

DYNAMIC FLOOD RISK ASSESSMENT FOR TRANSPORTATION INFRASTRUCTURE IN FRESNO, CA

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MOTIVATION

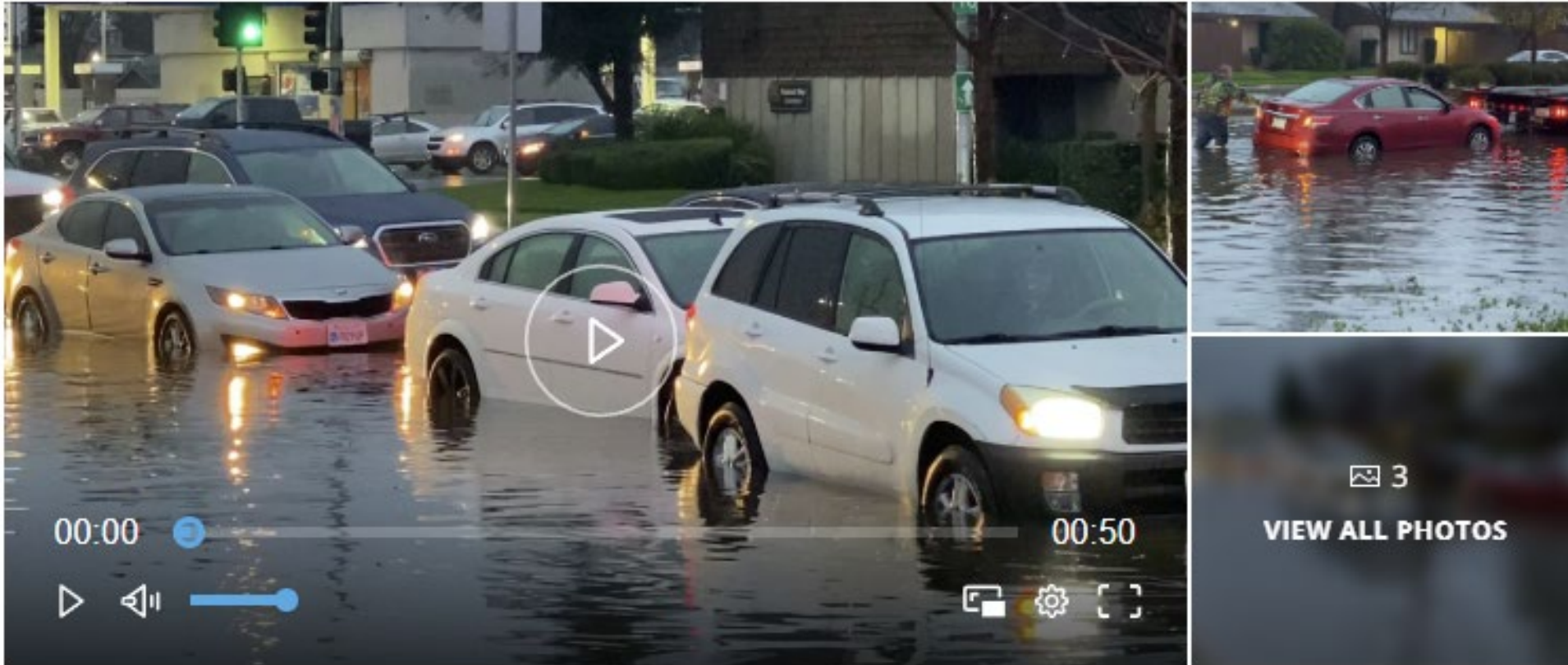
- **Urban Flooding in increasing**
 - **Approximately 34.7% of properties in Fresno are at risk of flooding within the next 30 years**
- **Roads and transportation networks are highly vulnerable**
 - **~25% pf bus yards in Fresno County are located near rivers or within FEMA-designated floodplains**
- **Fres faces seasonal flood risks from intense rainfall**
 - **2017 California Floods led to the San Joaquin River reaching its highest levels since 1997**



Rain floods Peach Avenue off Highway 180 in Fresno

by Peter Lopez | Thu, December 23rd 2021 at 6:00 PM

Updated Thu, December 23rd 2021 at 10:43 PM



As the rain continues to pour down onto the Central Valley, Peach Avenue and Highway 180 in Fresno is flooded with rainwater (Photo: KMPH Photographer, Anthony Guevara)

<https://kmpH.com/news/local/rainwater-floods-peach-avenue-off-highway-180-in-fresno>



Rain and flooding cause chaos on Fresno roads

Thursday, May 23, 2019



While the rain itself wasn't completely unexpected, the amount of water left on roads caught drivers and law enforcement by surprise.

<https://abc30.com/rain-fresno-weather-madera-valley/5315154/>

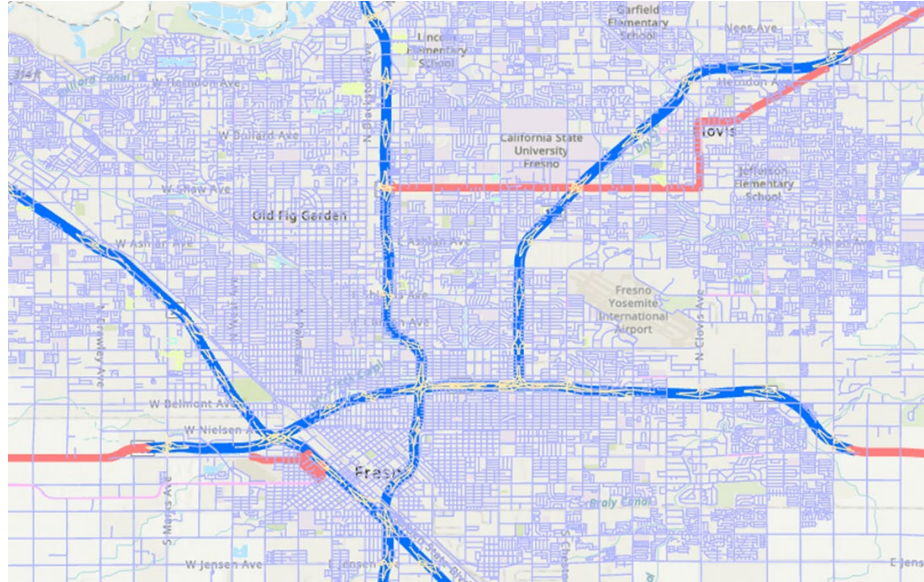


PROJECT OBJECTIVES

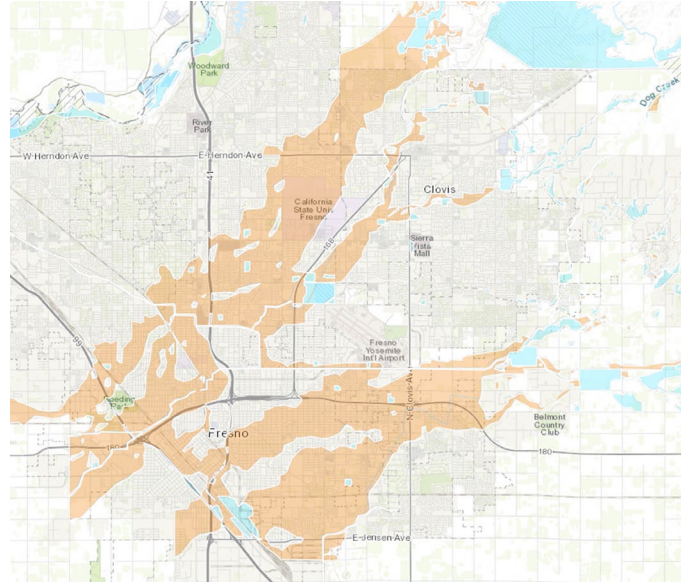
- Simulate how rainfall leads to overland flow
 - Assess flood risk on road infrastructure
 - Use HEC-HMS/HEC-RAS 2D to model realistic scenarios
- Impact of varying Resolution of DEM from Airborne LiDAR
 - Land use classification
 - Curb breakline extraction



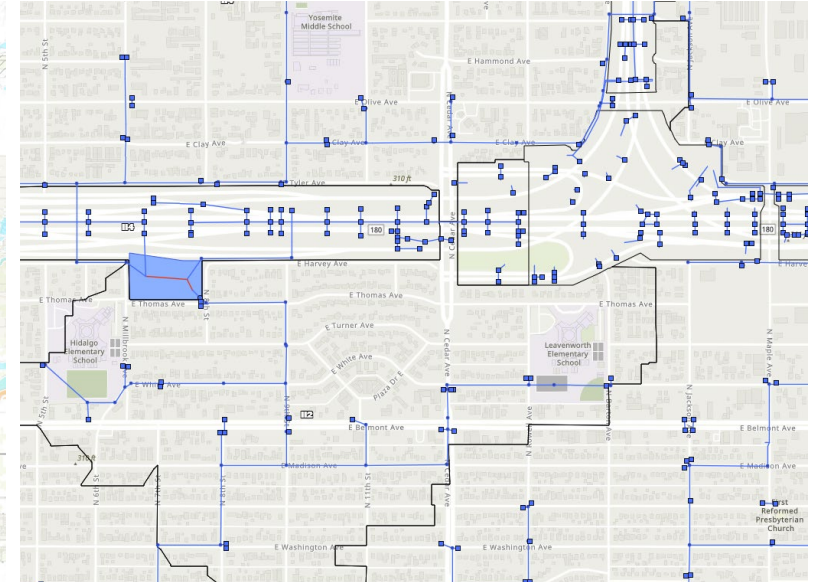
STUDY AREA OVERVIEW AND DATA



Roads Map

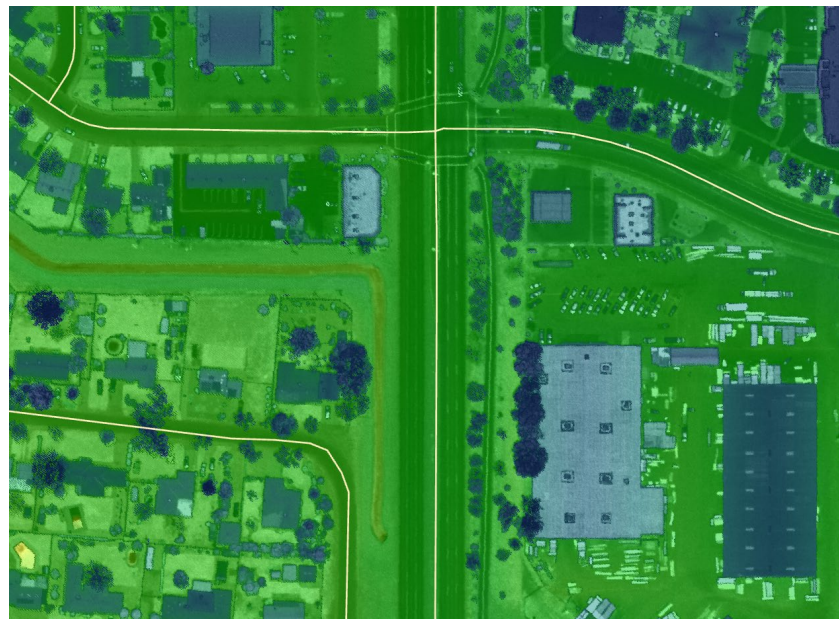
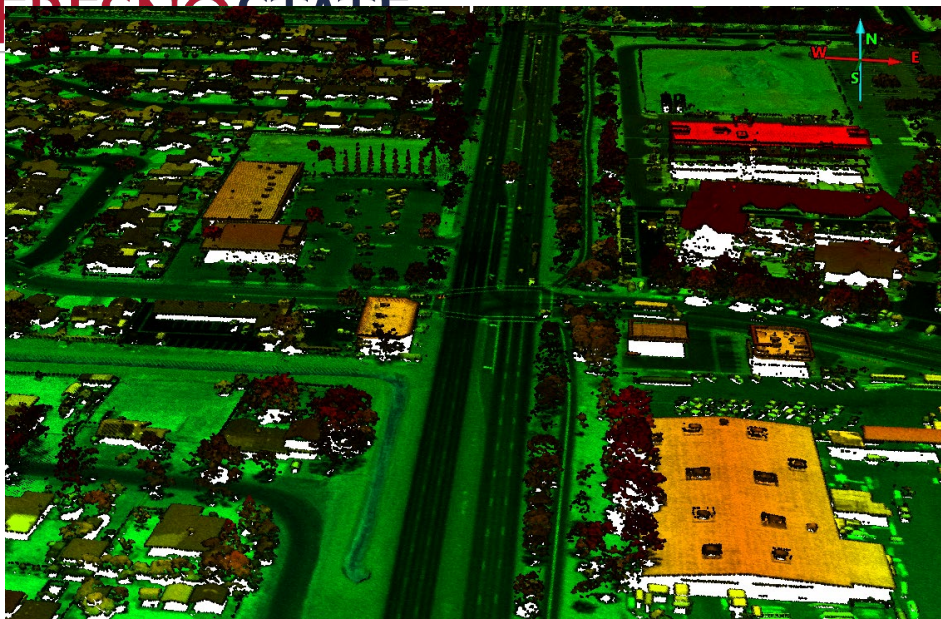


FEMA Map



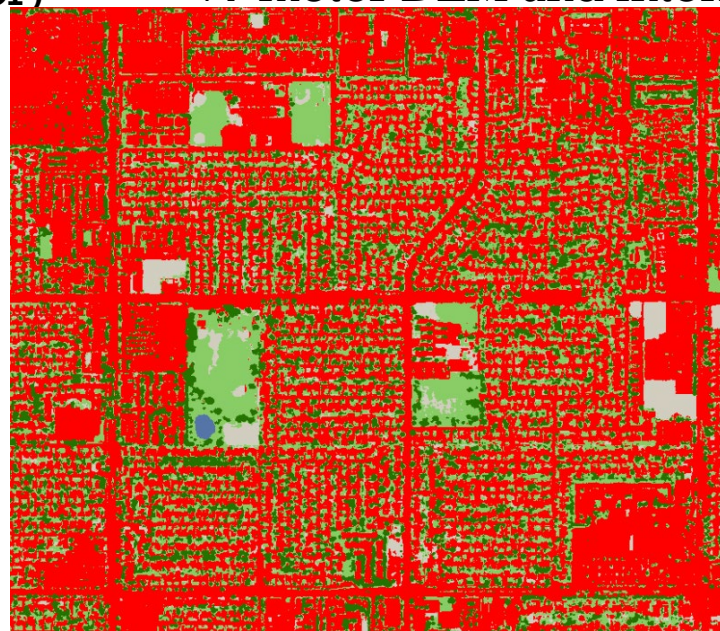
Stormwater Map





Point Cloud Data (~20 points/square meter)

1/4 meter DEM and Intensity



1 ft aerial image

1 meter Land cover



DATA

- DEM
 - 30 meter, 10 meter, 1 meter DEM
 - Airborne LiDAR point cloud, $\frac{1}{4}$ meter DEM
- Soil information: SSURGO, Infiltration rate
- Land Use: NLCD
- Rainfall: NOAA (i.e., 100-year, 1-hr storm)



COMPUTING RUNOFF CURVE NUMBER (CN)

- Data:
 - Digital Elevation Model
 - Land Use/ Land Cover, Urban/
 - Soil Data, Hydrologic Soil Group (HSC) for infiltration rate

Land Use	Description	HSG A	HSG B	HSG C	HSG D
Impervious roads / highways	Paved with curb and gutter, 100% impervious	98	98	98	98
Streets with open ditches	Paved but with grassed shoulders	83	89	92	94
Gravel roads	Unpaved, compacted gravel surfaces	76	85	89	91
Parking lots (paved)	Asphalt or concrete, flat or sloped	98	98	98	98
Railroad yards (compacted gravel)	Compacted surfaces, minor infiltration	76	85	89	91
Sidewalks / driveways	Concrete/asphalt, mostly impervious	95	96	96	96
Shoulders (grassed, maintained)	Grass strip next to road, minimal compaction	39	61	74	80

Example of CN for Transportation area



SOFTWARE TOOLS

- HEC-RAS 2D – Hydraulic Modeling, U.S. Army Corps of Engineers
- RAS Mapper
- QGIS – Open Source GIS software
- ArcGIS Pro



DEM RESOLUTION IN FLOOD MODELING

Resolution	Grid Size	Use
30 meter	Course	Watershed scale or regional scale
10 meter	Moderate	Small rural watershed urban analysis
1 meter	High	Urban flooding, road-scale analysis
0.25 meter	High	Micro-scale, gutters, curbs, parking lots.



CHALLENGES

- Data specific
 - Impervious surface
 - Detail curb features as breaklines
 - Stormwater specification
- Data that are not available
 - Tree lawn or Vegetated strip
 - Bare roadside
 - Landscaped buffer

Feature	Function
Curb	Barrier
Bare strip	Infiltration-permeable surface
Sidewalk	Slightly elevated paved surface
Gutter	Surface channel along the road
Driveway slope	Slope
Swale	Depressed vegetated infiltration zone

NEXT STEP

- Site selection using FEMA/Caltrans layer
- Prepare different resolution DEM
 - Possibly drone or Laser scanner for small area, if needed
- Impervious surface classification
- Roadside feature extraction



QUESTIONS / DISCUSSION



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