The influence of analysis period on pavement network performance in performance-based planning analyses

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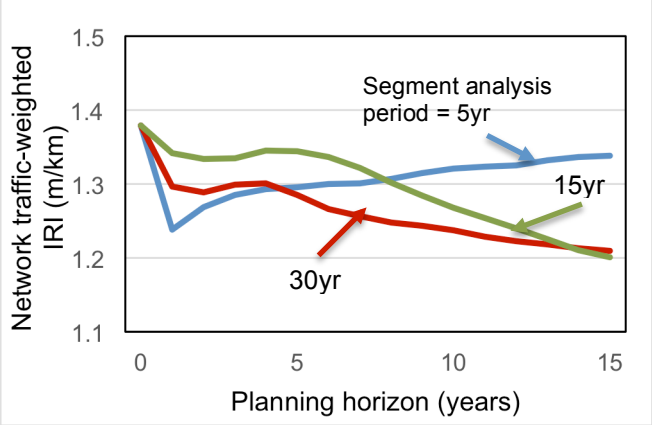
PROBLEM

An aging roadway infrastructure, limited funding, and federal regulations have forced transportation agencies to evaluate cost-effective ways to improve the performance of their pavement networks. Existing pavement management systems mainly offer data about, and allow for the evaluation of, current conditions. Performance-based planning is an approach that combines data about current conditions with models that estimate probable future performance based on a given strategy of maintenance, rehabilitation and reconstruction (MRR) actions. The CSHub has developed a probabilistic network allocation model that can be used to support performance-based planning allocation decisions for a given level of funding and planned portfolio of MRR actions for individual pavement segments in a network over a set future period of time, or planning horizon. The selection of MRR actions for specific pavement segments is based on the benefit-cost ratio of an action, which is related to the segment analysis period over which the action is evaluated. This study focuses on the influence of the segment analysis period on pavement network performance for a given planning horizon.

APPROACH

Our probabilistic allocation network model consists of a deterioration module, a cost module, and an optimization module. The deterioration module is applied to predict the deterioration process of each segment. The cost module predicts the price variation of different materials, as well as all the unit cost of different MRR actions. Both modules consider uncertainty as part of the prediction process. The optimization module involves two steps: First, it uses a dynamic decision rule to select the best MRR action in the project level based on the analysis period; then it decides which segments receive MRR actions on the network level within the budget constraint. We demonstrate the approach using data from the Virginia Interstate pavement network (see figure 1). The planning horizon is 15 years into the future and three segment analysis periods (SAP) are compared: 5, 15, and 30 years.



Average traffic weighted roughness (IRI) of the pavement network for three segment analysis periods.

FINDINGS

The figure shows the impact of the three SAPs on the average traffic weighted roughness (IRI) of the whole pavement network. The 5-year SAP scenario performs better than the other two scenarios for the first five years of the planning horizon, but then the traffic weighted IRI increases gradually to a higher level than the other scenarios, which is due to the preference of minor maintenance (short life) actions in the segment analysis period. The network performance can be improved for a short time, but the long-term benefit is low. By contrast, when the SAP increases, the network performance is a little worse for the first several years, but it improves over time. This is due to the long-term benefits of longer lasting maintenance and reconstruction actions being recognized in the longer SAPs. By comparing the 15 and 30-year SAPs, we see that the long-term benefits are realized for longer SAPs.

WHY DOES THIS RESEARCH MATTER?

- Performance-based planning is an important tool for transportation agencies to evaluate the cost effectiveness of different maintenance, rehabilitation and reconstruction (MRR) strategies.
- This study demonstrates that longer segment analysis periods can improve the pavement network performance by realizing the benefits of longer lasting MRR actions.
- This approach can enable agencies to improve the cost-effectiveness of their pavement management strategies.

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