Climate Change and Roads

The U.S. road network is one of the nation’s most important capital assets. Climate stress on roads will likely change in the future, with various potential impacts and adaptation costs. For example, roads may experience more frequent buckling due to increased temperatures, more frequent washouts of unpaved surfaces from increases in intense precipitation, and changes in freeze-thaw cycles that cause cracking.

Risks of Inaction

Without reductions in global GHG emissions, the costs of maintaining, repairing, and replacing pavement are projected to increase, which is consistent with the findings of the assessment literature regarding adaptation costs for road infrastructure. Figure 1 presents the estimated regional damages (in the form of adaptation costs) to the U.S. road network under the Reference scenario using the ISGM-CAM climate model. The greatest impacts are projected to occur in the Great Plains region, where costs are mainly due to erosion of unpaved roads associated with increased precipitation. Costs associated with the use of different pavement binders to avoid cracking of paved roads are also high, particularly in the Midwest and Southeast regions, and they increase over time in all regions due to the projected rise in temperature. Costs of rescaling roads after freeze-thaw events decrease over time as the climate changes, but the magnitude of the decrease does not offset the projected increase in other costs.

Figure 1. Projected Impacts of Unmitigated Climate Change on U.S. Road Infrastructure

Adaptation costs (billions 2014$, undiscounted) under the Reference scenario using the ISGM-CAM climate model. Results are presented for the six regions used in the Third National Climate Assessment.
Reducing Impacts through GHG Mitigation

Adaptation costs for the U.S. road network are substantially reduced with global GHG mitigation compared to the Reference scenario (Figure 2). These reductions are due in large part to the effect of lower temperatures under the Mitigation scenario on maintenance needs for paved roads. Specifically, costs associated with asphalt binders account for a large share of the adaptation costs nationally under the Reference, and these costs are significantly lower with mitigation. Costs associated with adaptation for unpaved roads are also substantially lower under the Mitigation scenario, as heavy precipitation events are projected to be less severe compared to the Reference. Costs of resealing roads after freeze-thaw cycles are projected to decrease under both scenarios, but the magnitude of the decrease does not offset the projected increase in other costs.

By 2050, the adaptation costs under the Reference scenario are substantially higher, illustrating the benefits that accrue over time with GHG mitigation. In addition, although the costs of adaptation increase over the course of the century under both scenarios, they do so at a much faster rate under the Reference. Under the Reference, adaptation costs are estimated at approximately $10 billion in 2100, whereas under the Mitigation scenario costs are estimated at $2.6 billion. As a result, global GHG mitigation is projected to avoid over $7 billion in damages in 2100. These results rely upon climate projections from the IGSM-CAM, which projects a relatively wetter future for most of the U.S. compared to the MIROC climate model (see the Levels of Certainty section of this report for more information). The projected benefits of global GHG mitigation are lower with the drier MIROC model (not shown), at $4.2 billion in 2100, reflecting the reduced impact of precipitation on unpaved roads under both scenarios.16

Figure 2. Projected Impacts on U.S. Road Infrastructure with and without Global GHG Mitigation

Costs of adaptation for the Reference and Mitigation scenarios using the IGSM-CAM climate model (billions 2014$). The reduction in adaptation costs under the Mitigation scenario relative to the Reference reflects the benefits of global GHG mitigation.

For more information on the CIRA approach and results for the roads sector, please refer to Neumann et al. (2014)17 and Chinowsky et al. (2013).18