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Energy Efficiency in Winter Road Maintenance
A Road Climatological Perspective

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ABSTRACT

Practices in winter road maintenance are dependent on the climate and weather impacting roads and the road users' requirements. As in many other fields of transportation, it is of interest to investigate fuel efficiency potentials in the different aspects of the road maintenance area. The main focus of this thesis was on investigating energy use in winter road maintenance activities in southern Sweden. It is crucial to understand which parameters are of the largest significance in slipperiness, as well as to investigate the weather information that the operations are based on, since the climate is the reason for requiring winter road maintenance in the first place. The original energy use needs to be set, to be able to know whether efficiencies are made. In this thesis, two approaches were taken to understand if existing fuel consumption models for heavy-duty vehicles could be applied within winter road maintenance or whether in-vehicle fuel data such as data from vehicle manufacturers should be used instead. Finally efficiency potentials were explored with the use of a route optimisation programme for winter road maintenance practices.

The climate data analyses showed that frost warnings are the most common type of slipperiness in the southern parts of Sweden. If such warnings were to be under- or overestimated, it could have a large impact on the energy used, since unnecessary slipperiness treatments could be performed. Furthermore, the mobile water depth measurements indicated that it is possible to detect differences in water depth along roads and that exit ramps could be interesting in terms of changed treatments, since the water depths were quite large on those ramps. From the use of the fuel consumption model included in the Swedish National Road and Transport Research Institute, or VTI, winter model, it was concluded that anti-icing would not be energy efficient in terms of traffic energy use, since drivers tend to drive at higher speeds on salted roads. Snow density and amount would however, impact fuel consumption, which is why the removal of snow could save traffic energy use.

The best method to evaluate energy use during winter road maintenance was the use of in-vehicle data. The existing fuel consumption model used in this thesis, underestimated the fuel use, which implied that the energy use in winter road maintenance practices depends on other aspects than what was stated in the model calculations. Such other aspects seemed to be the weather and way of work that in turn demand significant changes in speed. Changes in speed was also regarded as a potential efficiency measure, as the velocities of the heavy-duty vehicles seemed on average to be below what was estimated as the most fuel-efficient speed for this type of vehicle. Using the route optimisation programme further put a way for evaluating efficiency potentials. It was shown that installing underground heating systems or road surface–installed salt spreaders at strategic locations could save fuel use, as would changing operations from sanding to salting, as well as adding extra materials depots during the sanding operations. The analysis also indicated that additional materials depots for anti-icing measures would not result in any change in fuel use.

The thesis has contributed to finding ways to evaluate energy use and efficiency potentials within the field of winter road maintenance, where the main issues to consider are what energy road maintenance vehicles use and how road maintenance practices are planned. New measuring techniques and improved accuracy in the weather information system can contribute to reducing the use of both vehicles and fuel.

Keywords: Road climate, RWIS, frost, snow, fuel consumption, heavy-duty vehicles, route optimisation programme, energy efficiency, winter road maintenance