Towards Sustainable Dynamic Traffic Management
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Dynamic traffic management (DTM) measures are potentially powerful measures to not only improve network efficiency, but also to reduce externalities of traffic (e.g. emissions of substances, noise and safety). In current practice the deployment of DTM measures (or DTM-strategies) focuses on improving efficiency on a local level. Further the assessment of DTM is concerned with a number of predefined strategies where not always behavioral responses are taken into account. However, because of spatial correlations DTM has network wide impact, and the predefined set may not contain well performing strategies. So ideally the assessment and selection of a DTM strategy should be based on several network performance measures, including externalities, where potentially all possible strategies are considered. This can be achieved by optimizing multiple objectives on a network level, where decision variables are DTM measures. Previously no research has been done on how these objectives relate and what strategies can be effective, taking traffic dynamics and route choice behavior into account.

The Pareto optimal set of solutions, which is the outcome of a multi-objective optimization, can be used to attain this knowledge. Formulating a single objective function that contains elements of all individual objectives (i.e. a weighted sum of all objectives) does not provide such knowledge and assumes that the compensation principle is known in advance, which is not trivial. Therefore, the optimization problem is formulated as a multi-objective network design problem. In this bi-level optimization problem road management authorities try to optimize certain system objectives at the upper level. At the lower level, road users optimize their own objectives. Both levels are interdependent, resulting in a difficult optimization problem (NP-hard), identified as one of the most complex optimization problems in traffic and transport to solve. A framework is developed, connecting the Streamline dynamic traffic assignment model with externality models for emissions (ARTEMIS), noise (RMV and AR-INTERIM-CM) and an accident risk based model for safety. An efficient method is developed to model the dynamic traffic management measures time dependent. To solve the optimization problem, various solution approaches are developed and compared, incorporating response surface methods within multi-objective genetic algorithms to accelerate the solution approach.

Applications show that the objectives efficiency, air quality (NOx emissions) and climate (greenhouse gas emissions) are aligned, and are opposed to traffic safety and noise. Because objectives in general are conflicting, there is not one single solution that optimizes all objectives simultaneously, an optimization results in finding Pareto optimal solutions. To choose the best compromise solution, a compensation principle is needed. Pruning methods to reduce the Pareto optimal set retaining its main characteristics and ranking methods like cost benefit analysis, analytical hierarchy process and ELECTRE III have been applied and compared. Both types of methods may be useful to circumvent the possible difficulties in analyzing the large Pareto optimal set in the decision making process. The availability of the Pareto optimal solutions also offers the possibility to investigate the consequences of using a certain method and the sensitivity of the weights per objective used within the multi criteria decision making methods. Using cost benefit analysis shows for example that efficiency is the dominant objective. Other multi criteria decision making methods are potentially more useful

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as a basis for an interactive decision support tool. Analyzing the Pareto optimal solutions further shows that metering traffic on the right locations may be an effective strategy to reduce externalities and further that lowering the speed limit not necessarily reduces externalities on a network level.

**Author’s publications**

**Journal publications**


Wismans, L. J. J., E.C. van Berkum & M.C.J. Bliemer (2010). Wisselwerking tussen bereikbaarheid en externe effecten bij de optimalisatie van DVM maatregelen in verkeersnetwerken [Interaction between accessibility and external effects when optimizing DTM measures on network level (in Dutch)]. Tijdschrift Vervoerswetenschap, (ISSN 0040-7623), 46(2), 44-54

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