SJSU SAN JOSÉ STATE UNIVERSITY

FRESNO STATE

Dynamic Flood Risk Assessment for Transportation Infrastructure in Fresno, CA

Project 2536
July 2026

Yushin Ahn, PhD Fayzul Pasha, PhD

Introduction

Urban roadway flooding is a problem in cities where the ground is flat. In these cities, water does not always flow downhill easily. Even a little bit of water on the road can cause problems. It can slow down traffic, make it hard to get around, and increase the risk of accidents when it rains. Traditional methods of studying water flow often use computer models that look at the shape of the land. However, these models do not always work well in cities where the ground is flat. This is because the models can produce results that are not realistic in areas where the ground is very flat and water flows slowly. This study looks at using a kind of technology called LiDAR to study the shape of the land. The goal is to find parts of the road that are likely to flood.

By just looking at how water flows, the study tries to find small areas where water can collect. The main question is whether this technology can help identify parts of the road that are prone to flooding in flat cities. The study uses LiDAR to make detailed maps of the land, which can help find areas where water can accumulate. This can be a help in cities where flooding is a problem. Urban roadway flooding can be mitigated with tools and technology such as LiDAR-based terrain analysis.

Study Methods

The study used high-resolution airborne LiDAR data from the U.S. Geological Survey 3D Elevation Program. This data was used to create digital elevation models of an urban area in Fresno, California. The LiDAR data was classified on the ground and used to generate a very detailed terrain surface. This surface was so detailed that it could capture features such as the crowns and curbs of roadways. To find the areas on the surface, a special approach was used that filled in the areas and then compared the filled surface to the original digital elevation model. The difference between the two surfaces was used to calculate the depth of the areas. Any area that was deeper than a certain threshold was marked as a place where water could collect.

These low areas were then turned into objects and compared to the roadways. The roadways had a buffer zone around them to help isolate the areas that were directly on the roadways. For each area on a roadway, several factors were calculated. These factors included how deep the water could get, how much water could be stored, and how far it was to the stormwater inlet. All of these factors were combined into a score that showed which parts of the roadways were at risk of flooding or ponding. This score was designed to highlight the parts of the roadways where water could collect and be difficult to drain.

Findings

The analysis identified substantial differences in how roadway ponding features are represented depending on the LiDAR dataset used. One dataset detected more than twice as many roadway depressions, capturing numerous shallow micro-depressions distributed across the road network. The second dataset detected fewer depressions but identified deeper and larger storage features. Despite these differences, both datasets revealed consistent spatial patterns of roadway ponding potential.

Many ponding areas occur where small topographic depressions coincide with relatively large distances to stormwater inlets. Interestingly, the average distance to drainage infrastructure was similar between datasets, suggesting that inlet spacing alone does not explain roadway flood vulnerability.

Instead, the spatial frequency and distribution of micro-topographic depressions appear to play an important role in determining roadway flood risk. The results also show that depression depth alone does not fully determine storage capacity; the size and shape of the depression strongly influence the volume of water that may accumulate.

Policy/Practice Recommendations

The results show that high-resolution LiDAR data can help quickly identify which parts of the roadway network might have problems with water collecting on the surface. We can use LiDAR data to look at the shape of the land and find areas where water might collect during rain, which would allow transportation agencies to more easily identify where flooding might happen. Because this method is based on the shape of the land and uses LiDAR data that is easy to acquire, it can be a useful and cost-effective tool for planning. Agencies can use this method to decide which areas to inspect first, where to focus their maintenance work, and how well the drainage system is working in cities. By looking at how the land affects where water collects and combining this with information about the drainage system, agencies can find out where it might be hard for stormwater to flow. This information can help improve drainage systems and streamline responsive planning so that the transportation systems can continue to operate efficiently. Thus, LiDAR data and terrain based analysis can ensure that our roadways can handle even heavy rain and continue to serve our communities.

About the Authors

Yushin Ahn, PhD, Yushin Ahn is an Associate Professor in the Department of Civil and Geomatics Engineering at California State University, Fresno. Fayzul Pasha, PhD, is a Professor of Water Resources Engineering and Chair of the Department of Civil and Geomatics Engineering at California State University, Fresno.

To Learn More

For more details about the study, download the full report at https://transweb.sjsu.edu/research/2536

MTI MINETA TRANSPORTATION INSTITUTE

MTI is a University Transportation Center sponsored by the US Department of Transportation, the California Department of Transportation, and public and private grants, including those made available by the Road Repair and Accountability Act of 2017 (SB1). The Institute is part of San José State University's Lucas Graduate School of Business.