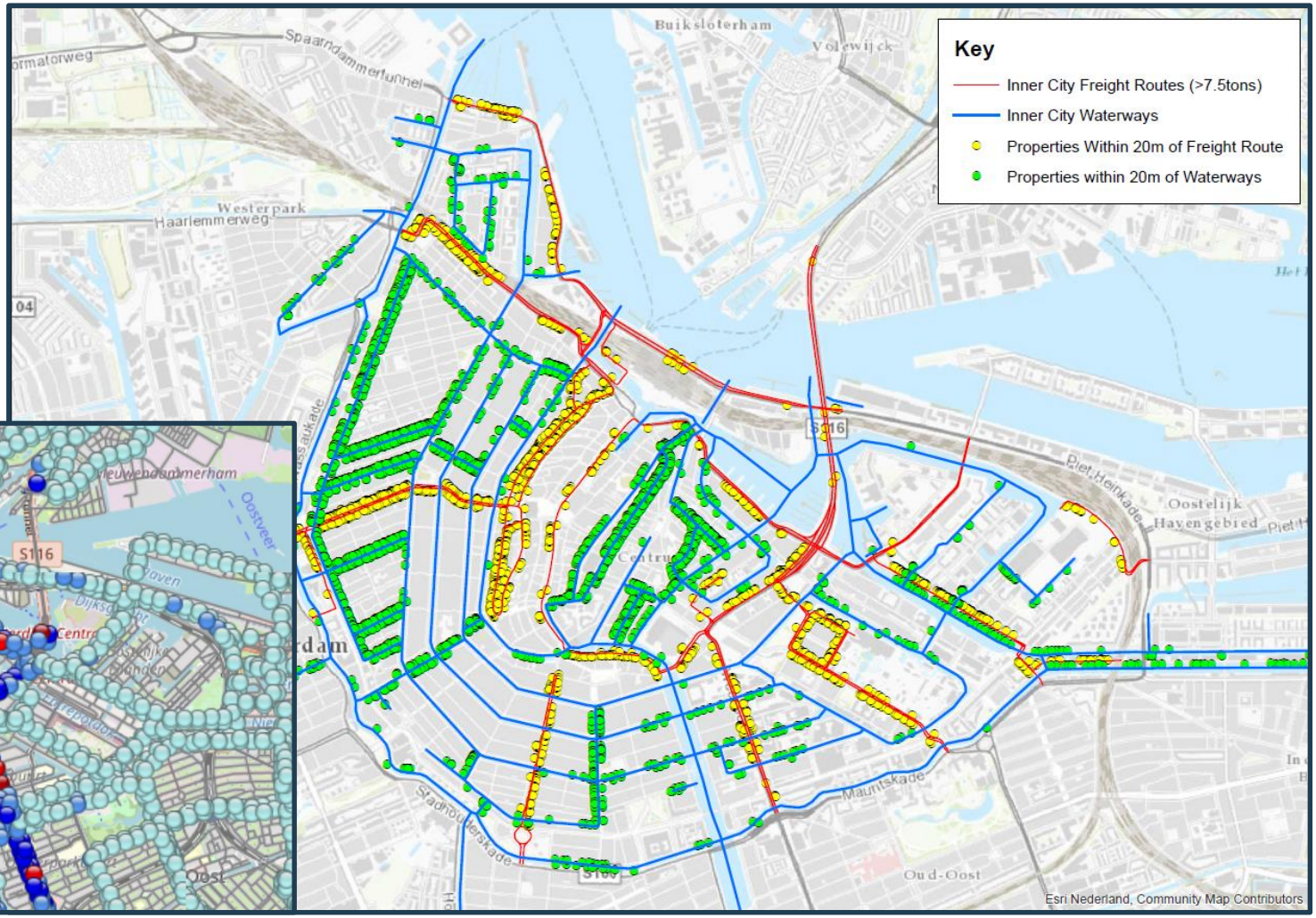
- *NIBM Tool for calculating increase / decrease in concentration due to change in traffic*
- *Change in roadside concentration is ~0.1ug/m3 per 10 trips/day displaced; decreasing over time*

Worst-case berekening voor de bijdrage van het extra verkeer als gevolg van een plan op de luchtkwaliteit

	Jaar van planrealisatie	2018
Extra verkeer als gevolg van het plan		
	Extra voertuigbewegingen (weekdaggemiddelde)	10
	Aandeel vrachtverkeer	100.0%
Maximale bijdrage extra verkeer	NO_2 in $\mu g/m^3$	0.10
	PM_{10} in $\mu g/m^3$	0.01
Grens voor "Niet In Betekenende Mate" in $\mu g/m^3$		1.2
Conclusie		
De bijdrage van het extra verkeer is niet in betekenende mate; geen nader onderzoek nodig		

2. Modal Shift and Air Quality

Inner City



- *3,852 properties within 20m of principal freight routes (~285/km)*
- *4,569 properties within 20m of inland waterway (~91/km)*

3. Example Actions at PoA

Port of Amsterdam

- ***Provision of Information: Intermodal Planner***

PORT OF AMSTERDAM - 60528 FRANKFURT, GERMANY

EN

1-10 10

Route	Transport time (days)	Frequency (per week)	Number of transshipments	Modality
Amsterdam - Rotterdam - Ludwigshafen	3	7	1	
Amsterdam - Rotterdam - Mannheim	3	5	1	

- ***Improved Inland Shipping Facilities***

Currently 44% of freight arrives/departs via inland waterways. Port is expanding berths and improving safety for IW. Actively further developing inland navigation connections, e.g. connections on the Rhine and towards the northern Dutch provinces

3. Example Actions at PoA

Port of Amsterdam

- ***Improved Rail Links***

Currently port of Amsterdam is connected to a freight only rail shuttle link between the ports of Amsterdam and Rotterdam and the rest of Europe, offering a direct and non-stop connection with the European. Actively seeking to establish more cost-effective and frequent services from PoA

- ***Improved Rail Provision (National)***

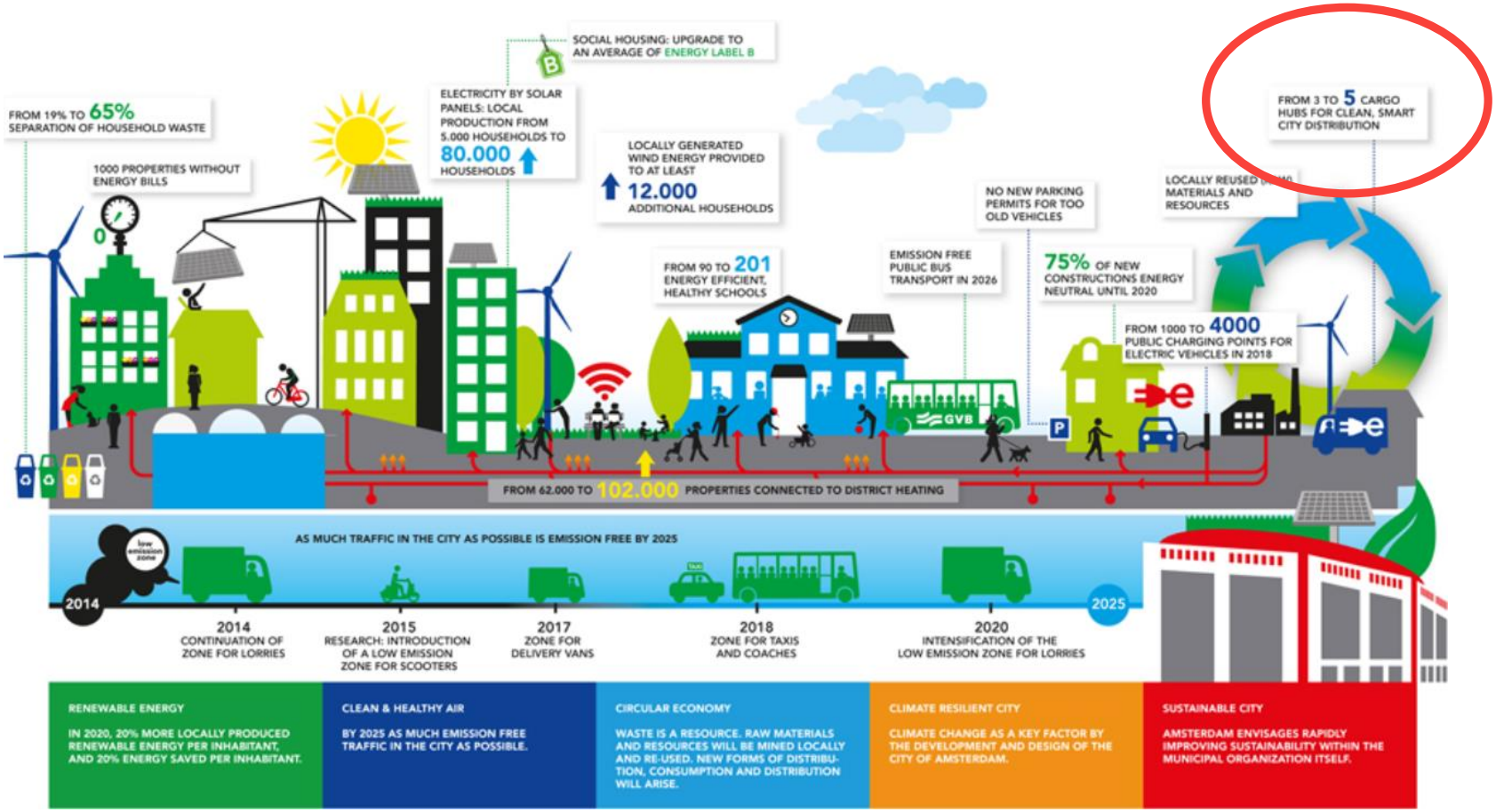
Currently 4 million tonnes of freight shipped by rail to and from port of Amsterdam. Germany and Netherlands are upgrading the principal line (Betuwe) inc 3rd track (to 2023)

- ***Improved Roads***

Actively promoted for short trips only & links to Schiphol Airport

3. Example Actions at PoA

Clean Air Plan



4. Barriers to Model Shift (from road)

I. Not Transort Cost

(if final destination within 50km of hub)

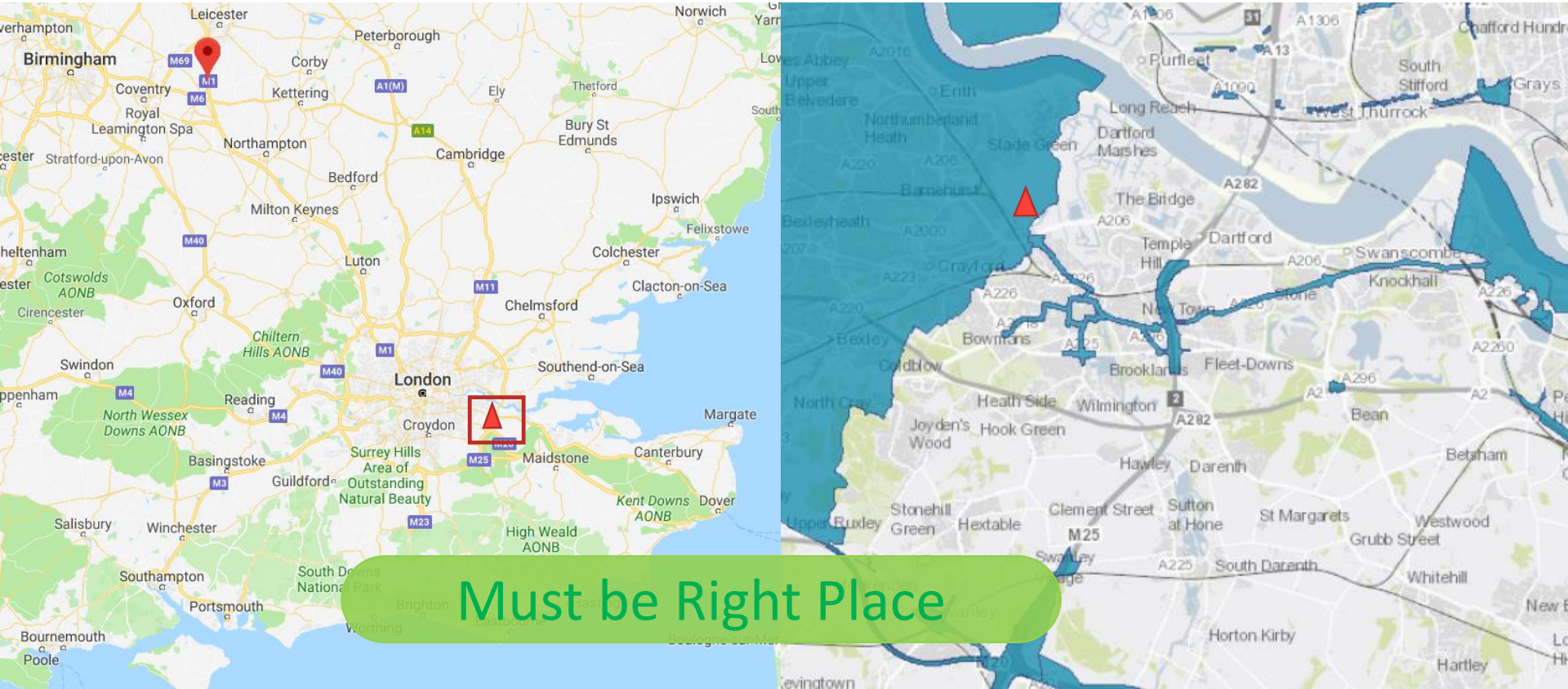
TO/FROM DUISBURG (per parcel)					
ORIGIN	BY TRUCK	BY RAIL	BY RAIL	BY IWT	BY IWT
		At the rail station	Within 50 km of station	At the inland water terminal	Within 50 km of River Terminal
MOERDIJK	€ 1821	€ 1023	€ 2152	€ 743	€ 1872
ROTTERDAM (Pernis)	€ 1994	€ 1023	€ 2152	€ 771	€ 1900
AMSTERDAM	€ 1967	€ 1046	€ 2175	€ 821	€ 1950
IJMUIDEN	€ 2029	€ 1135	€ 2264	€ 883	€ 2011
ANTWERP (Main Hub Terminal)	€ 1856	€ 1101	€ 2230	€ 893	€ 2021
VLISSINGEN	€ 2175	€ 1430	€ 2559	€ 947	€ 2076

Need multiple intermodal hubs

4. Barriers to Mode Shift (from road)

II. Hub must be in right location

(Near market, but no unintended consquences)



Must be Right Place

4. Barriers to Mode Shift (from road)

III. Lack of flexibility

Road transport is extremely flexible, requires limited investment and can handle multiple cargo sizes

But…

New railways are very expensive ($1M per km are typical)

Water requires unloading facilities and river maintenance

Need to provide options

4. Barriers to Mode Shift

IV. Inertia

Difficult to shift companies from existing practices

Need information

V. Timings

Just-in-time deliveries / Perishable goods prefer road

Need to optimise schedules

4. Barriers to Mode Shift

VI. Congestion

Local canals very busy

Rail also busy

But..

In city IW can be used to avoid delivery time restrictions (but client may have already adapted to restrictions – inertia again) and weight restrictions for last mile delivery

Optimisation of schedules

4. Barriers to Mode Shift

VII. Low or Zero emissions capability requires investment

Cost of purchase of zero emissions barges may be prohibitive ~12 year payback; but low risk if sufficient client base; retrofitting may be required to meet standards

Need to provide financial support / incentive

5. Conclusions

I. *Potential not yet maximised*

II. *Potential highest where demand is concentrated e.g. urban areas or multi-modal hubs*

III. *Road transport will continue to be part of low-emission solution for some time*

IV. *Low Emission Technology is emerging (for all modes) but costs remain high for freight in particular*

V. *Which pollutants?*

VI. *Air quality impacts of multi-modal hubs (inc. diffuse dust) must be considered*

VII. *Remove – Reduce - Mitigate*

Thanks

Roy van Eijsden – WSP Netherlands

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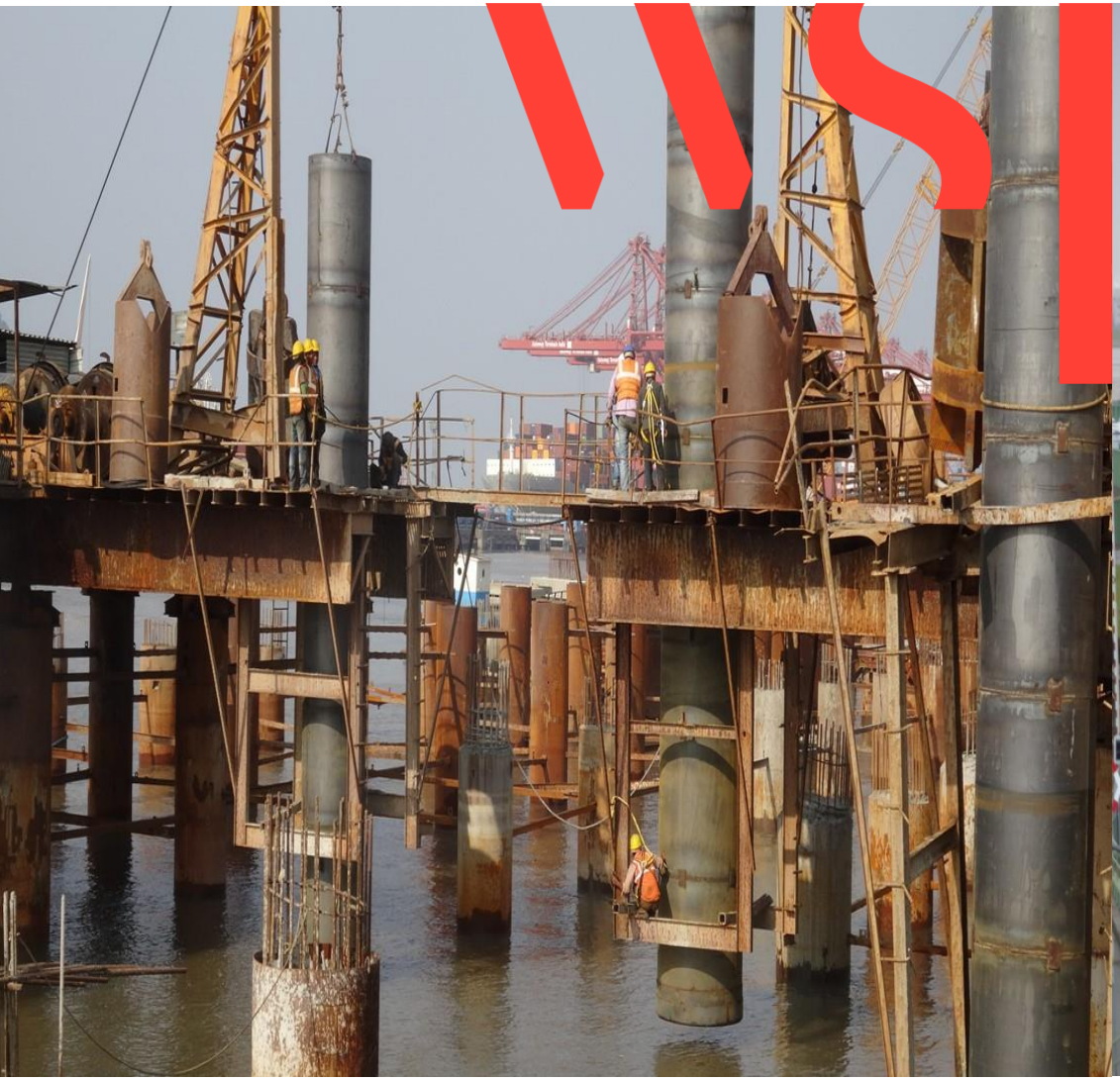
Jonathan Westerlund – WSP Sweden



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