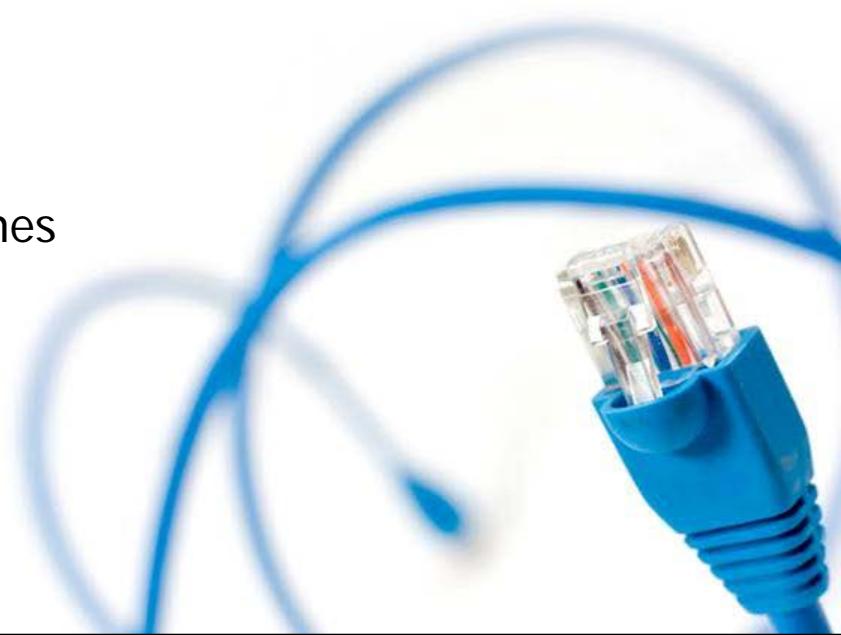


Traffic Flow Theory and Simulation

H. Taale

Lecture 13
Evaluation, Simulation and Guidelines





Rijkswaterstaat
Ministerie van Infrastructuur en Milieu

Evaluation, Simulation and Guidelines

Measuring and estimating effects of
traffic management

dr. Henk Taale
TrafficQuest



Contents presentation

- Dutch traffic and transport policy
- Evaluation
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- Case study pilot traffic management Amsterdam
- Summary



[Photo](#) by shutterstock



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[Photo](#) by shutterstock



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Congestion in The Netherlands

- August 1925: disaster tourism to Borculo (twister)
- May 29th, 1955: to the beach on Whit Monday
- February 8th, 1999: busiest morning peak ever: 975 km.
- November 29th, 2010: busiest evening peak ever: 870 km



Photo by Rijkswaterstaat



[A2 Ouderrijn](#) by onencyclopedia /CC BY NC SA



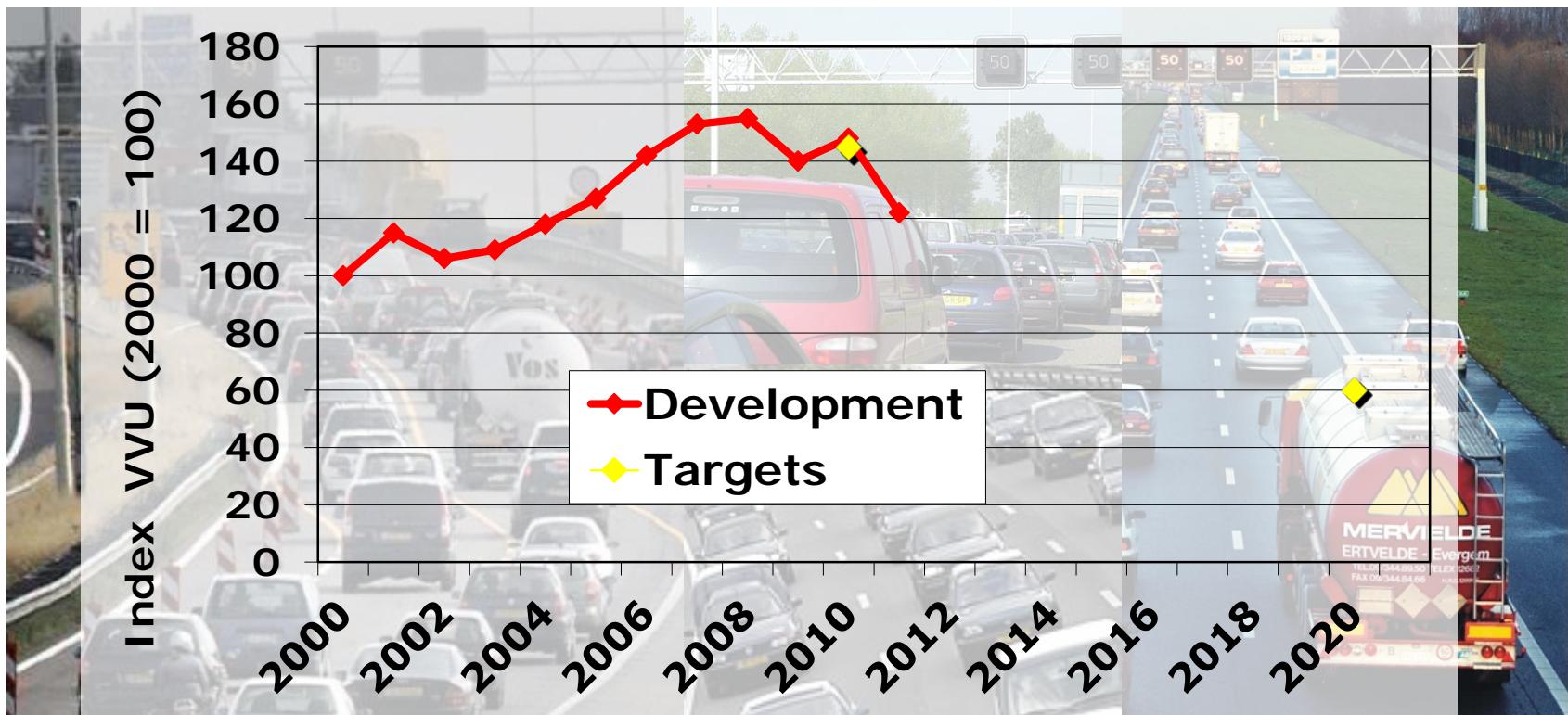
[Photo](#) by hcnet



[Bermtoerisme](#) by unknown



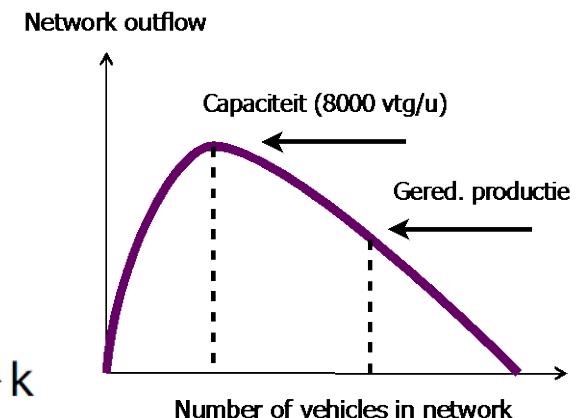
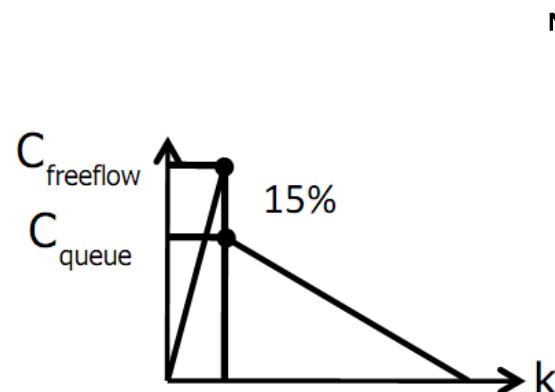
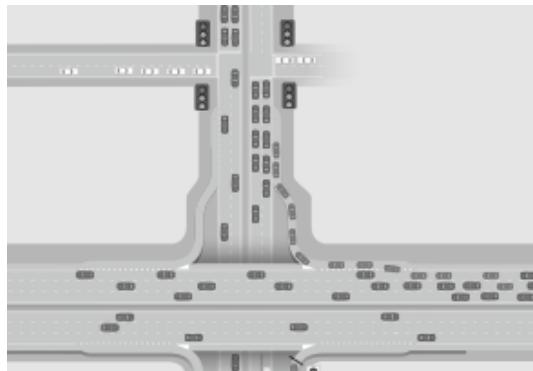
Congestion trend





Aspects of congestion

- Balance of traffic demand and capacity
- Blocking back important cause of extra delay
- Capacity drop gives more and longer congestion
- Suboptimal choice behaviour leads to unbalanced distribution





Traffic and transport policy



Building: “*very effective, expensive, long*”



Pricing: “*politically difficult*”

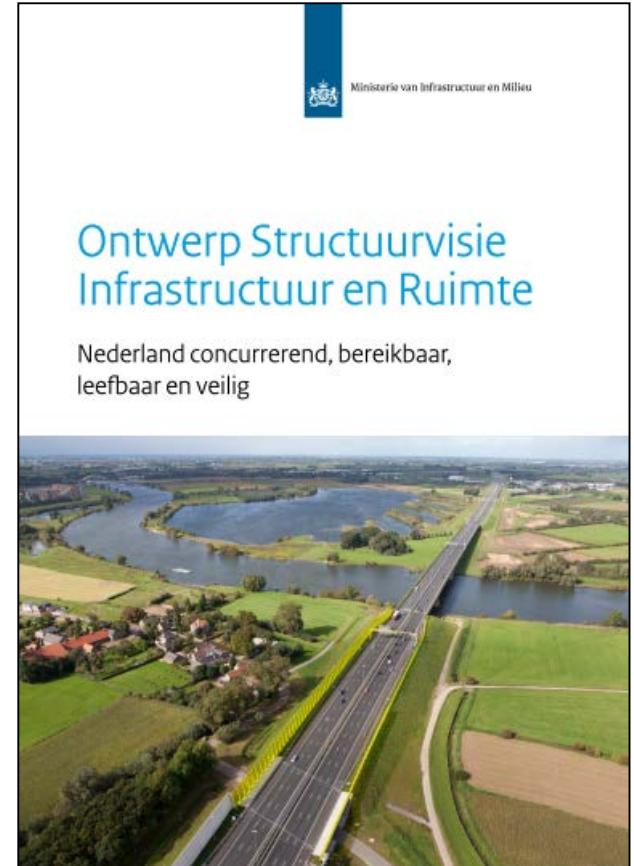


Traffic Management: “*effective, less expensive and quick*”



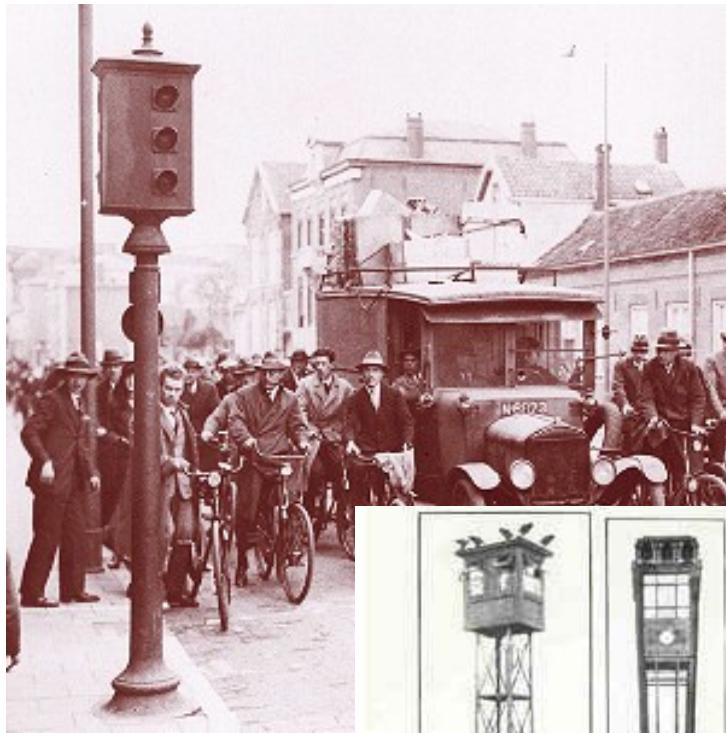
Mobility policy document

- New plans for spatial developments and mobility
- More responsibility for provinces and municipalities
- Strengthen the spatial-economic structure of the Netherlands
- Liveable and secure environment
- Improve accessibility
 - Extra lanes for motorways
 - Increase frequency of PT
 - More usage of rush-hour lanes
- Standards for travel time





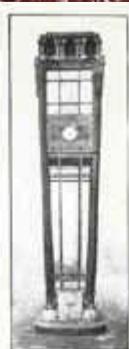
Traffic management long ago



[Eerste stoplicht by Eindhoven in beeld](#)



Original Wooden
Tower (1919)



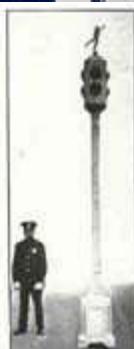
Fifth Avenue
Street Scene (1922)



Original Utrecht
Signal (1924)



Present Utrecht
Signal (1925)



Proposed Fifth Avenue
Signal Unit (1929)

[Traffic lights from 1919-1929](#) by lakelandgov





Traffic management 21st

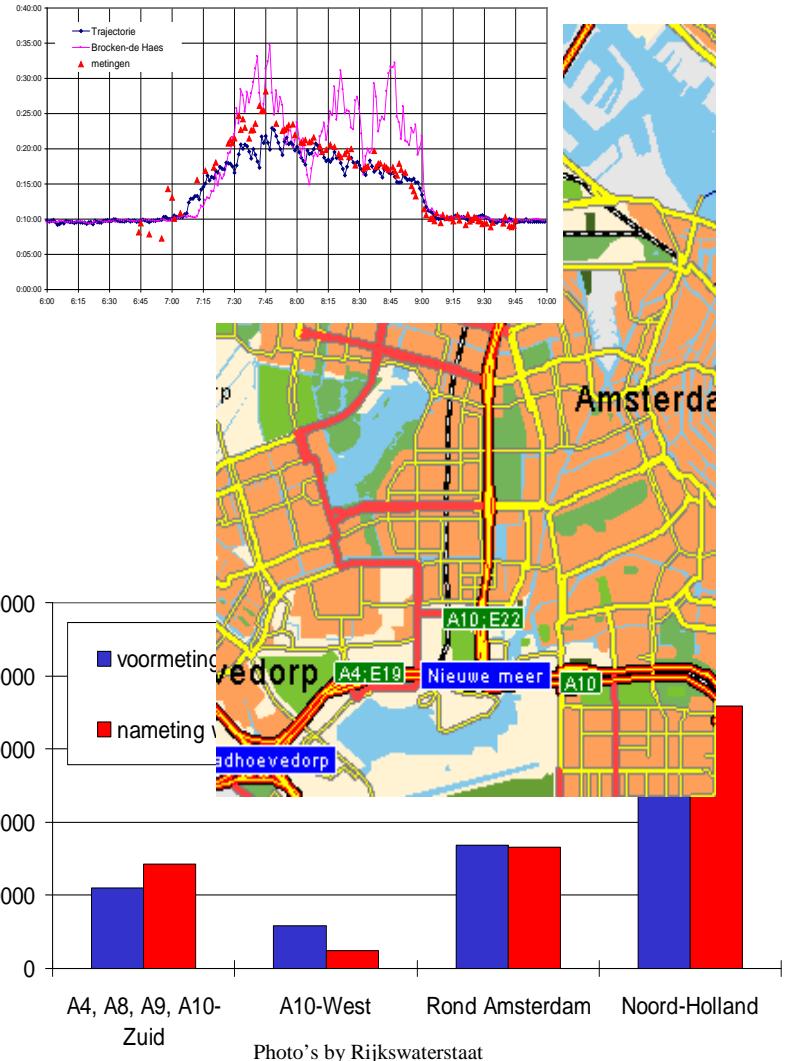


Photo's by Rijkswaterstaat



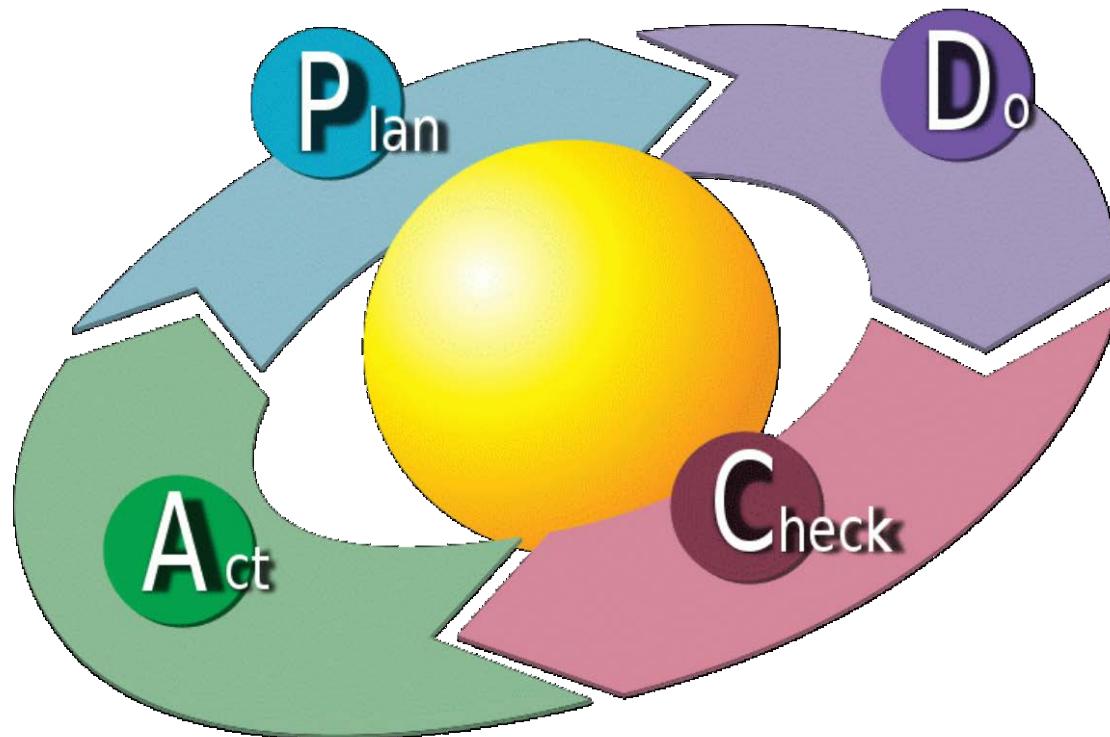
Contents presentation

- Dutch traffic and transport policy
- Evaluation
- Simulation
- Guidelines
- Case study pilot traffic management Amsterdam
- Summary



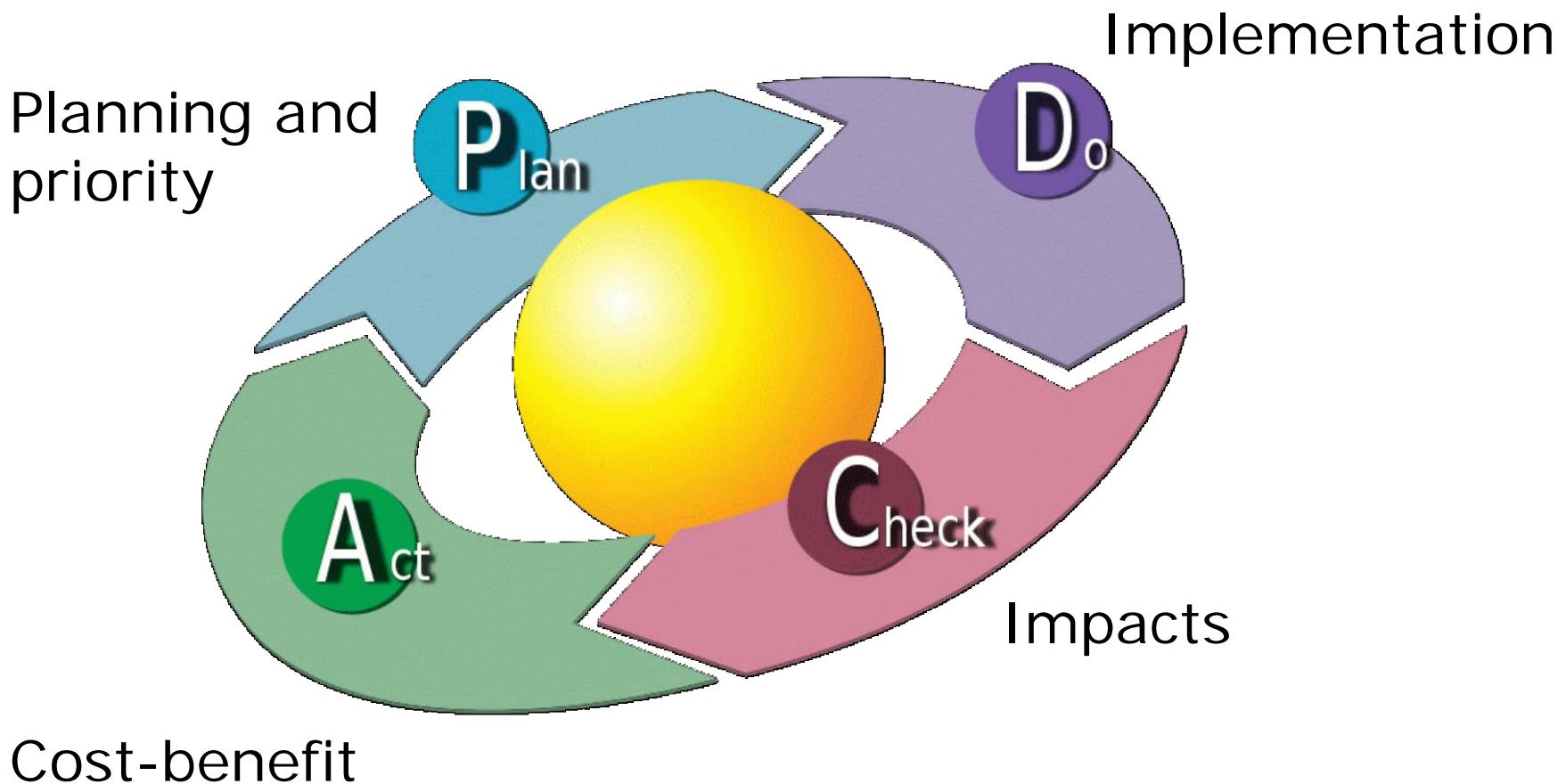


Policy evaluation



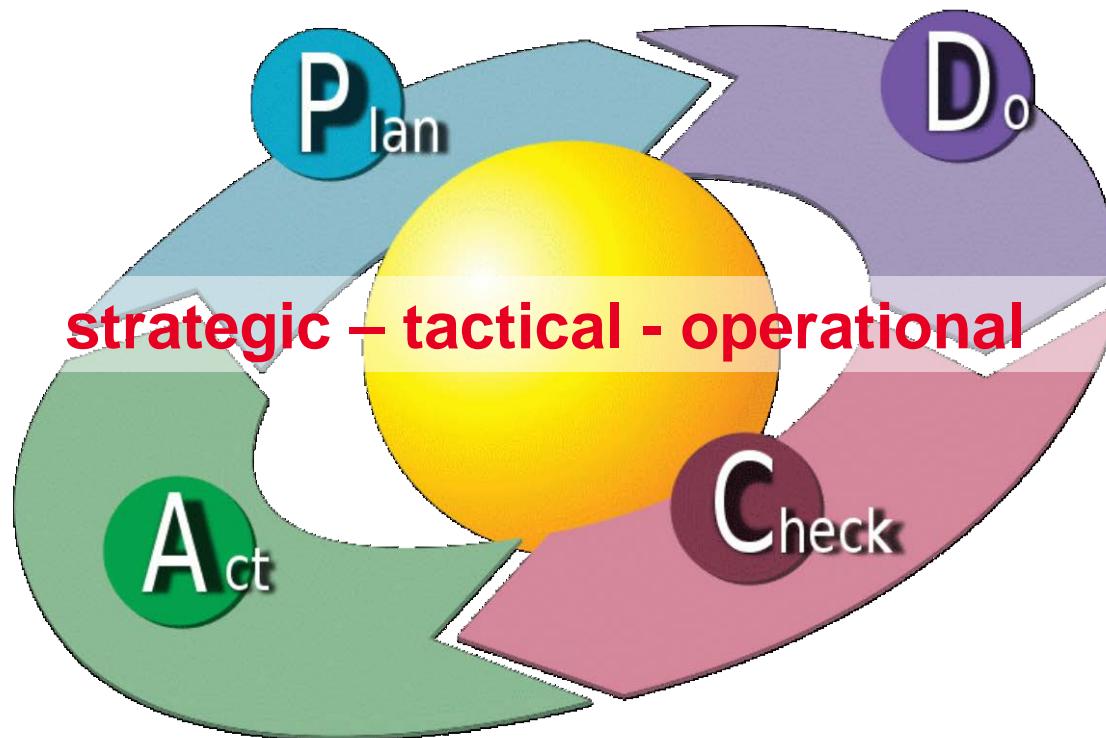


Policy evaluation





Evaluation levels





Evaluation types (1)

- Monitoring: trends in time
- Evaluation: analysis of data to determine effects
- Ex-ante (feasibility study, model study)
- Ex-post (measurements, surveys, etc.)
- Technical analysis (system performance)
- Impact analysis (traffic, safety, environment)
- Socio-economic evaluation (effectiveness, costs)
- Analysis of legal and institutional aspects
- Analysis of behaviour and public acceptance



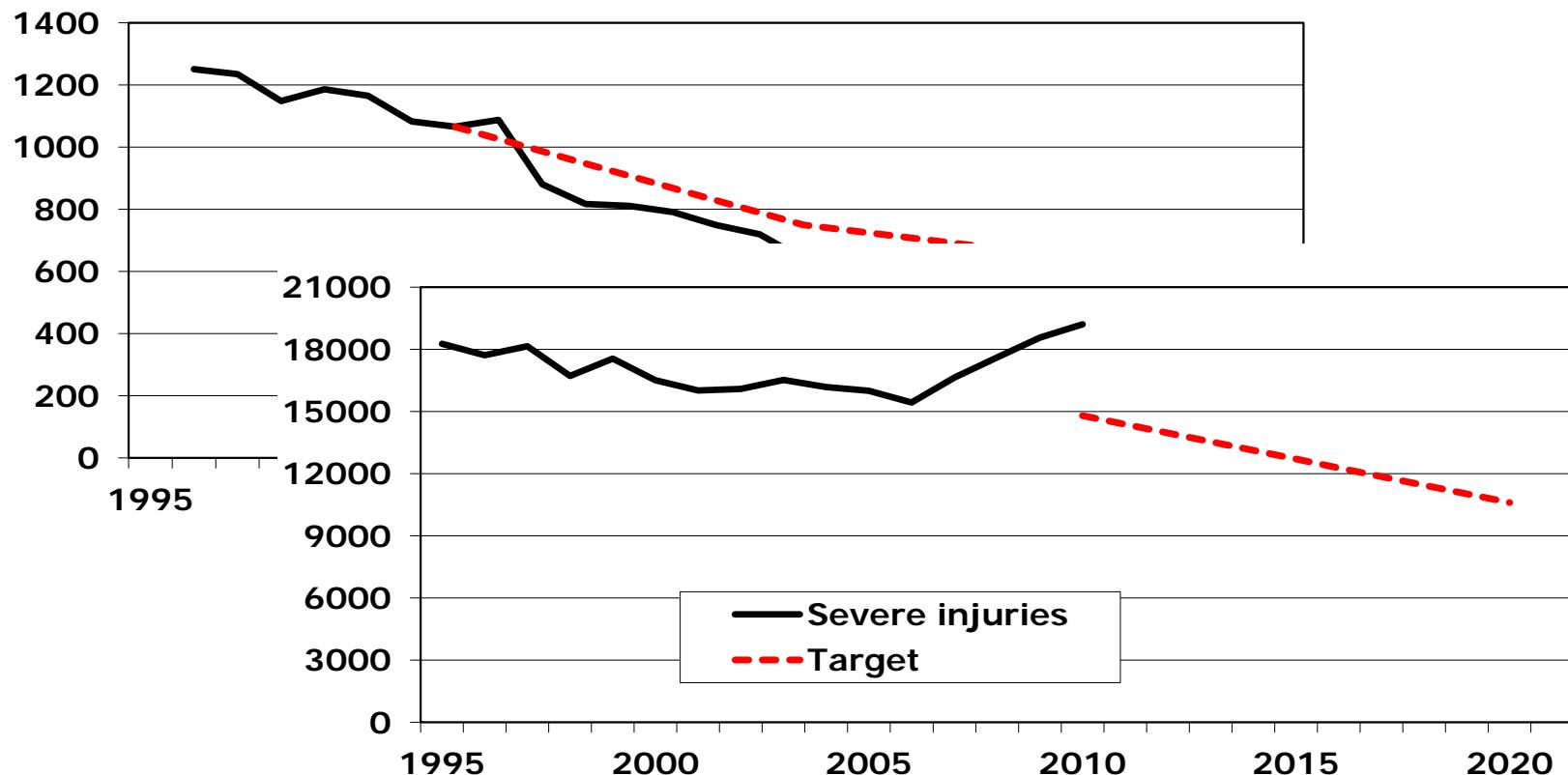
Evaluation types (2)

- Expert judgement
- Literature scan
- Monitoring with trend analysis
- Simulation study
- Quick scan analysis
- Impact analysis
- Cost-benefit analysis

- Local measures
- Set of measures
- Network traffic management
- Program evaluation
- General overview



Monitoring trends

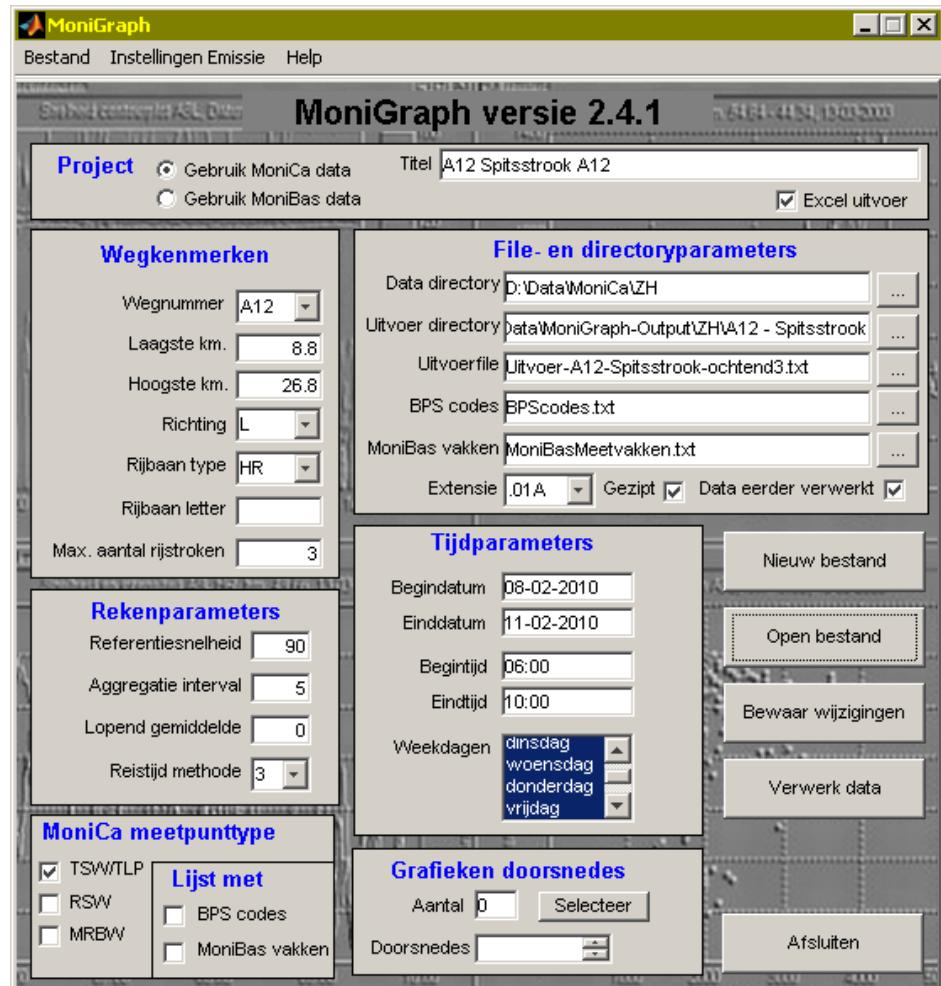


Source: SWOV



Quick scan evaluations

- A lot of extensive evaluations available
- Extensive evaluations need a lot of data and take a lot of time to do
- Need for quick evaluations to know the effects of pilot measures
- Since 2004 monitoring data available for large part of motorway network
- MoniGraph is a tool to process data and generate traffic indicators

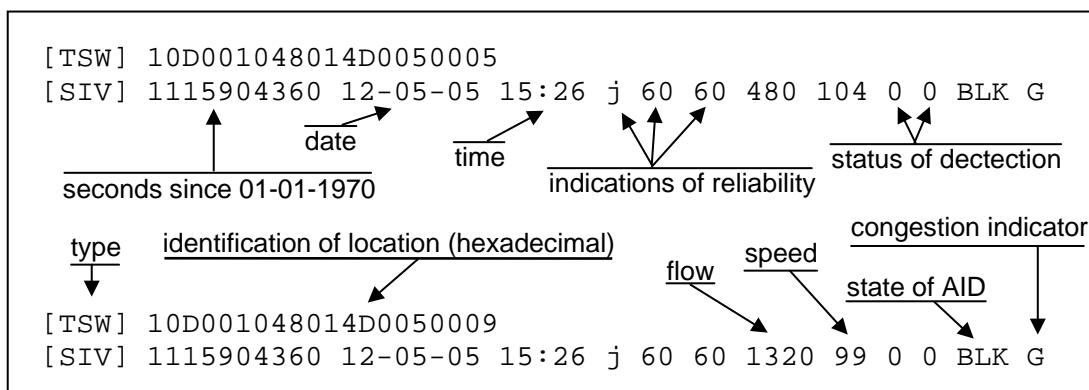
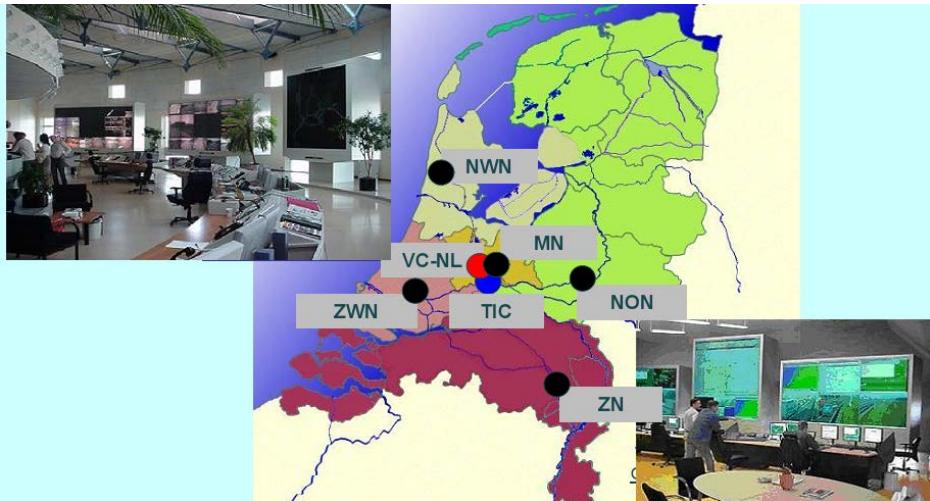
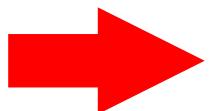




Monitoring data

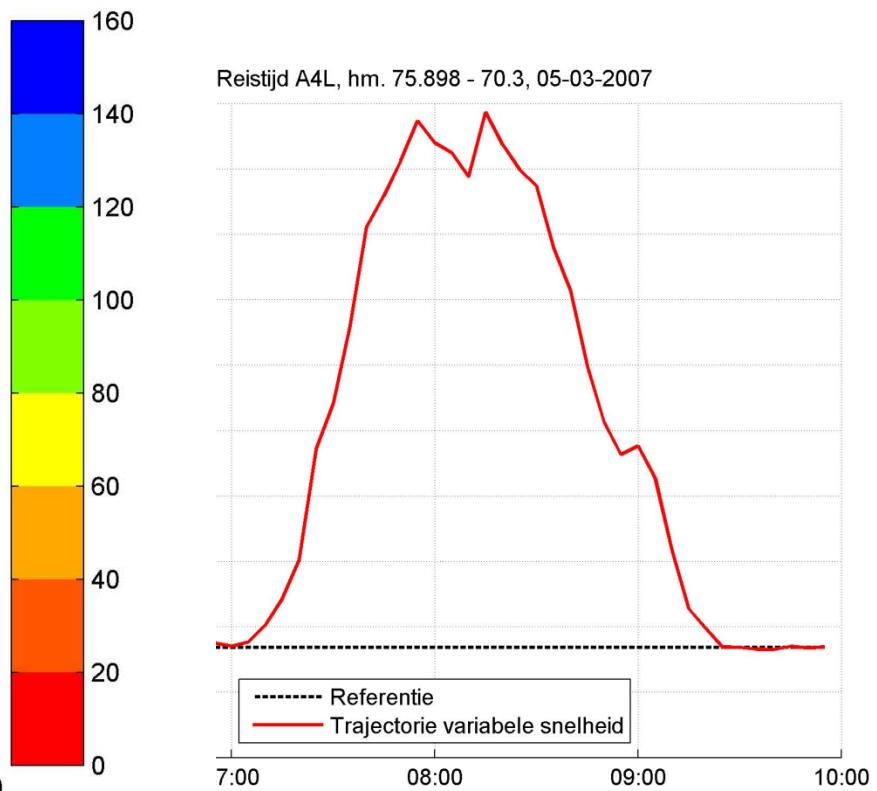
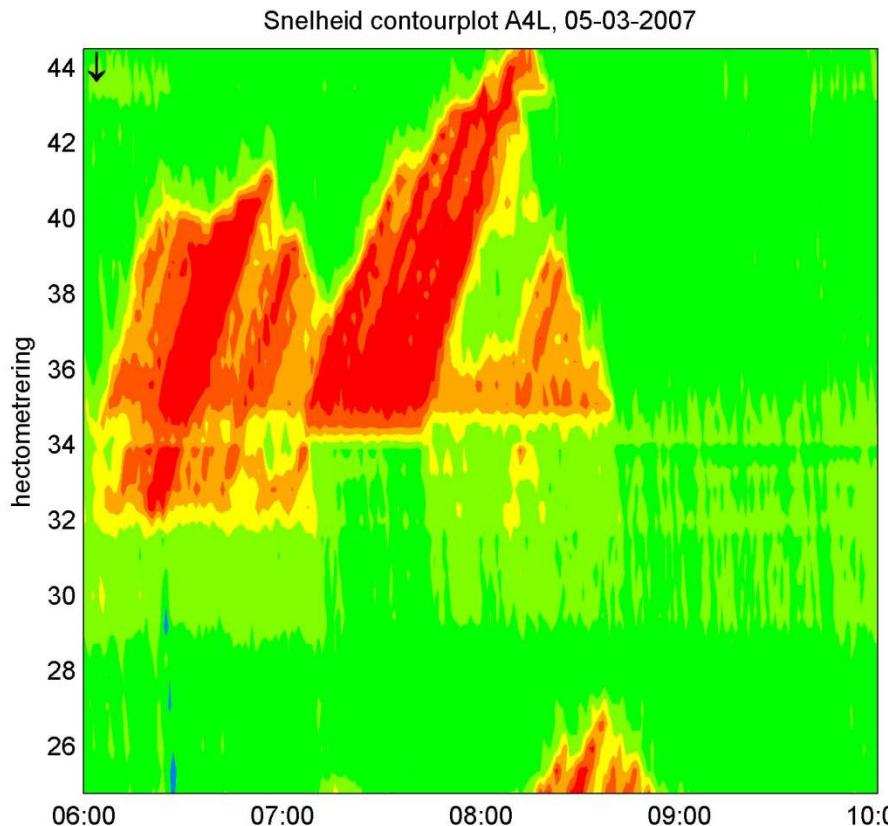


Photo's by Rijkswaterstaat





Speed contour and travel time plot





Rush hour lanes A12

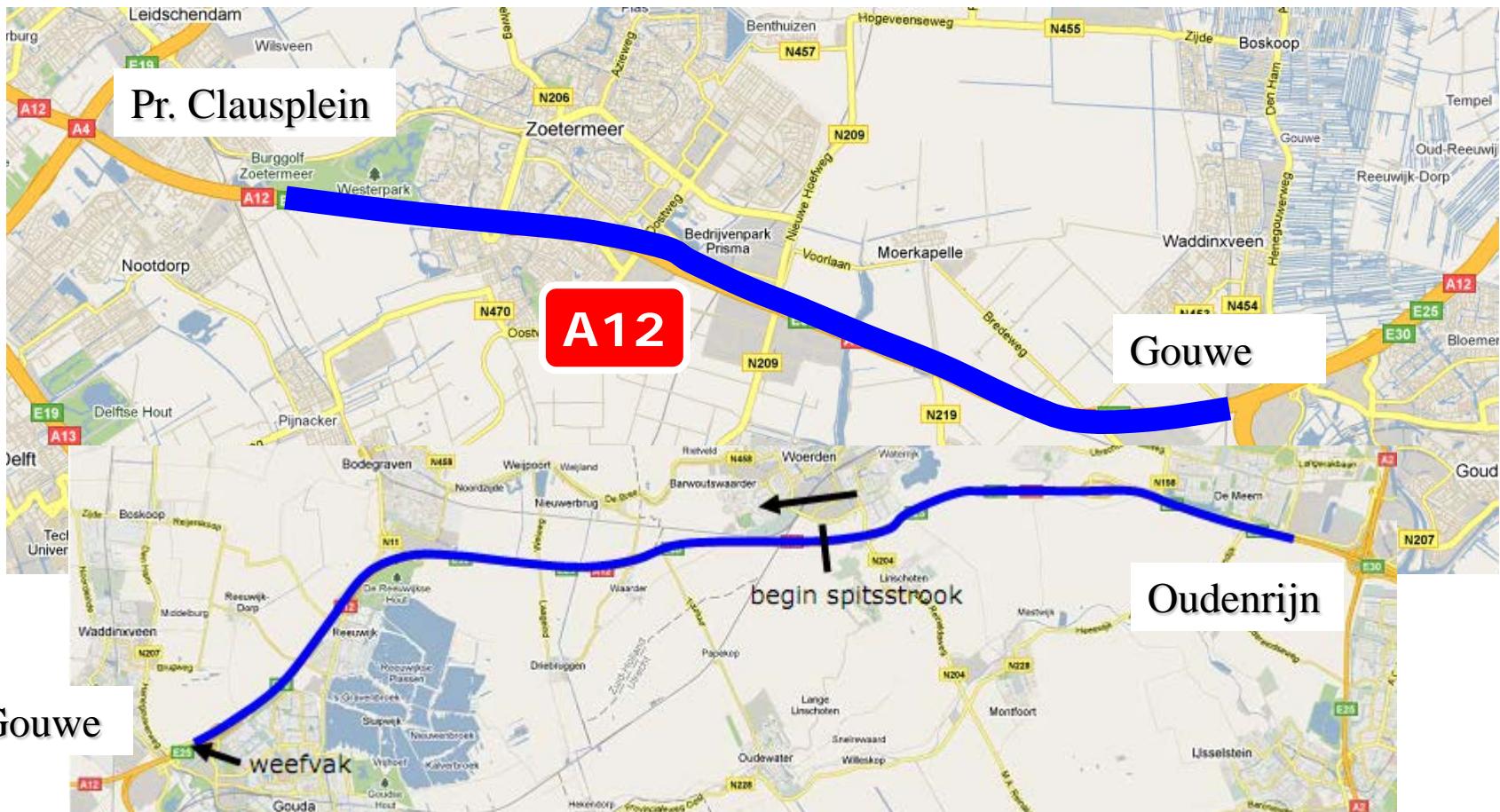
- Motorway A12 between junction Gouwe and Zoetermeer
- Operational since January 2010
- Use hard shoulder lane as extra lane in the morning and evening peak
- A12 between Woerden and Gouwe
- Bottleneck 4 -> 3 lanes
- Operational since 03-12-2010



[Plusstrook](#) by wikipedia / CC BY SA

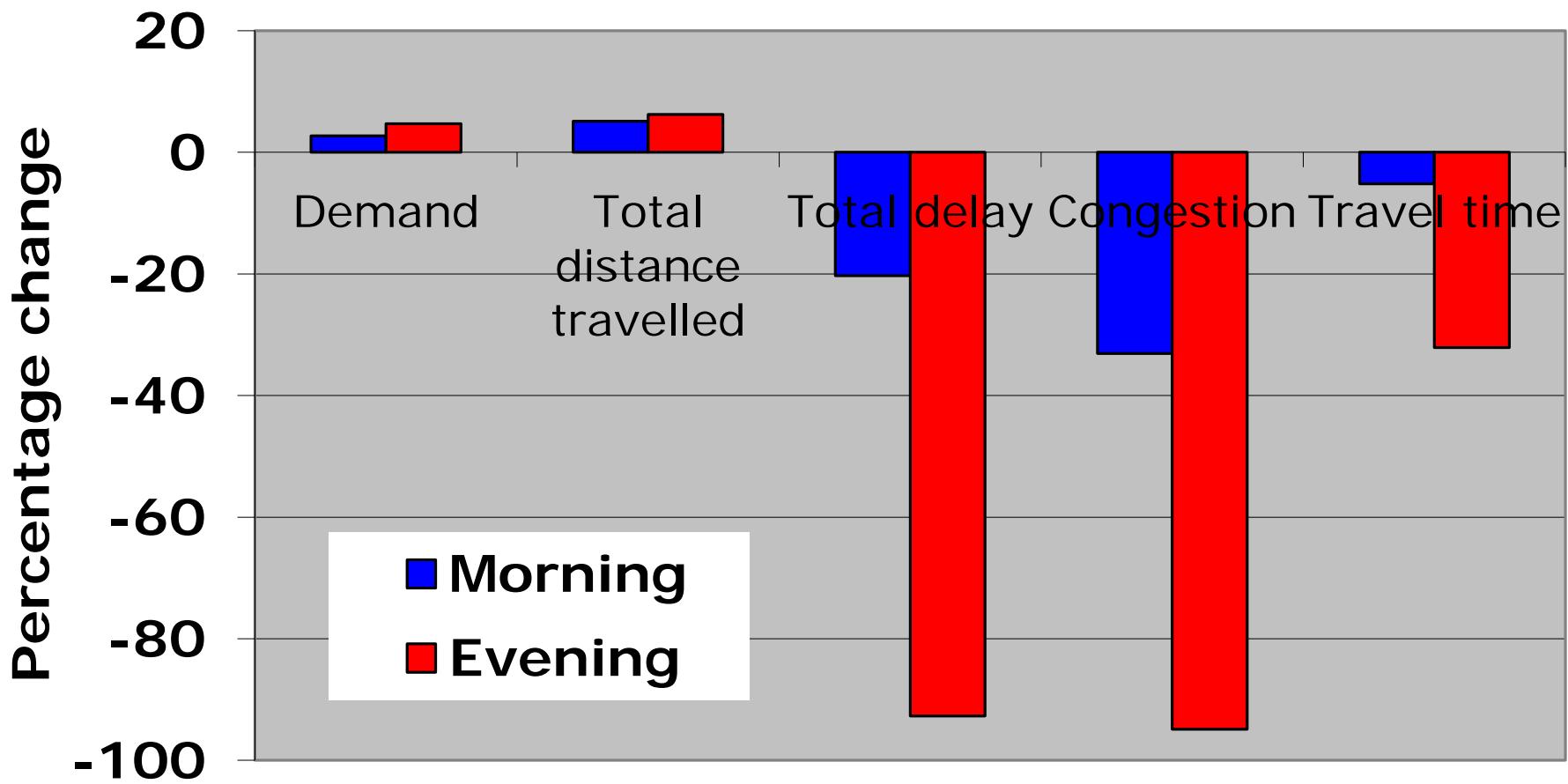


Rush hour lanes A12



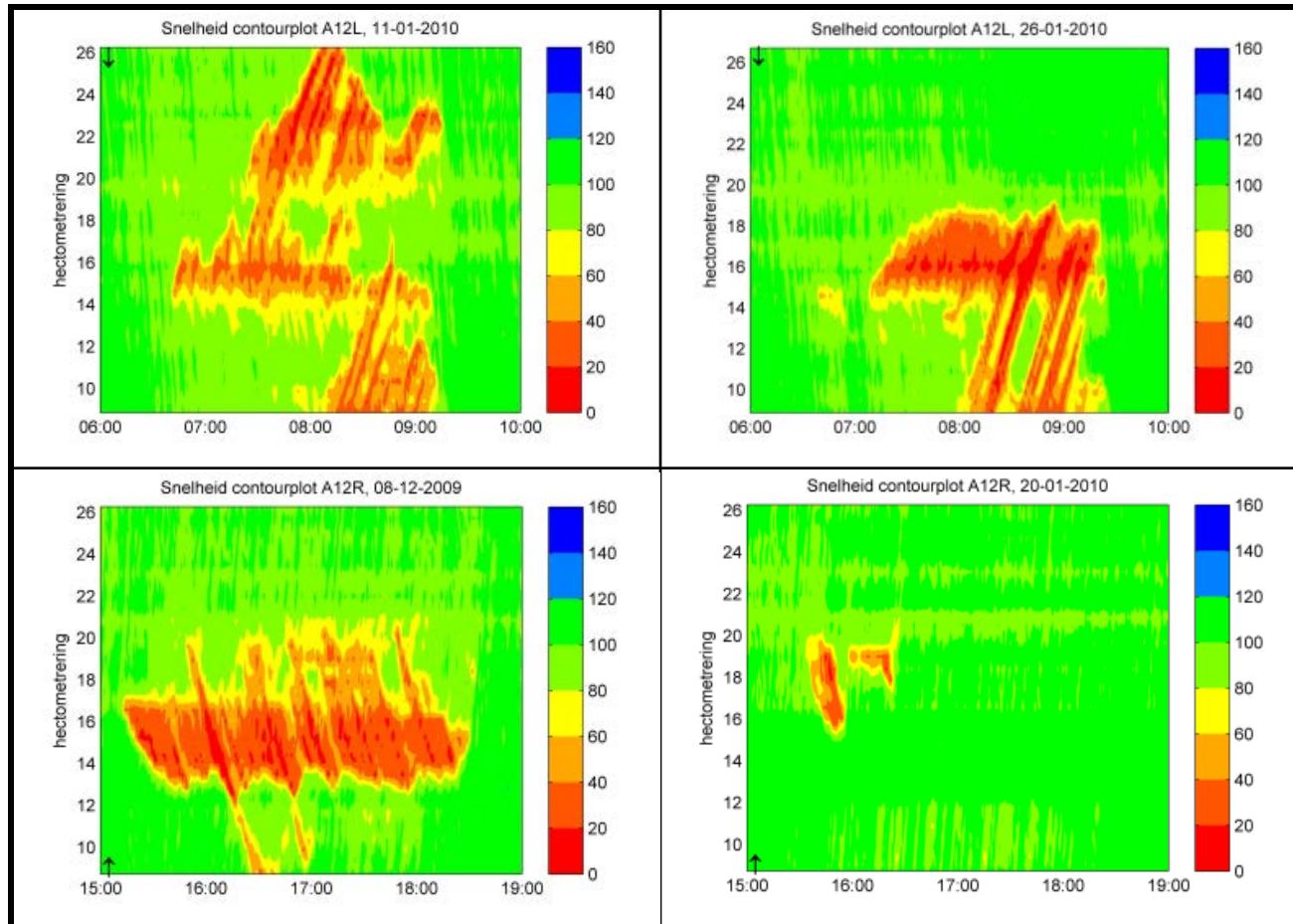


Results rush hour lane A12 Gouda-The Hague



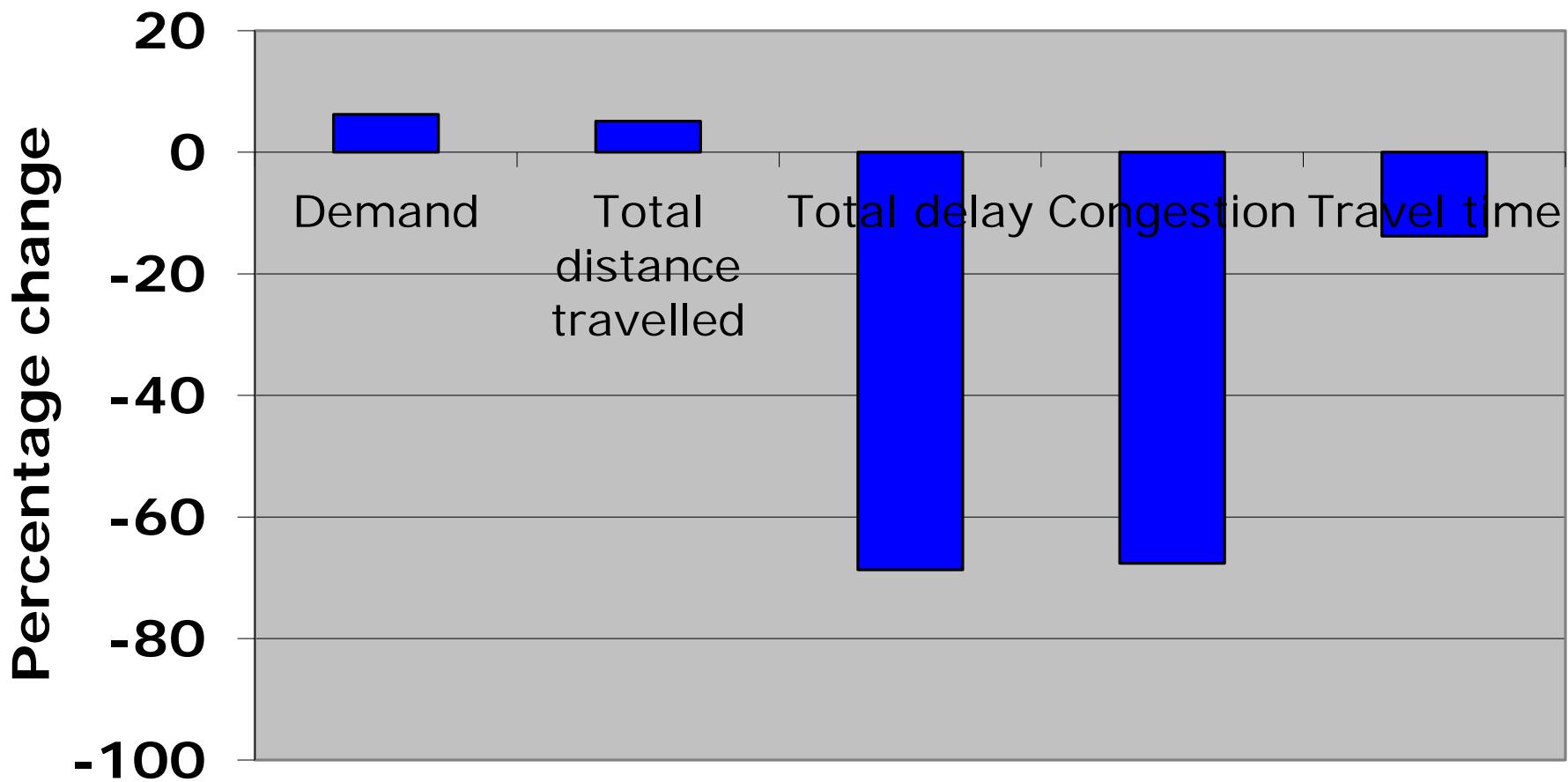


Speed contour plots A12 Gouda-The Hague



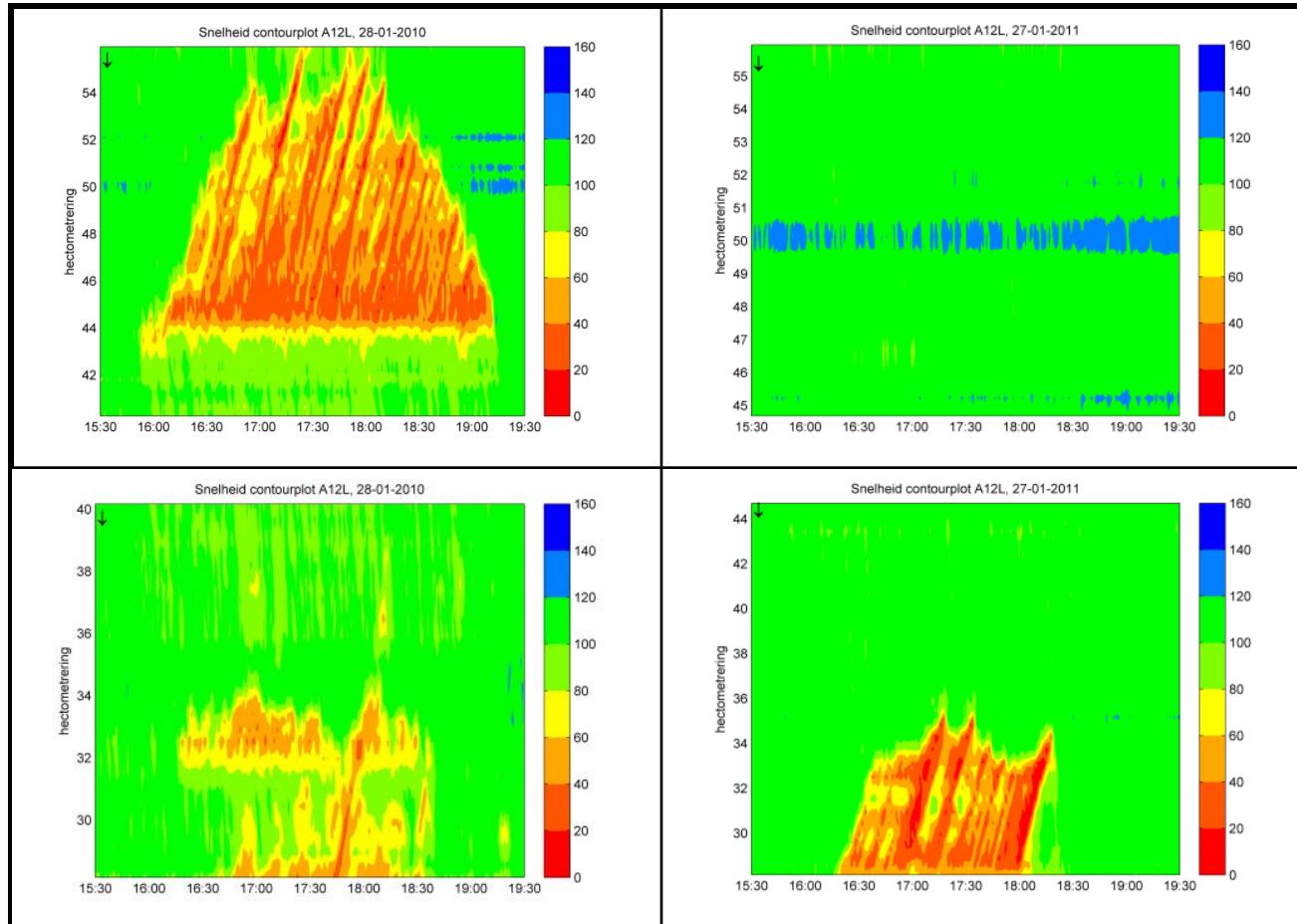


Results rush hour lane A12 Woerden-Gouda





Speed contour plots A12 – Woerden-Gouda



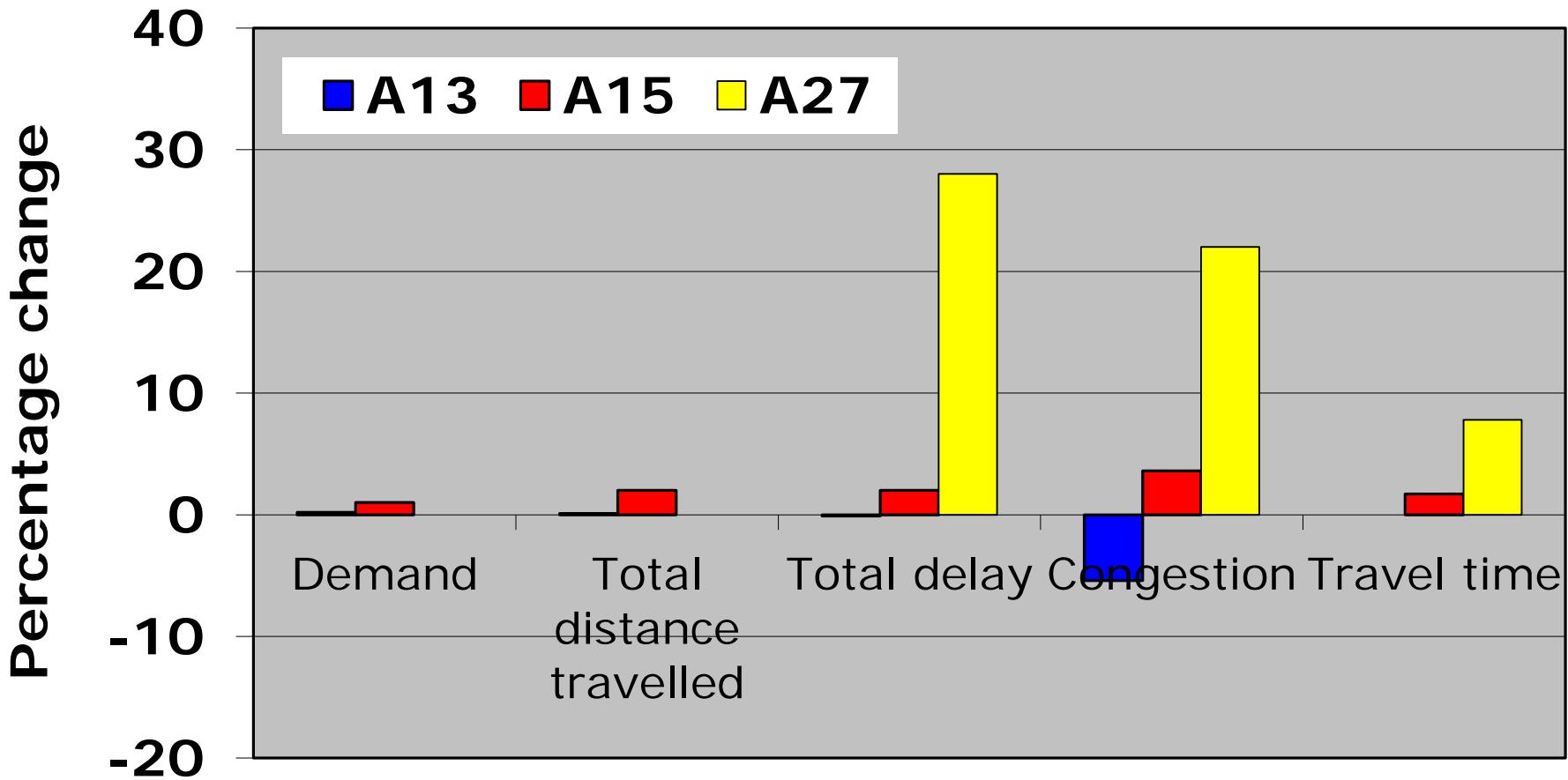


Traffic management scenarios A13, A15 and A27





Results TM scenarios





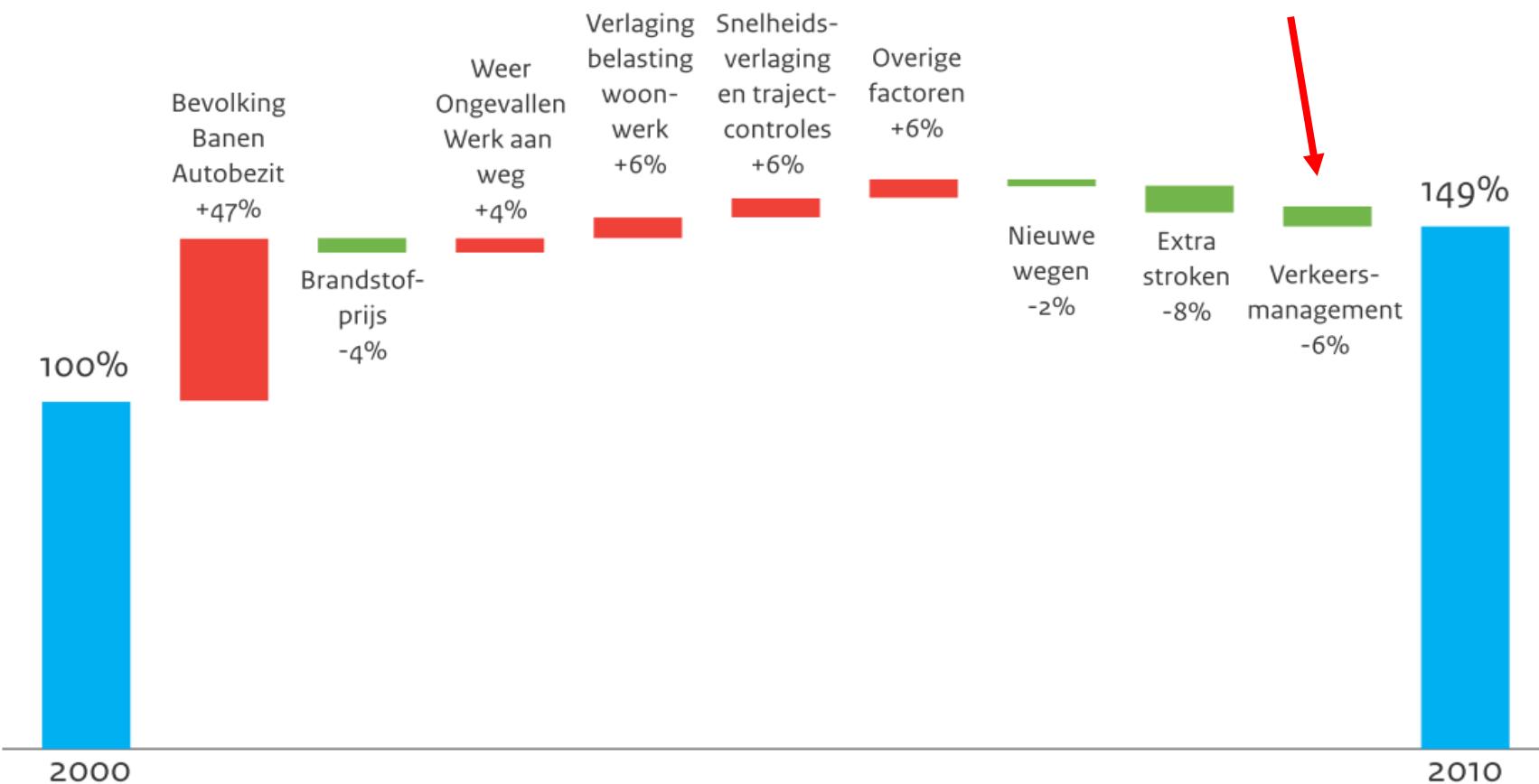
Policy evaluation

- Accountability
 - Goals: do we reach the goals set?
 - Efficiency: if the goals are met, what is the contribution of policy?
 - Effectiveness: what are the benefits and costs?
- Learning (act phase)
 - What are the effects and under what conditions are these effects valid?
 - Is it possible to deduce rules of thumb?



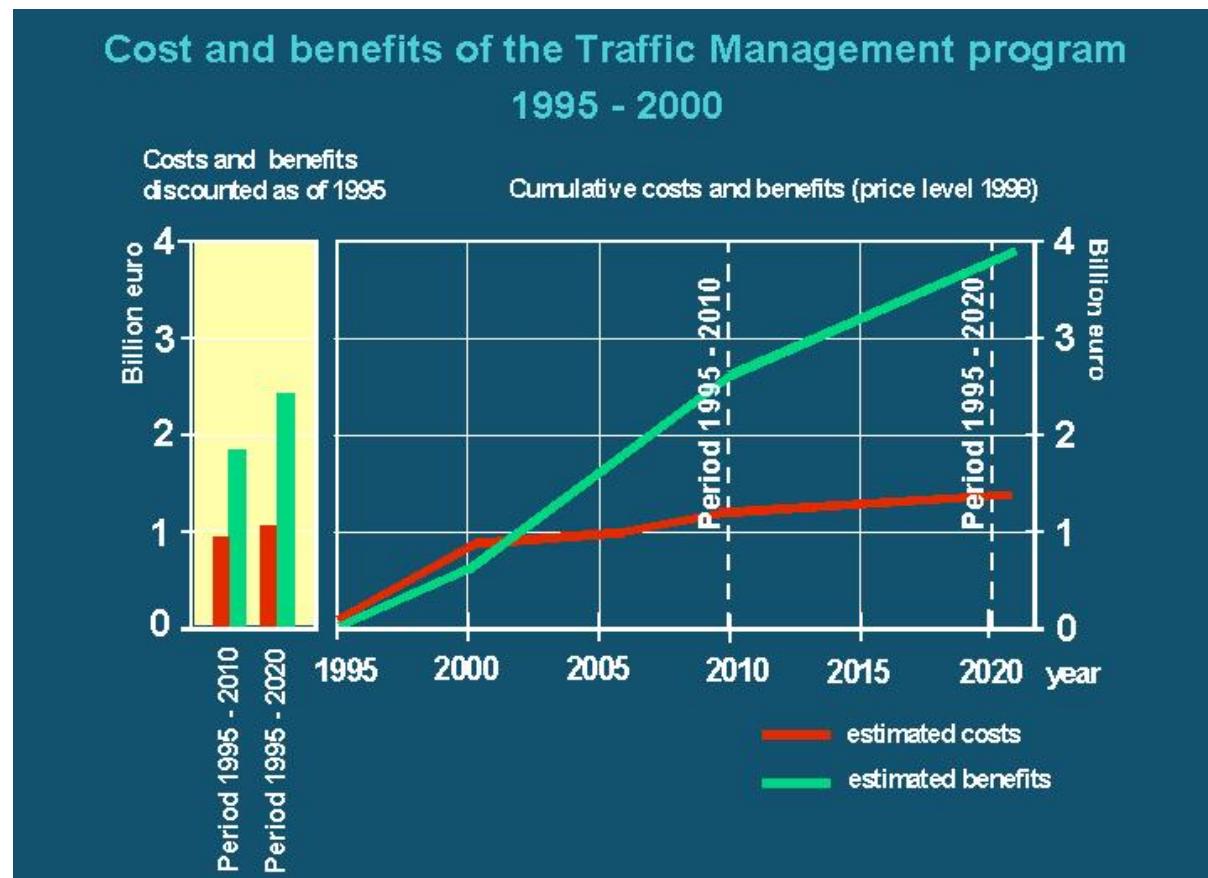
Explanation increase congestion

Traffic management





Investment and effects of ITS



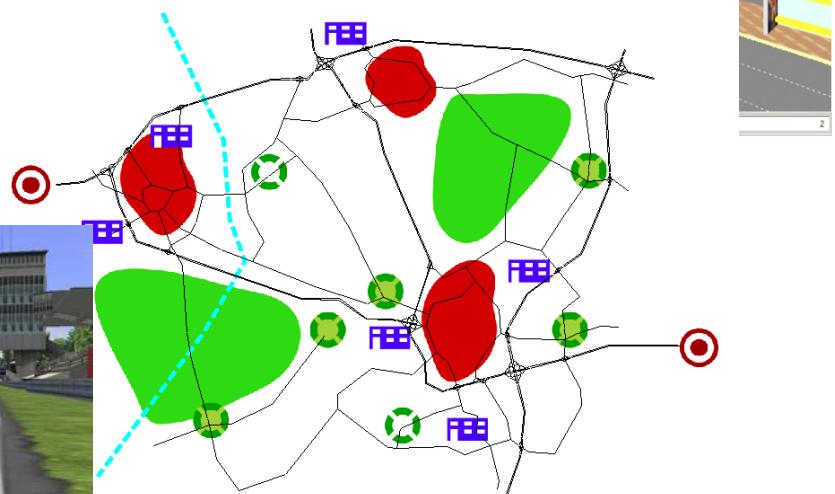


Contents presentation

- Dutch traffic and transport policy
- Evaluation
- Simulation
- Guidelines
- Case study pilot traffic management Amsterdam
- Summary



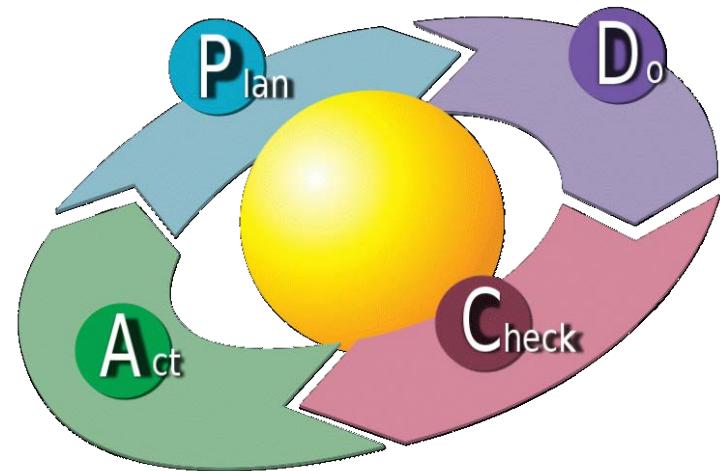
[Photo by 9lives](#)





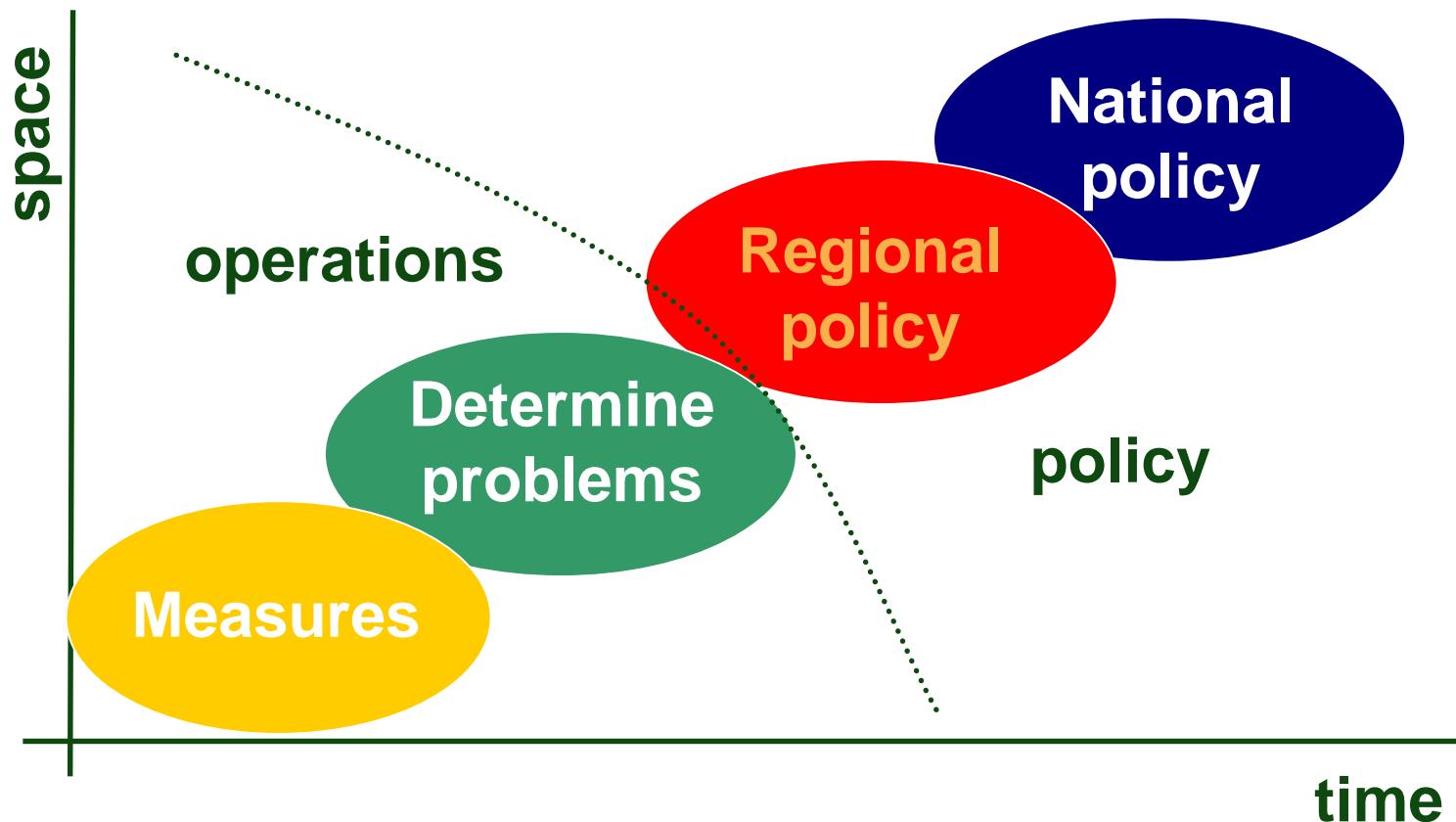
Relation evaluation and models

- Models used in feasibility studies
- On all levels of the PDCA cycle
- To decide whether or not to implement measures
- Cheaper than real-life pilots
- No impact on drivers and safety
- Easy to study alternatives



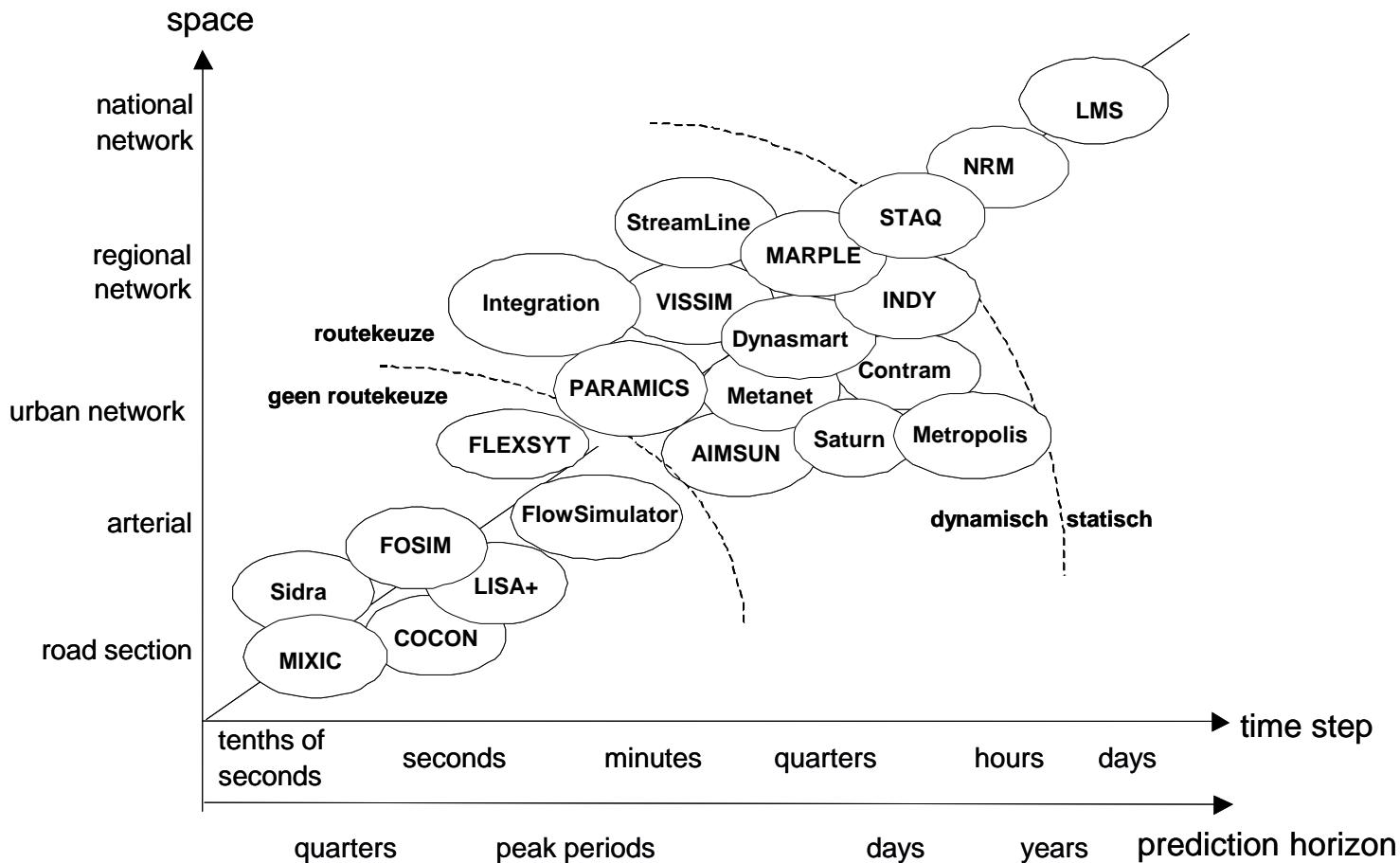


Scale levels





Overview models





Dynamic models

- Developed since the sixties
- In the first place for optimisation of traffic control plans
- Webster: microscopic simulation to determine delay formulas in 1958
- Take the time component into account
- Divided into:
 - Macroscopic (traffic as a flow)
 - Microscopic (individual vehicles)
 - Mesoscopic (hybrid form)



Models used in The Netherlands

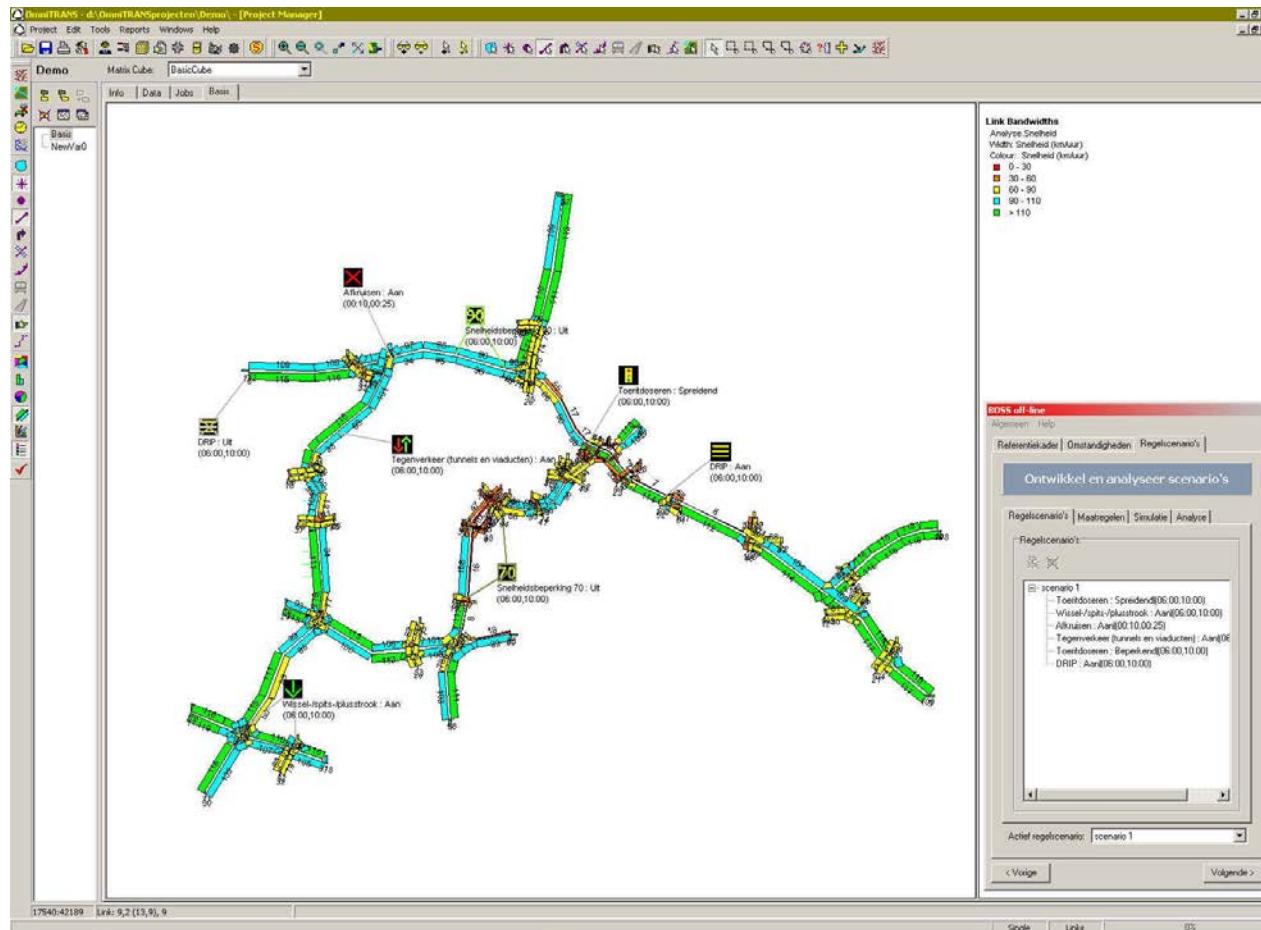
- Macroscopic
 - FASTLANE
 - INDY
 - MaDAM (StreamLine)
 - MARPLE (RBV)
- Mesoscopic
 - DYNASMART
 - FLEXSYT-II-
 - METROPOLIS
- Microscopic
 - AIMSUN
 - FOSIM
 - Paramics
 - VISSIM



[Photo](#) by 9lives



FASTLANE



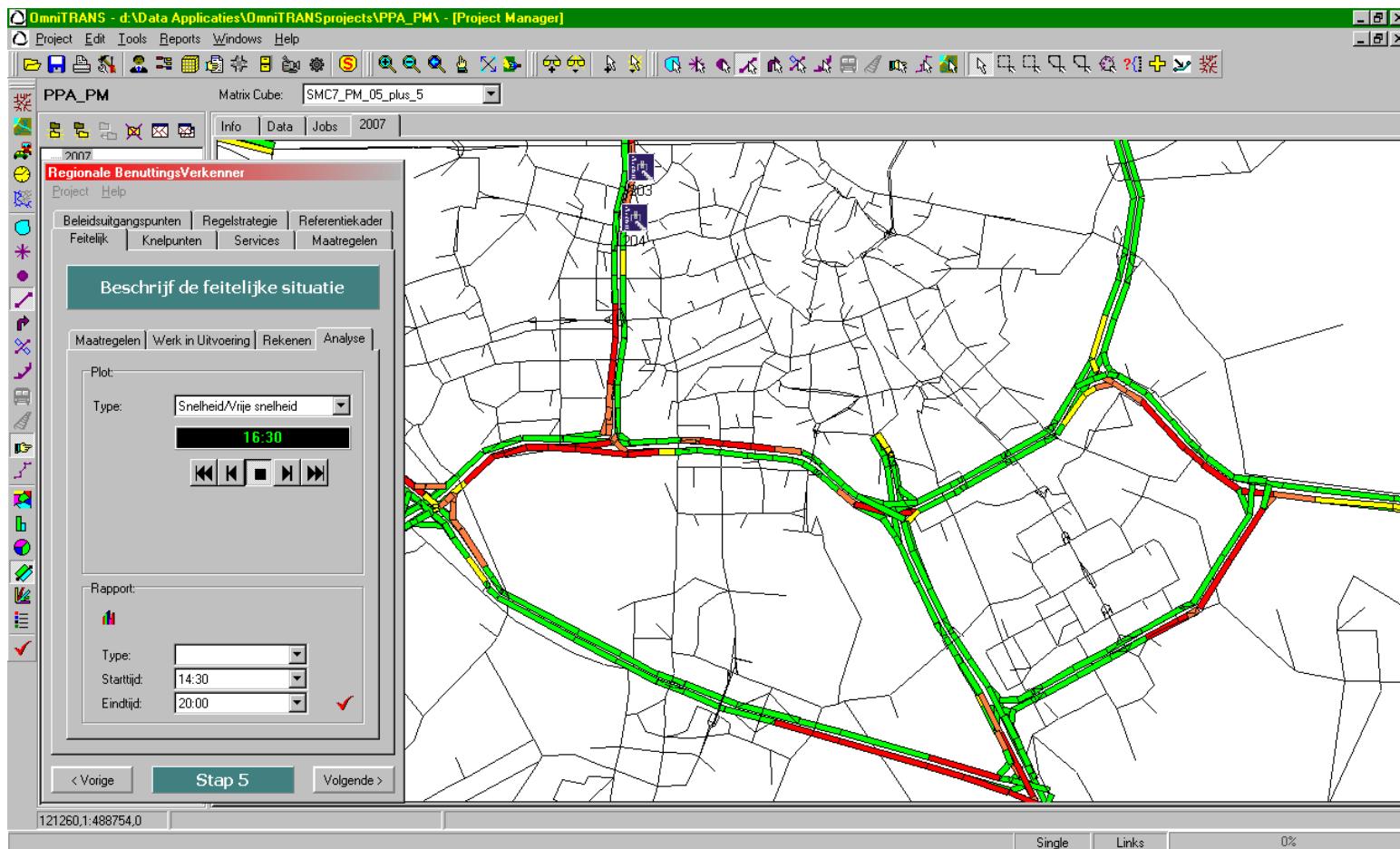


INDY



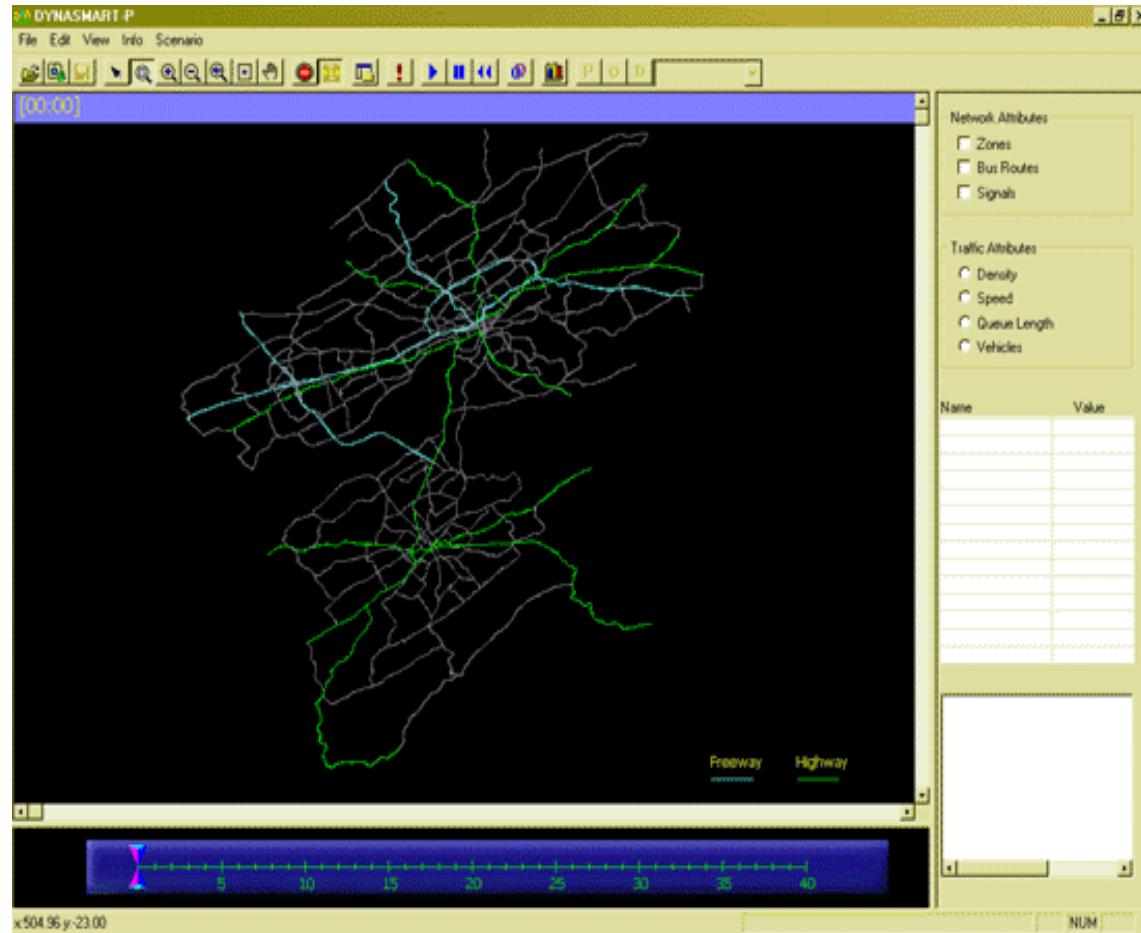


MARPLE (RBV)



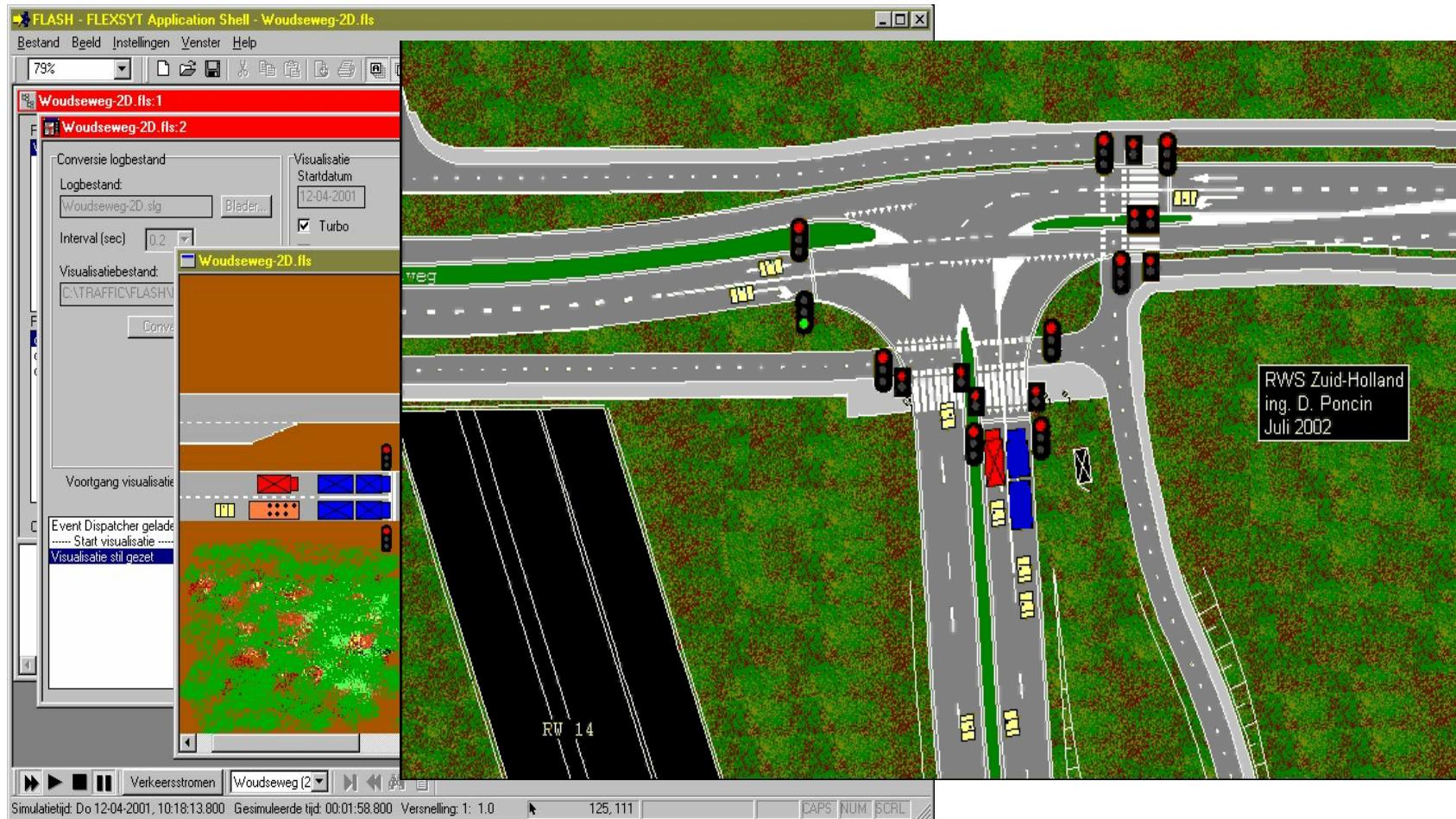


DYNASMART

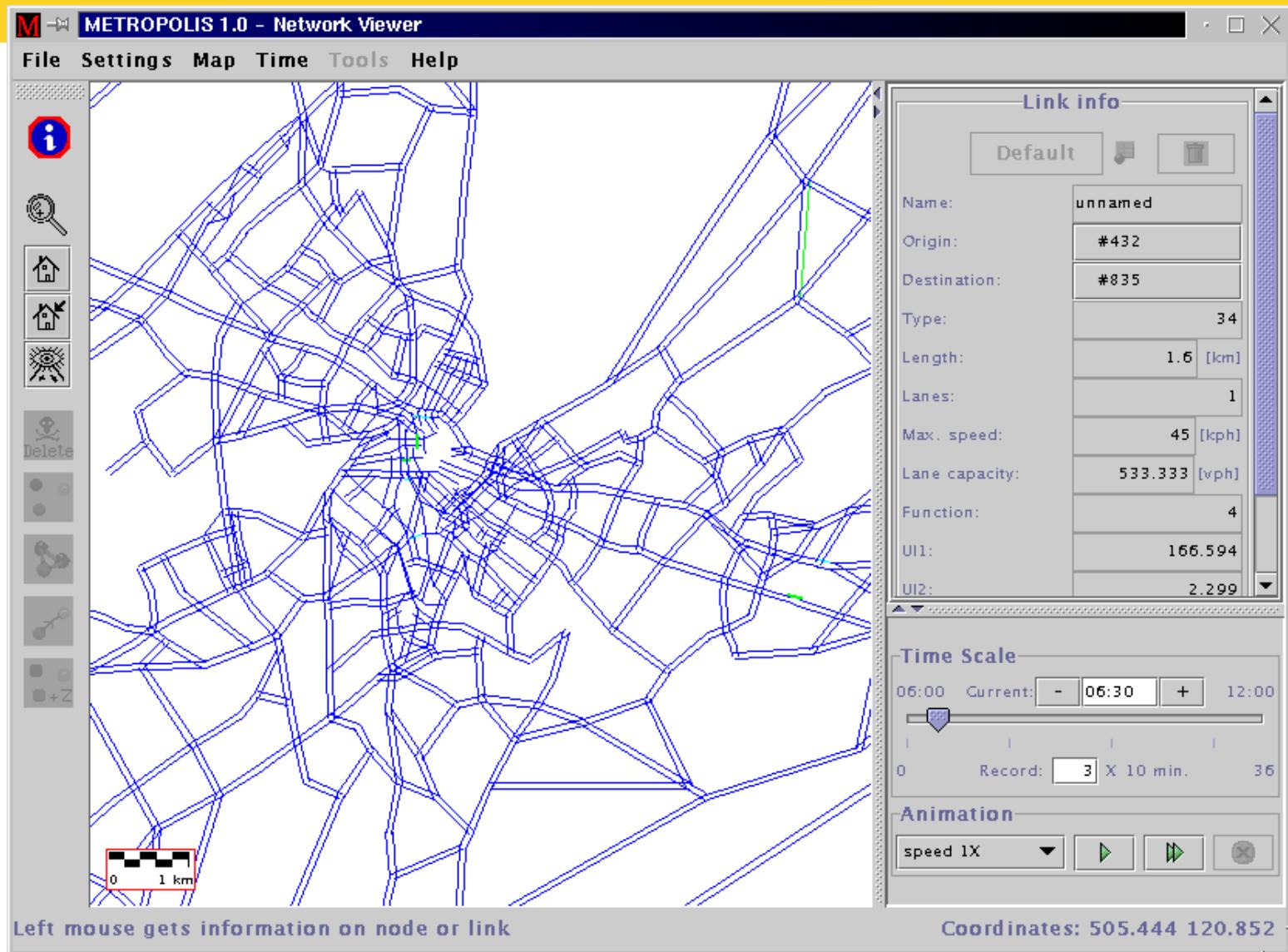




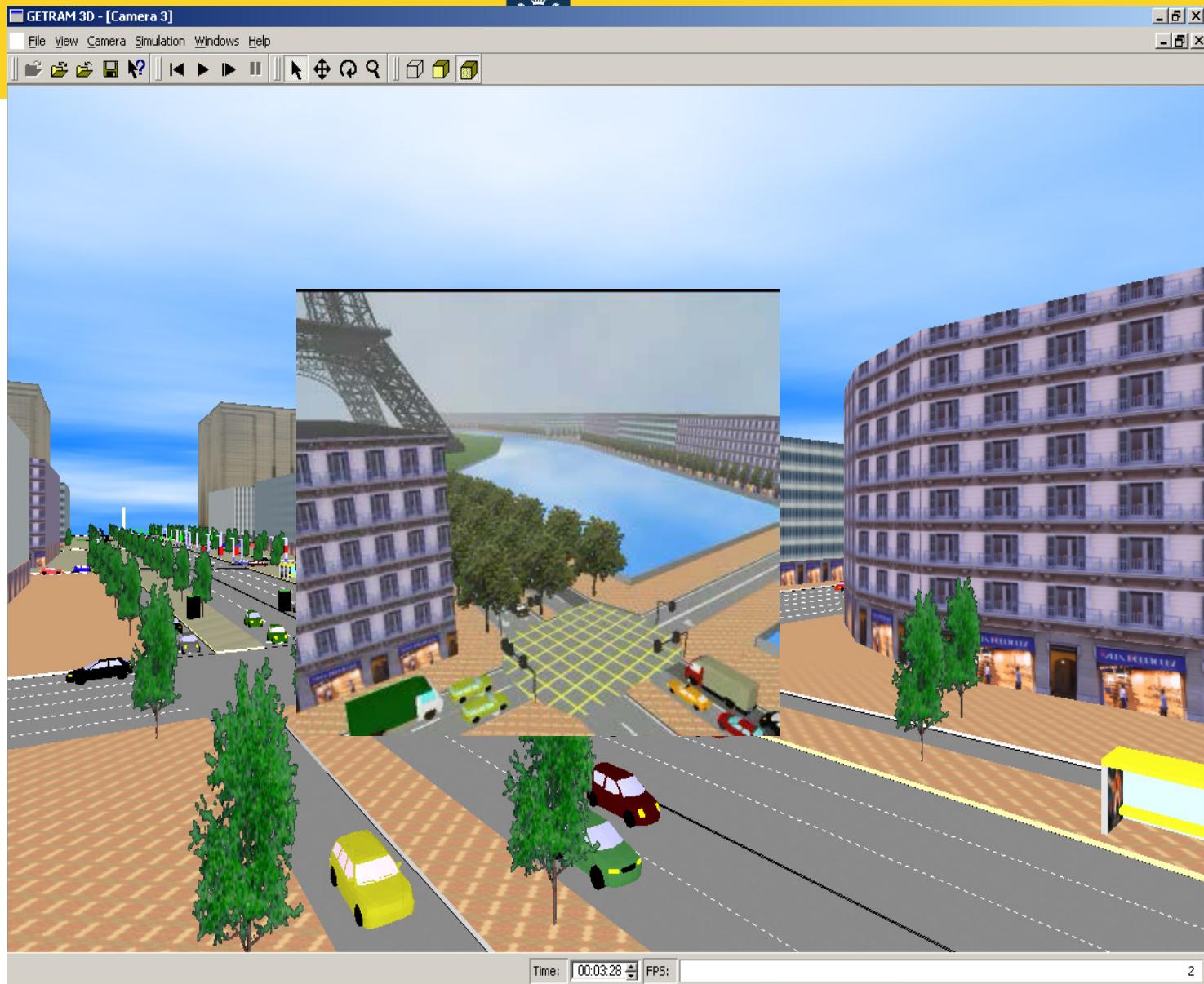
FLEXSYT-II-



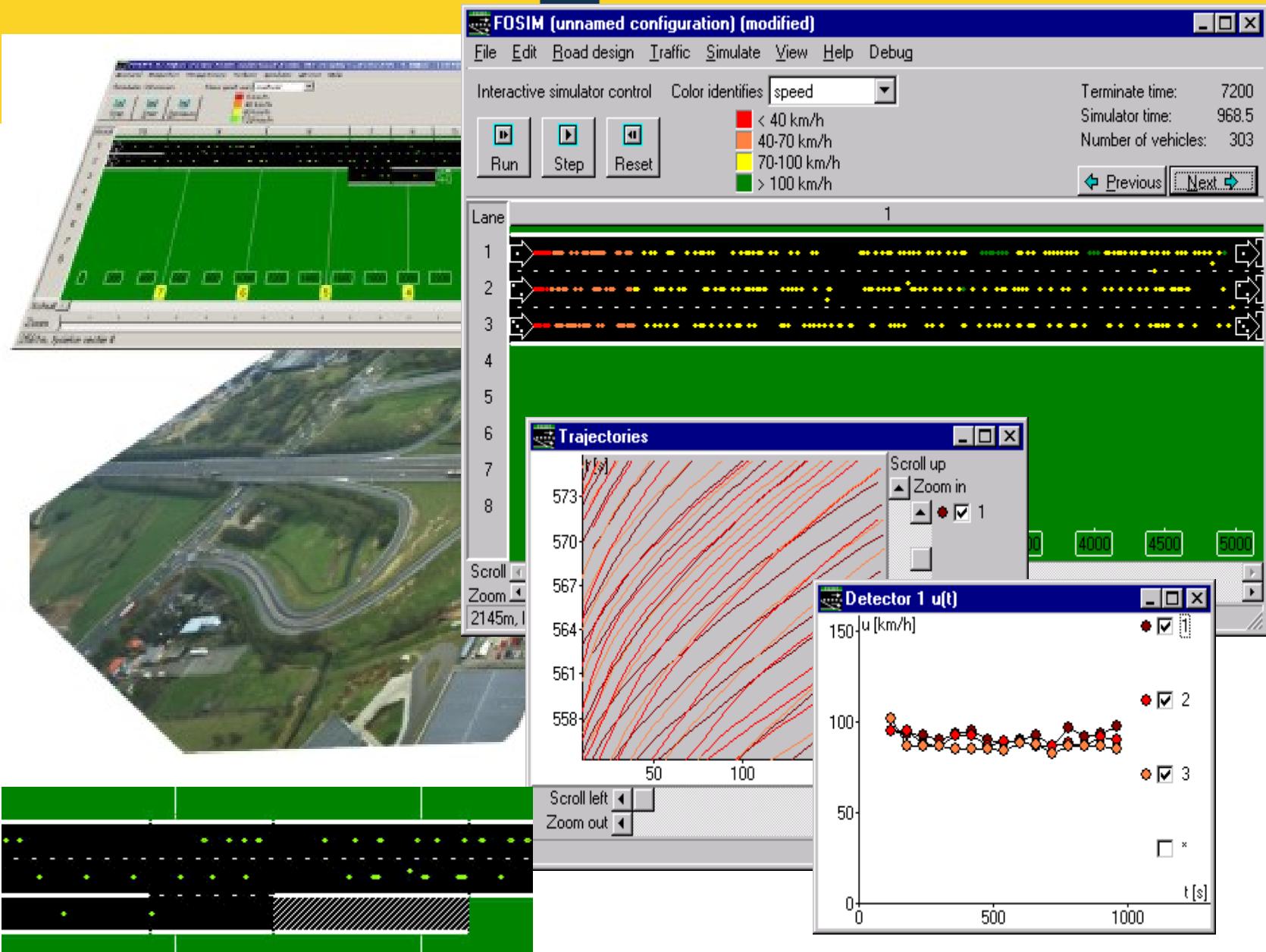
METROPOLIS



AIMSUN



FOSIM





Paramics





VISSIM





Advantages and Disadvantages

- Advantages
 - Realistic modelling of the traffic
 - Gives good knowledge of effects of measures
 - Visualisation and presentation
- Disadvantages
 - Need a lot of detailed input data
 - Calibration is difficult
 - Computer run time is (still) long for larger networks
 - Danger of focus on graphics!



Applications

- Effects of traffic management measures
- Effects of changes in the infrastructure
- Road works
- Testing of systems
- Training of operators
- Decision Support Systems
- Optimisation of traffic control plans
- Part of evaluations studies



Contents presentation

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- Evaluation
- Simulation
- Guidelines
- Case study pilot traffic management
Amsterdam
- Summary





Problems with Evaluations (1)

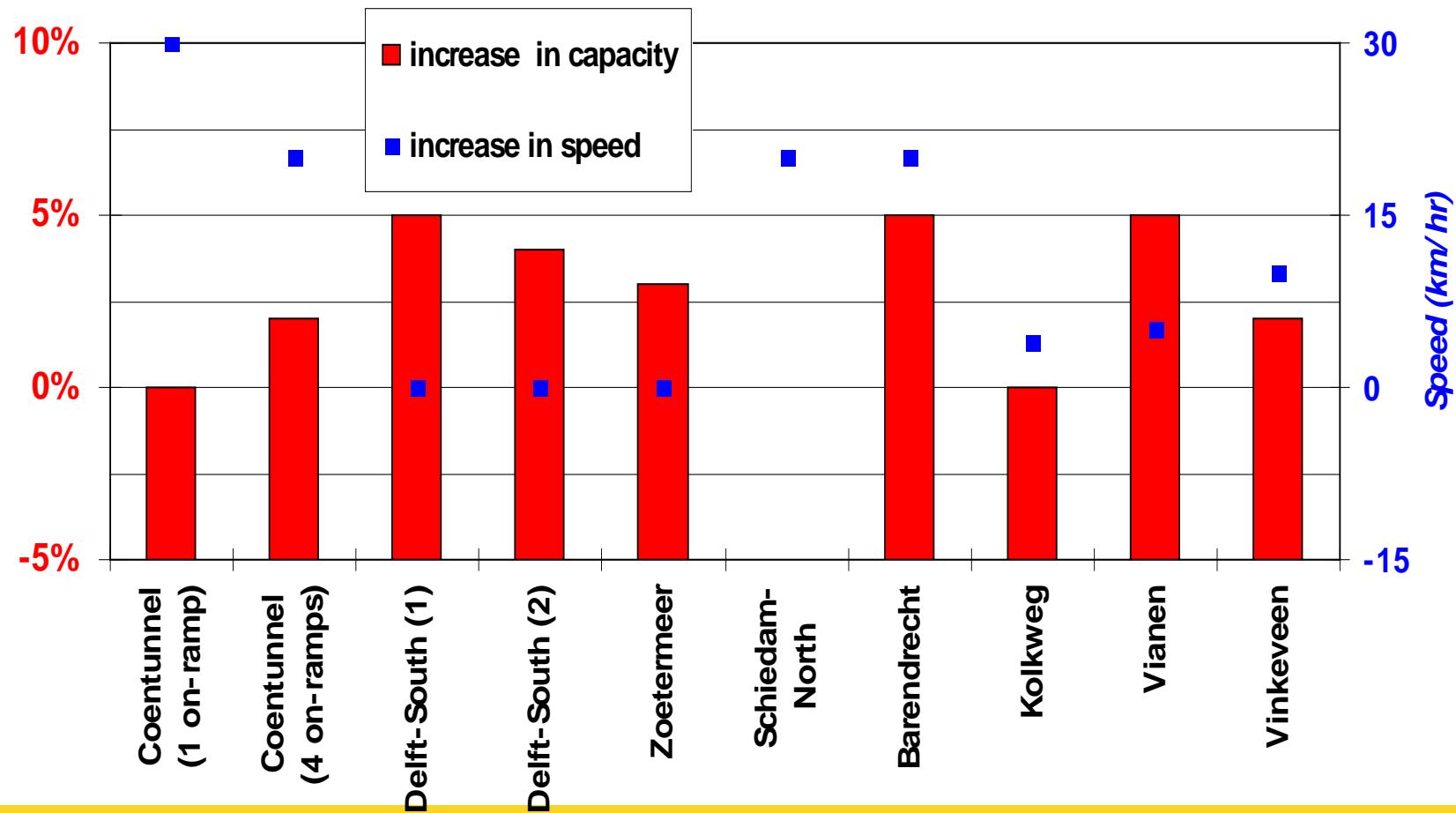
- About 150 evaluations studies
- Non-uniform approach evaluation studies
 - Different for every measure
 - Different by every consultant
 - Different measure and statistical methods
 - Difficult to compare evaluations
- Local effects (not much research on network wide traffic management)
- Effects on safety and sustainability unknown
- No much information about driver behaviour
- Difficult to determine costs and benefits

Case ramp metering





Effects of ramp metering





Overview important effects

	Measure	Effect on traffic	Effect capacity
1	Motorway Traffic Management System	Flow improvements 0%- 5%	0% to 5%
2	Speed Measures (80 km/hr zones)	Congestion varies from -40% to +53%	-9% to +4%
3	Ramp Metering	Speed on the motorway increases: +4 to +30 km/h	0% to +5%
4	Overtaking prohibition trucks	Different per location	-4% to +4%
5	Peak lanes (using hard shoulder)	Decrease travel times from 1 to 3 minutes Extra traffic from 0% to +7%, delay -42% on average	+7% to +22%
6	Bus lanes, truck lanes, tidal flow lanes	Travel time busses/trucks –14 minutes Travel time other traffic from –5 to +2 minutes	
7	Measures for Road Works	Less demand, sometimes to –11% Less traffic on the section with road works: to –38%	
8	Traffic Signal Control	Change in travel times from –33% to +10%	
9	Other measures	Congestion from –28% to +45%	
10	Incident Management (camera's)	Congestion –7% (Utrecht)	
11	Dynamic Route Information Panels (VMS)	Congestion from –7% to –30%	
12	Radio Traffic Information	Route changes, more change if travellers are informed individually	



Problems with Evaluations (2)

- Lot of knowledge on traffic related aspects
- Not much known on the effect on policy indicators
 - Except for program evaluations and incident management
 - Relevant questions not asked?
- Effects for irregular conditions not known
- Not much known about conditions which are related to the effects



Guidelines

- Purpose of the guidelines
 - To structure and disseminate knowledge
 - To uniform methods
- Existing guidelines?
 - European guidelines (CORD, CONVERGE, TEMPO)
 - Guideline for policy evaluations
 - Guideline for impact analysis
 - Guideline for evaluation of traffic management scenarios
 - Guideline for simulation studies



Guideline for evaluation studies

- Organise project and write evaluation plan
- Select and describe measures
- Define use cases, situations and scenarios
- Define research questions and hypotheses
- Research design
- Indicators
- Legal issues
- Sensors and measurements
- Data collection, database and analysis tools
- Data selection and data analysis
- Answer research questions
- Report and communicate results



Evaluation plan

- Necessary for
 - Good tender procedure
 - Make sure that all parties involved have the same expectations
 - Improve comparability of evaluation studies
- Contents
 - Description of the measure
 - Goal of the evaluation
 - Research questions
 - Significance of effects
 - Research design
 - Indicators
 - Study area
 - Data collection
 - Data selection
 - Analysis
 - Report
 - Organisation
 - Communication



Guideline for simulation studies

- Define problem
- Define goals
- Choose model
- Prepare application
- Apply model
- Analyse results
- Report study





Contents presentation

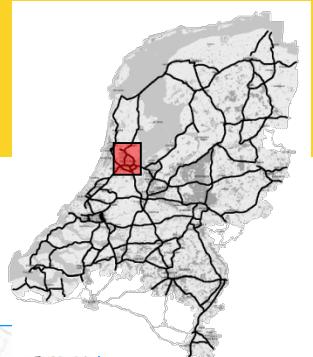
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- Evaluation
- Simulation
- Guidelines
- Case study pilot traffic management
Amsterdam
- Summary



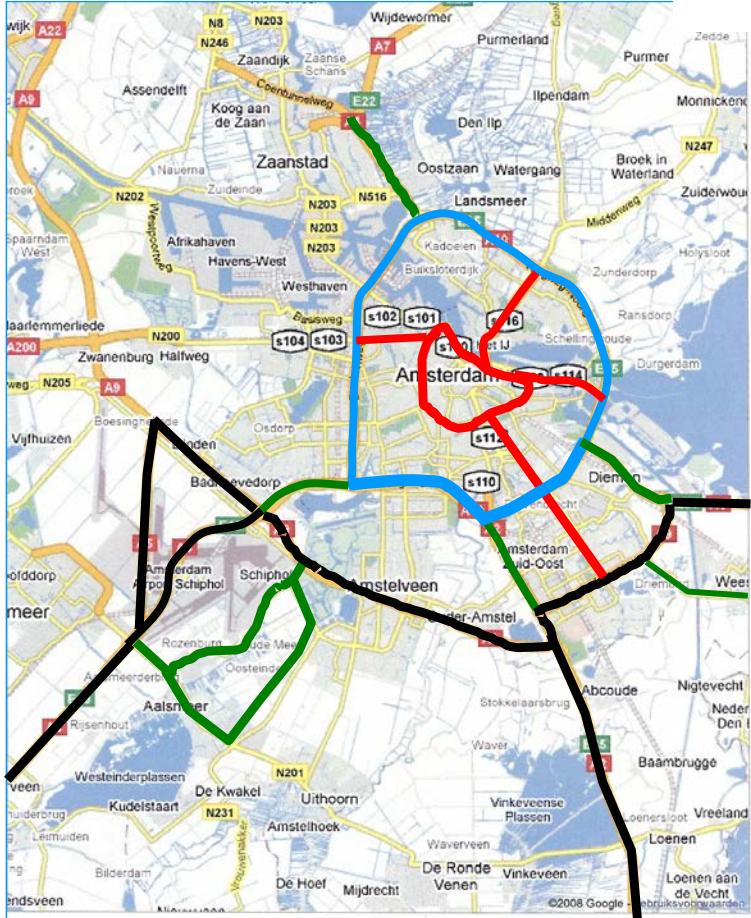
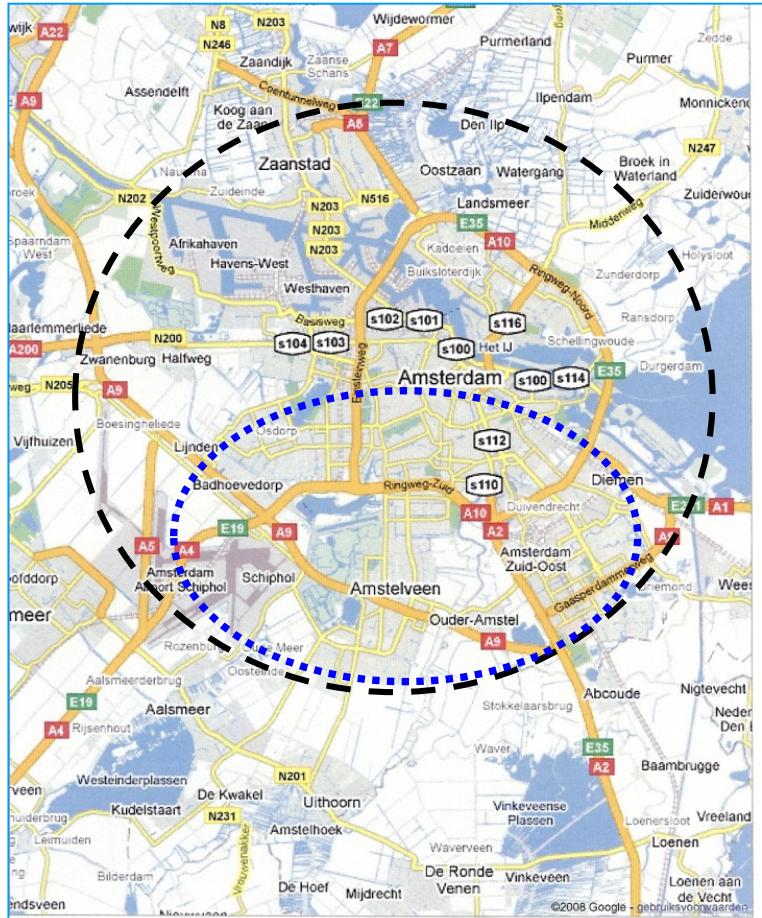


Traffic management trial Amsterdam

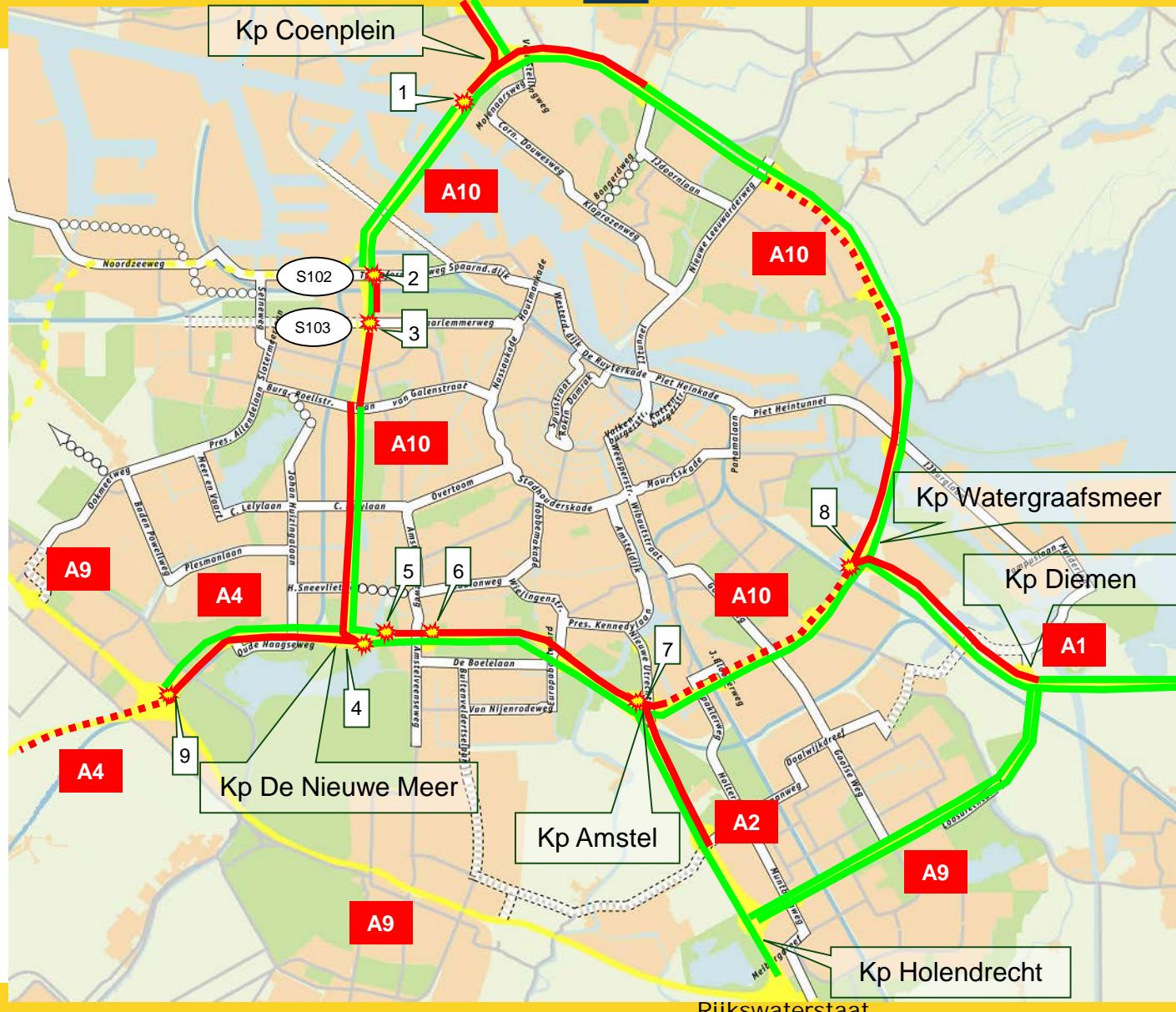
- Network approach for traffic management
- Traffic Management Trial Amsterdam: test case
- Is coordinated network-wide traffic management cost effective?
- Coordinated control of the local traffic management measures
- Trial should provide knowledge about:
 - Optimising traffic flows in a network
 - Optimising local and coordinated measures
 - Coordinated application of traffic management in a network
 - Adaptation of the behaviour of the road users
 - Transferability of the results



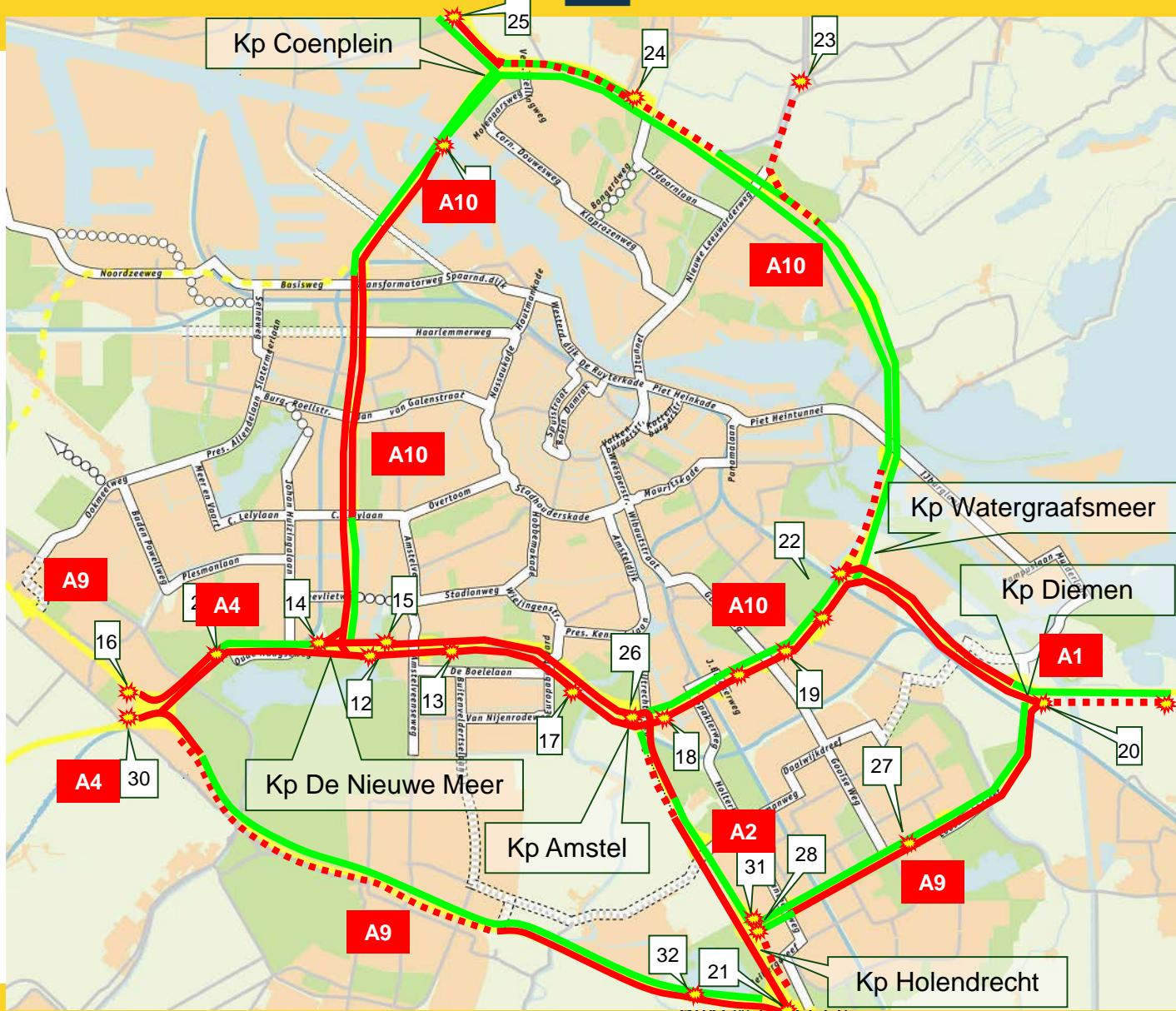
Study area



Bottlenecks morning peak

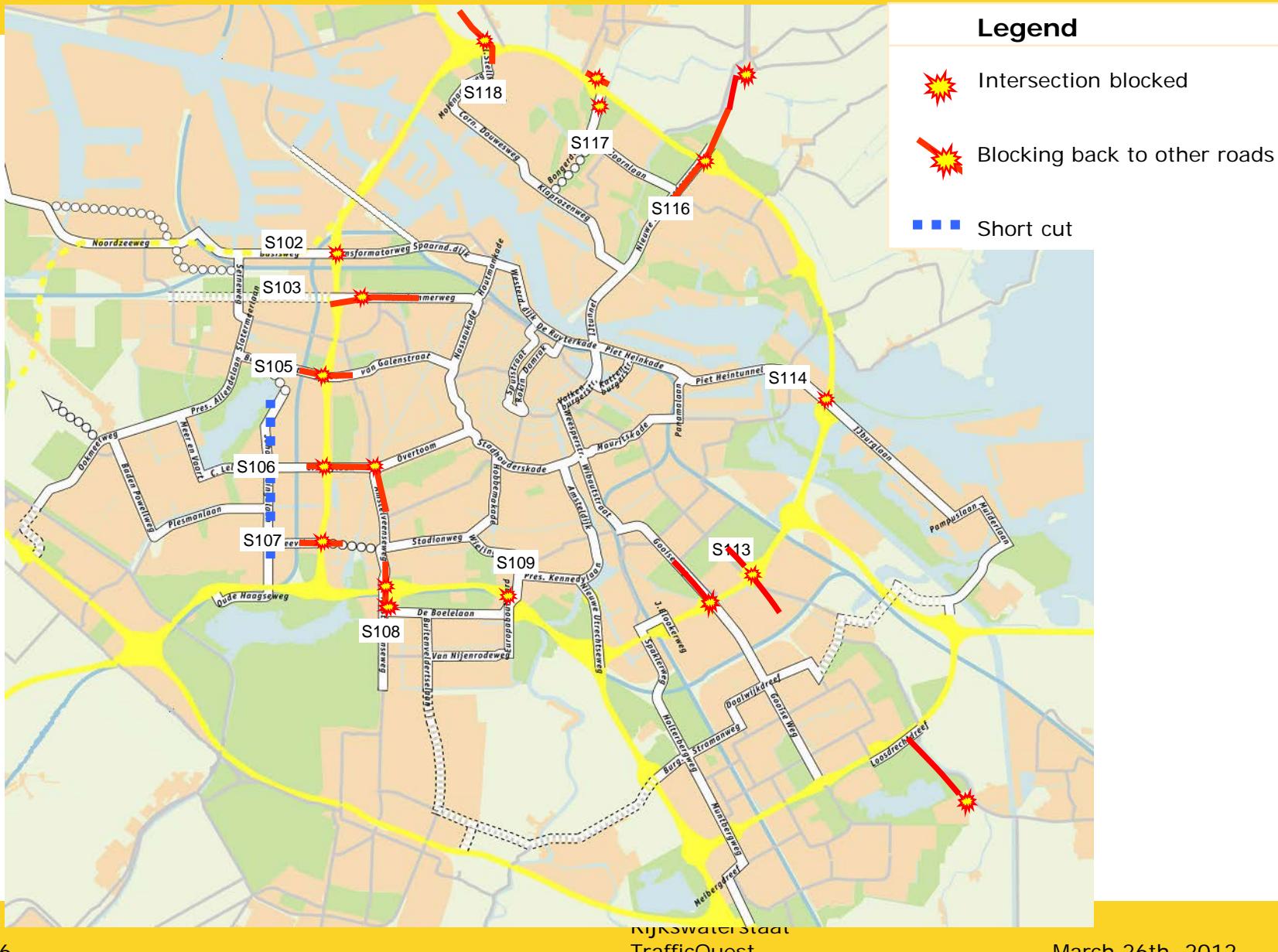


Bottlenecks evening peak





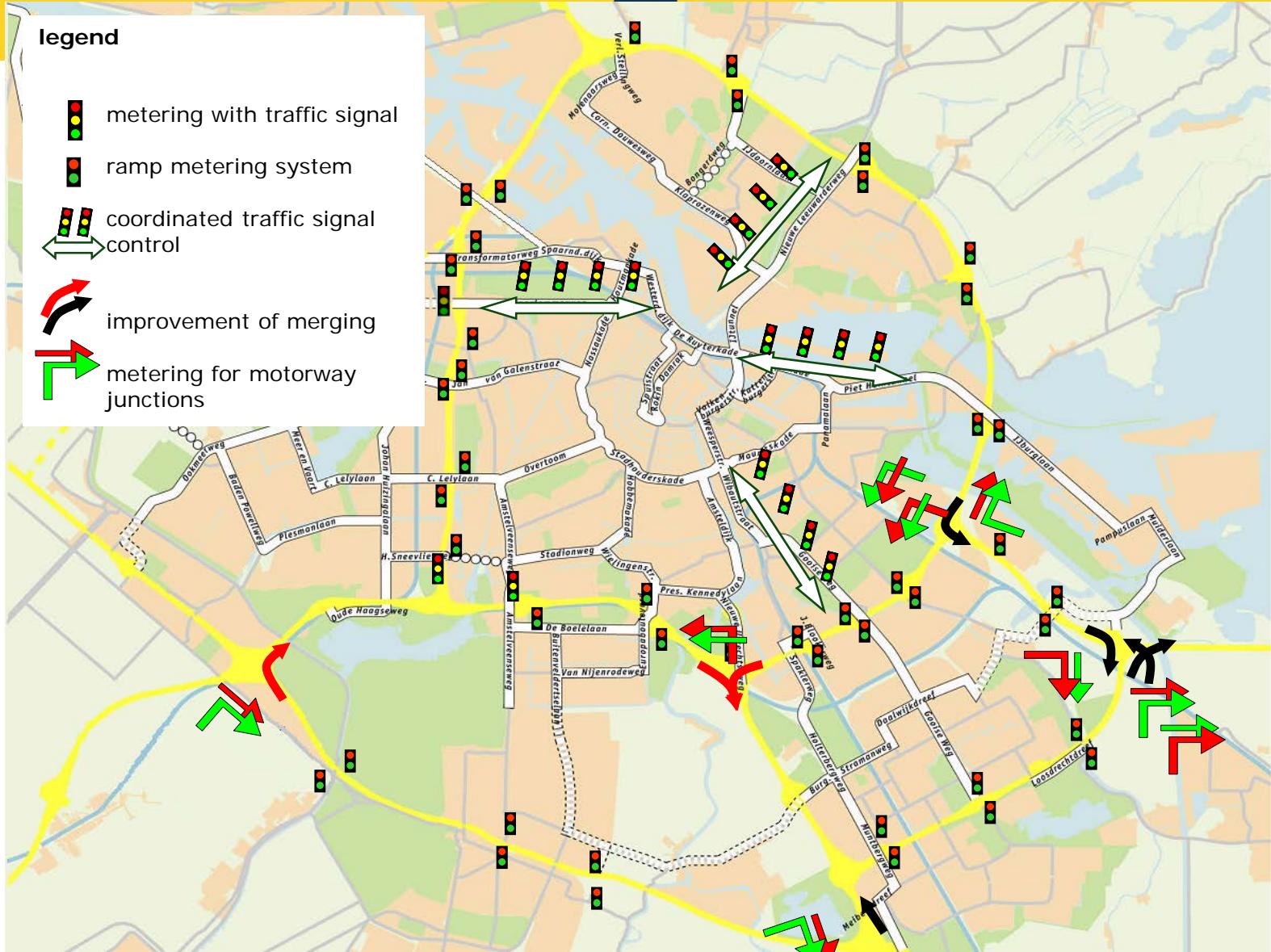
Bottlenecks urban network peak periods





Selection of measures

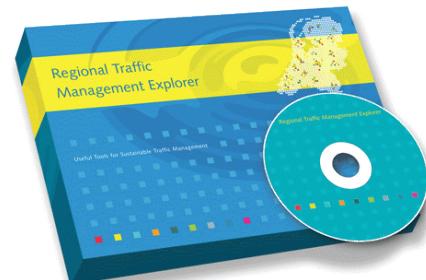
- Local approach
 - Directed at separate bottlenecks
 - Optimise traffic flows on main road network
 - Optimise outflow from main road network
- Network approach
 - Directed at connection between bottlenecks
 - Reroute traffic aiming at an equal distribution on the network
 - Priority is for the ring road A10
 - Control inflow to the main road network





DTA model MARPLE

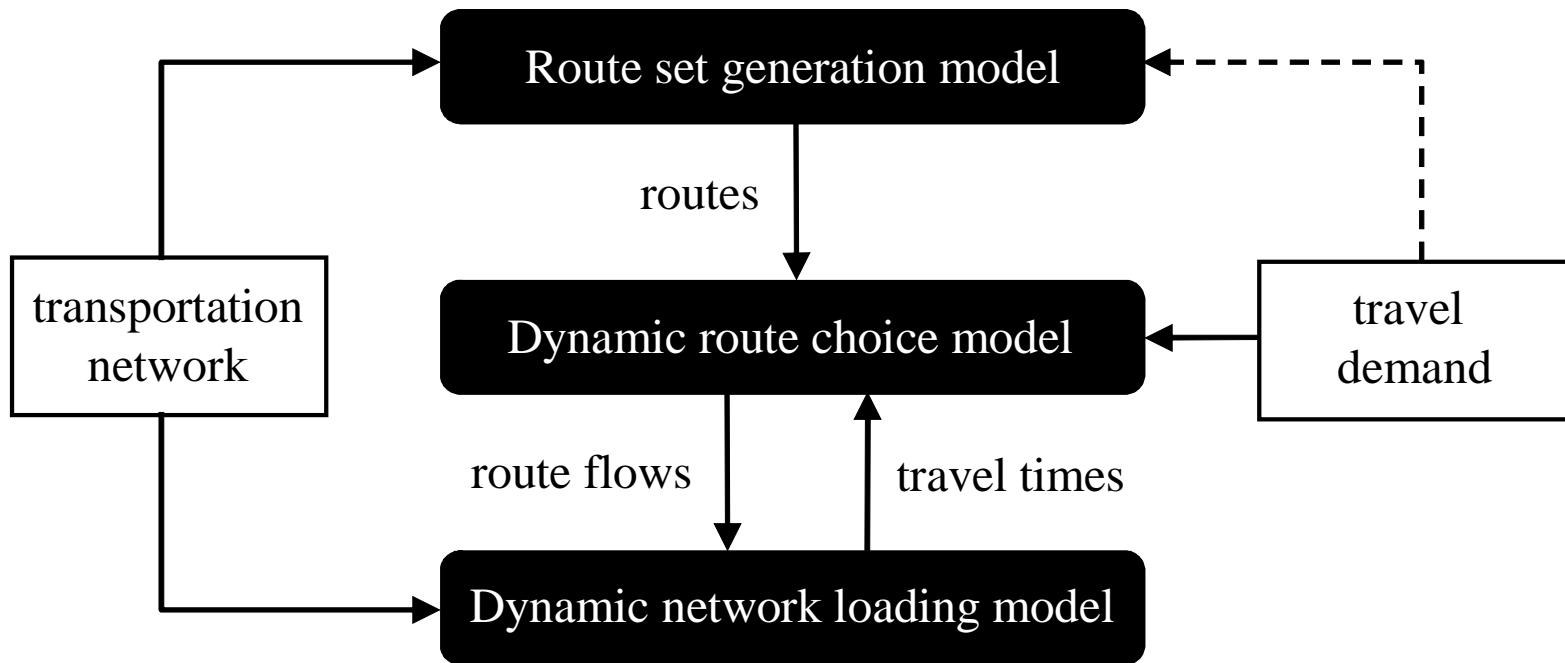
- Model for Assignment and Regional PoLicy Evaluation (MARPLE)
- Macroscopic, based on realistic travel time functions, also for controlled links, roundabouts and priority
- Route choice for predefined routes (deterministic and stochastic)
- Traffic flows through the network based on capacities of links and nodes (blocking-back)
- Part of Regional Traffic Management Explorer
 - Sketch planning and modelling tool
 - Quantify benefits of sets of measures
 - Compare different scenarios
 - National tool, independent of consultant
 - Plug-in of OmniTRANS software



[Photo](#) by Omnitrans International

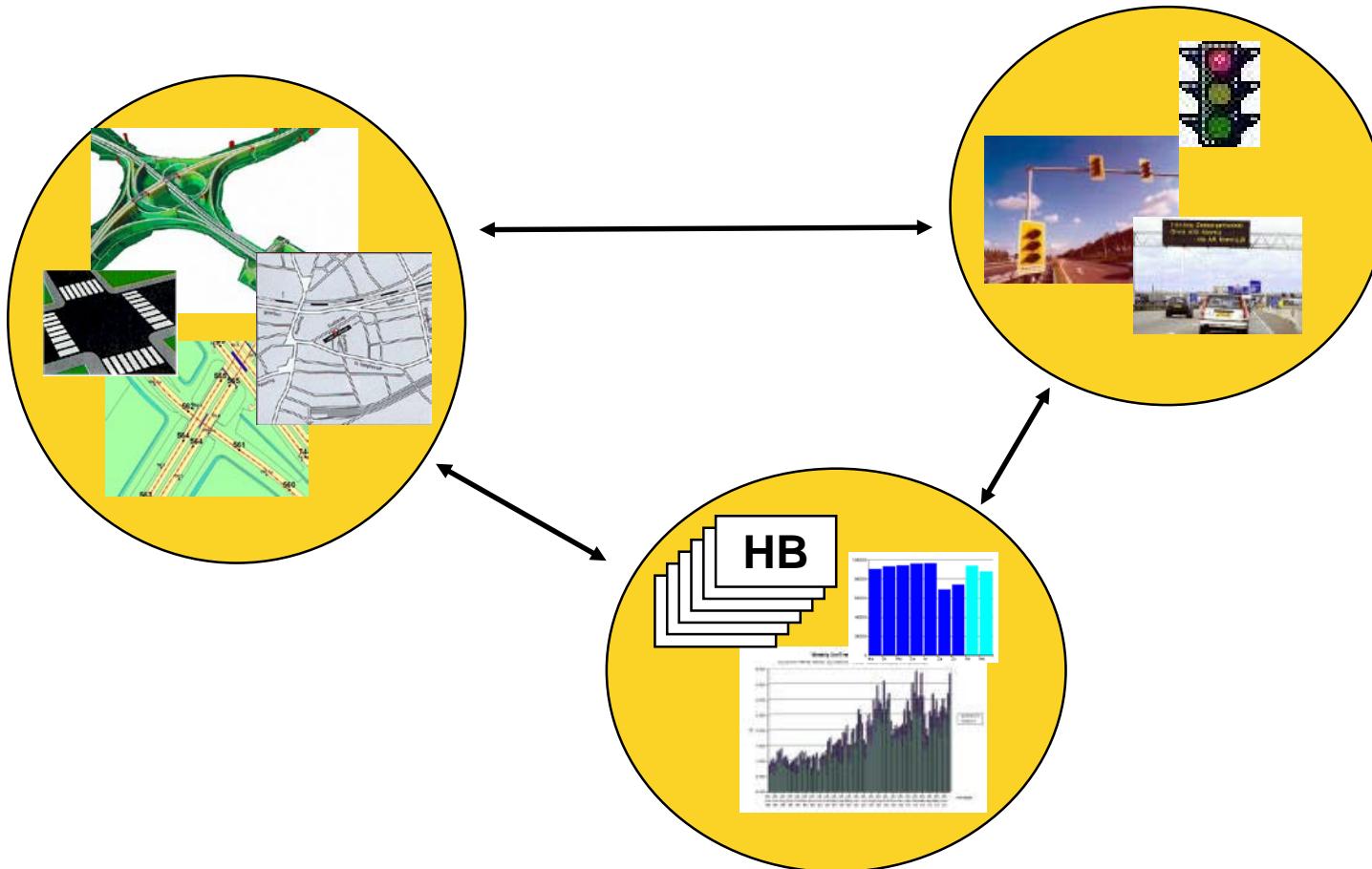


Structure DTA model





Input



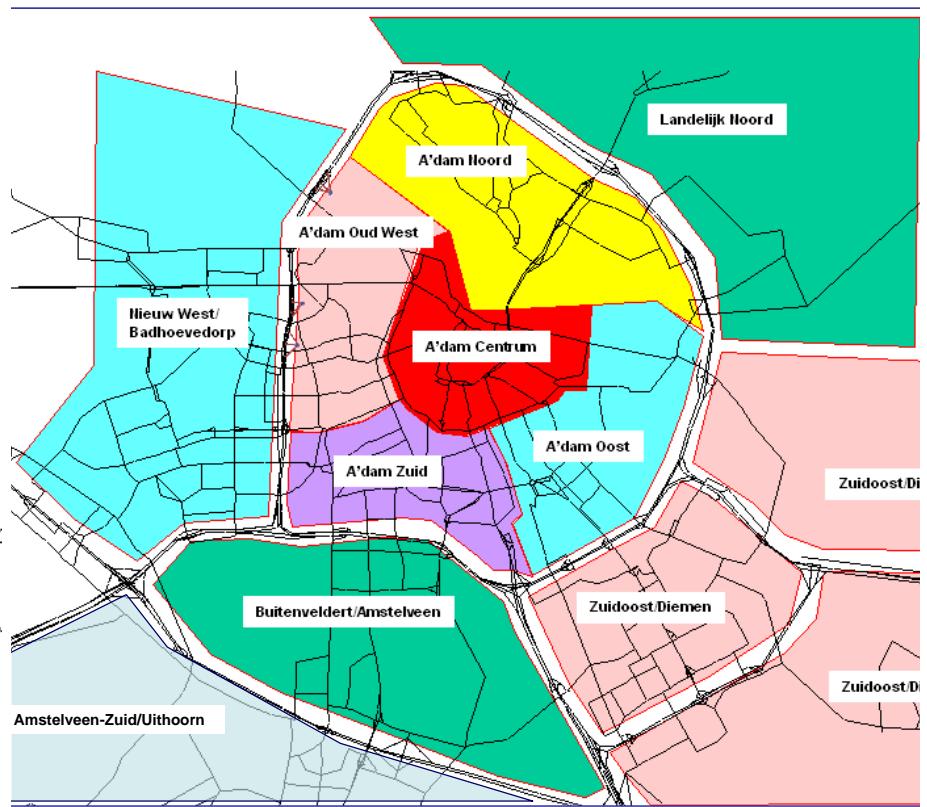


Approach modelling study

- Use an existing network as the base network
- Update network
 - Intersection types
 - Network types
- Measures (existing and new ones)
 - Infrastructure adjustments (capacity)
 - Ramp-metering (control algorithm)
 - Information to road users (route choice parameter)
- Calibration
 - Capacity of weaving sections
 - Demand for certain OD pairs
 - Traffic signal control settings

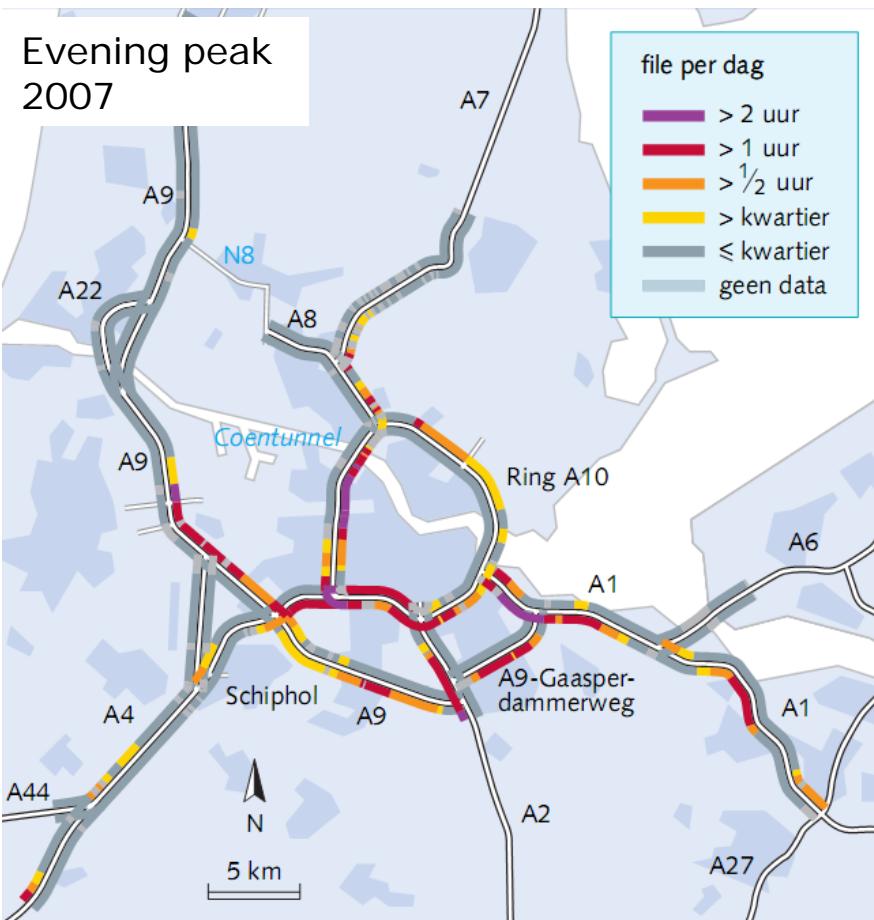


Netwerk





Calibration



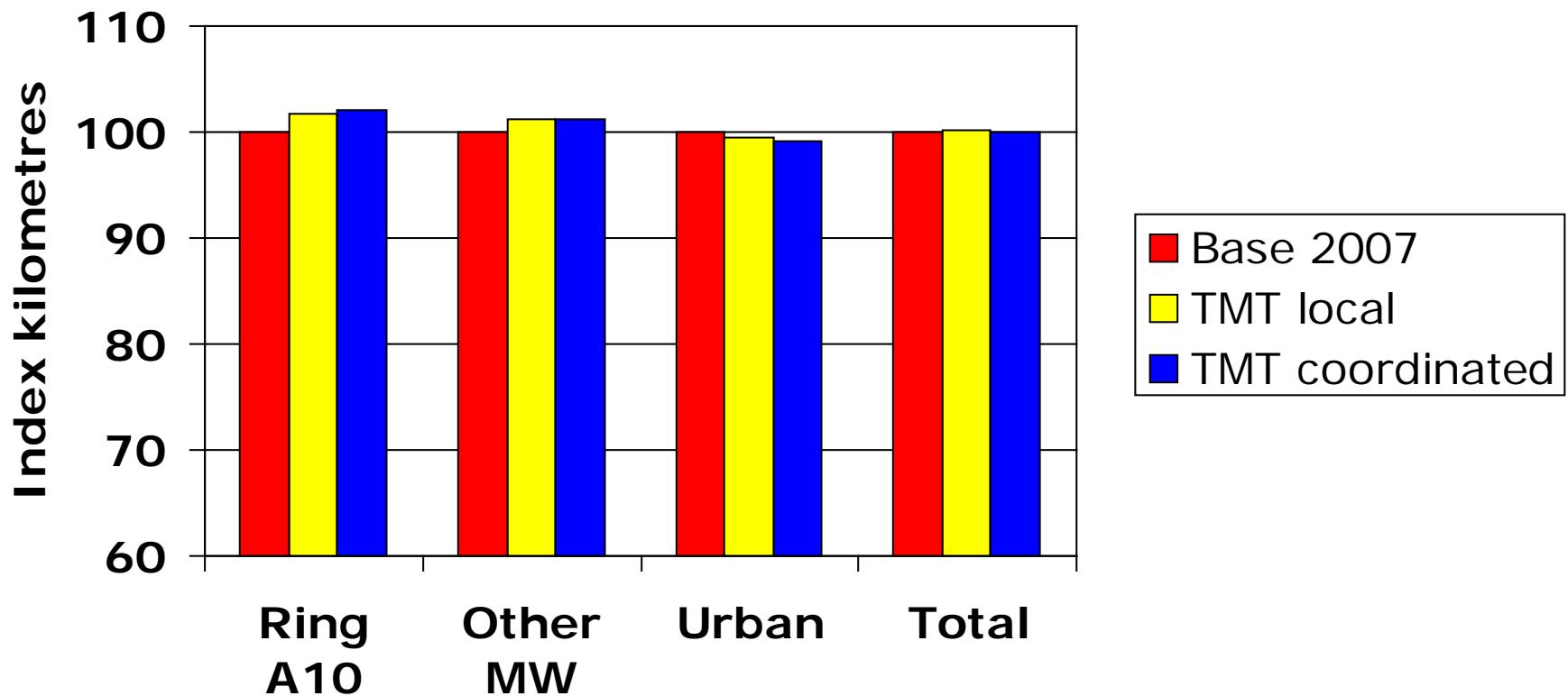


Simulation runs

- Two periods
 - Extended morning peak (05:30 – 11:00 hrs.)
 - Extended evening peak (14:30 – 20:00 hrs.)
- Three scenarios
 - Base year 2007
 - Traffic management trial local
 - Traffic management trial coordinated
- Output indicators
 - Vehicle kilometres driven (per sub network)
 - Vehicle hours delay (per sub network)
 - Travel times for 25 relations

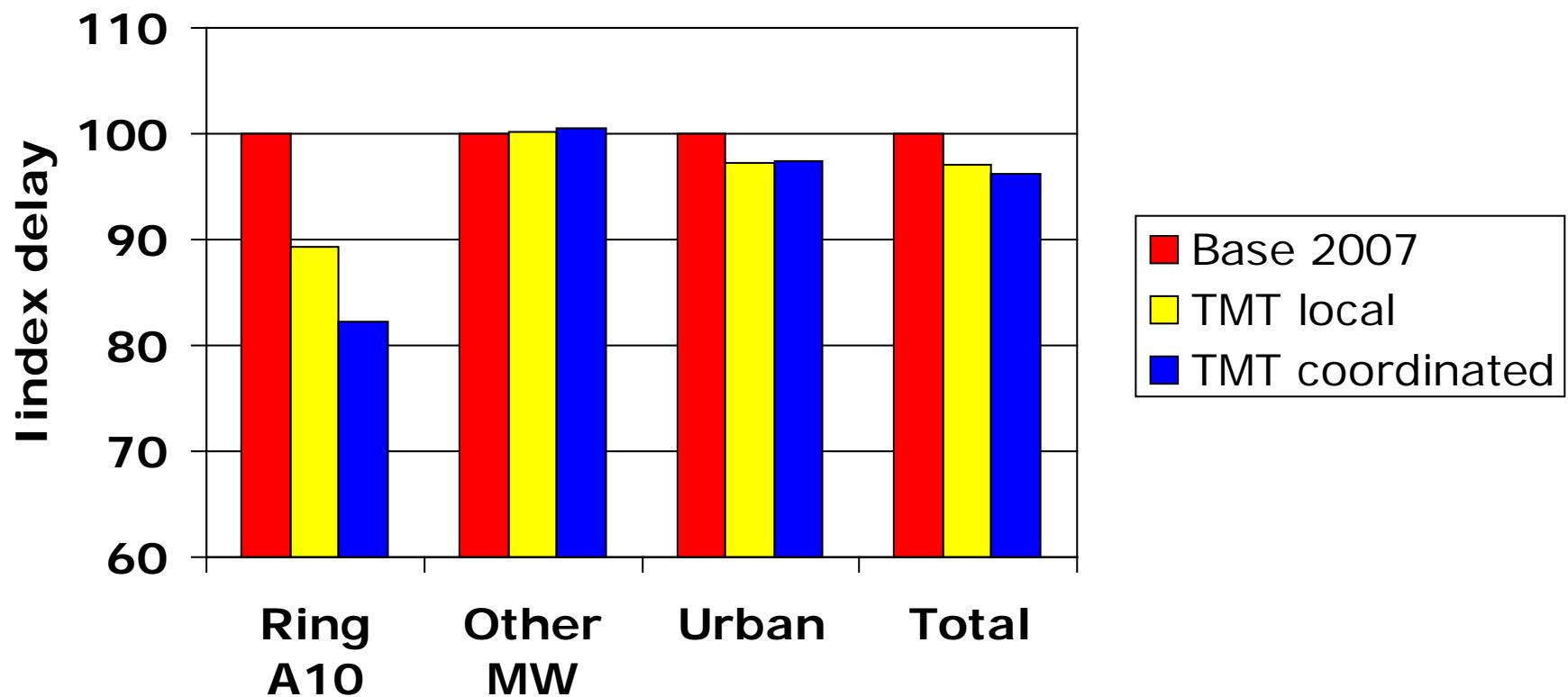


Results vehicle kilometres evening peak





Results vehicle hours delay evening peak





Other benefits evening peak

- Travel times
 - 9 routes improvement > 1 minute
 - 15 routes improvement < 1 minute
 - 12 routes no improvement
 - 10 routes longer travel time < 1 minute
 - 1 route longer travel time > 1 minute
- Savings in delay (simple calculation)
 - TMT local: about 1000 veh.hrs less delay, per year sums up to EUR 1.9 million
 - TMT coordinated: about 1500 veh.hrs. less delay, per year sums up to EUR 3.0 million



Evaluation local measures

- Local measures implemented
 - 32 ramp metering systems
 - Connection with local signal control
 - Adjustments for 6 local intersections
 - Adjustment for some weaving sections on the A10
- Results
 - Delay on A10: -10,8% (simulation -10%)
 - Congestion: -14%
 - Travel times inner ring morning: -5,5%
 - Travel times outer ring morning: +10,3%
 - Travel times inner ring evening: -12,5%
 - Travel times outer ring evening: -7,0%



Contents presentation

- Dutch traffic and transport policy
- Evaluation
- Simulation
- Guidelines
- Case study pilot traffic management
Amsterdam
- Summary



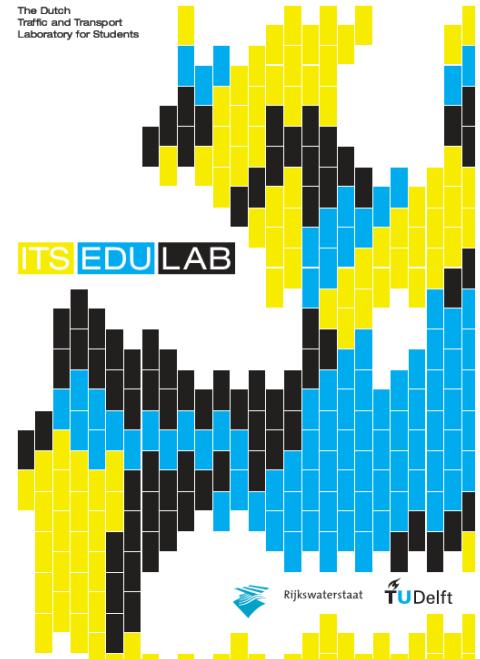
Summary

- Traffic management is essential part of the Dutch traffic and transport policy
- Evaluation (with models or measurements) is common practise in The Netherlands
- A lot of experience with traffic management and traffic impact analysis
- Models are not the solution to a problem, but are tools to analyse the problem, study alternatives and choose the most effective one
- A model is as good as the person using it



ITS Edulab

- Cooperation Rijkswaterstaat DVS and Delft University of Technology
- Goal: connection between scientific research and the actual practice of Rijkswaterstaat
- Rijkswaterstaat DVS
 - Workplaces, PC's, data, models, etc.
 - Research topics and questions
 - Part of the supervision of students
- TU Delft
 - Research questions
 - Supervision of students
 - Educational program and public relations towards students





Colophon

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Pictures: Rijkswaterstaat, Wikipedia

Thank you for your attention!

