Predicting flood damage probability across the conterminous United States

Elyssa L. Collins[1], Georgina M. Sanchez[1], Adam Terando[1,2,3], Charles C. Stillwell[4], Helena Mitasova[1,5], Antonia Sebastian[6], and Ross K. Meentemeyer[1,7]

Center for Geospatial Analytics, NCSU[1] | U.S. Geological Survey, Southeast Climate Adaptation Science Center[2] | Department of Applied Ecology, NCSU[3] | U.S. Geological Survey, South Atlantic Water Science Center[4] | Department of Marine, Earth and Atmospheric Sciences, NCSU[5] | Department of Earth, Marine and Environmental Sciences, UNCCH[6] | Department of Forestry and Environmental Resources, NCSU[7]

Background

Did you know that floods are the costliest natural disaster in the United States?
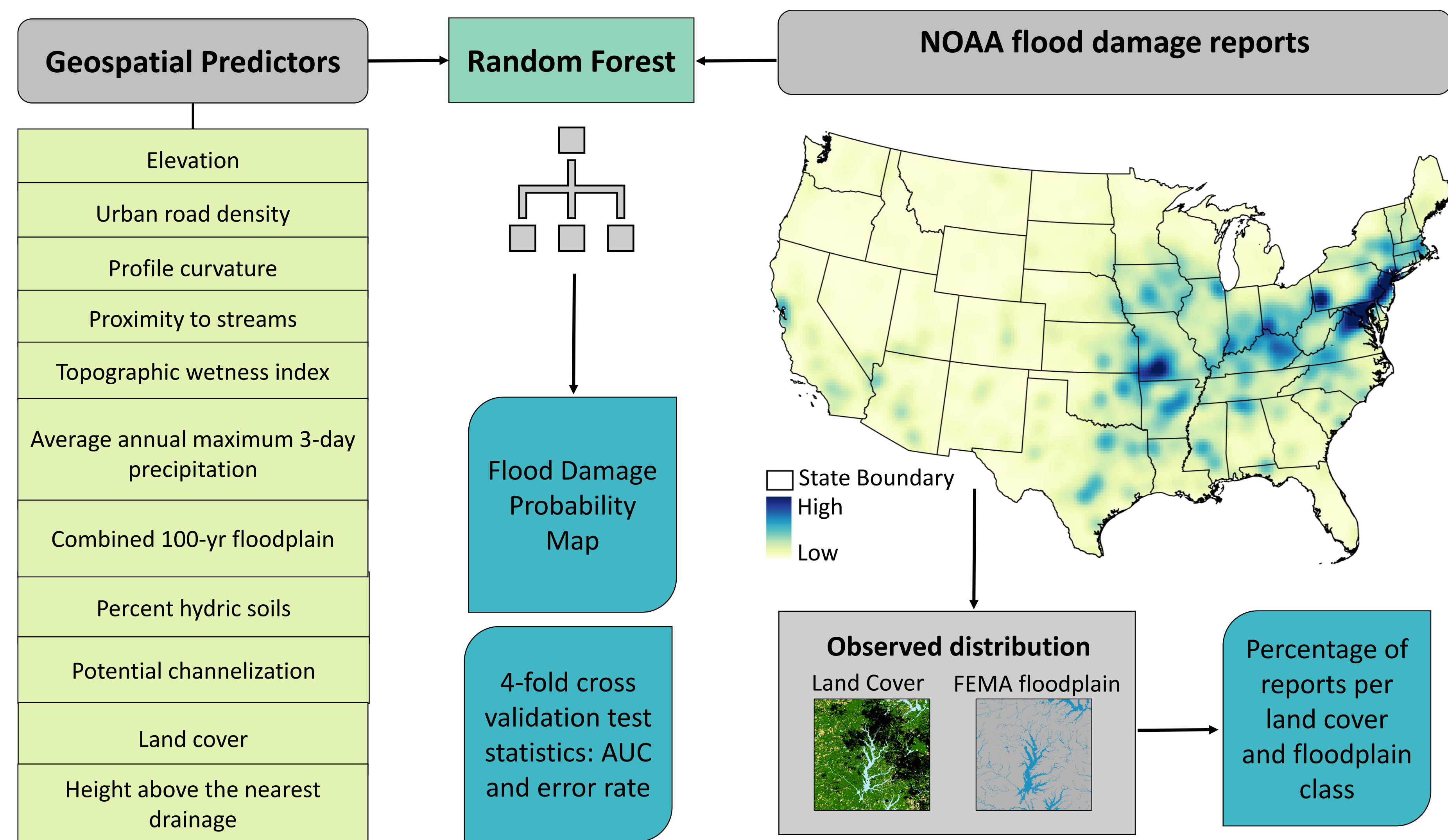
The problem

FEMA oversees the delineation of floodplains to mitigate flood damages, but disparities exist between locations designated as high risk and where flood damages occur due to land use and climate changes and incomplete floodplain mapping.

Our solution

Using Big Data and Machine Learning, we analyze the spatial distribution and underlying drivers of flood damage probability caused by excessive rainfall and overflowing water bodies. We produced the first spatially complete map of flood damage probability for the nation. Our approach can be easily updated in response to changing environmental conditions.

Modeling approach

Geospatial Predictors → **Random Forest** ← **NOAA flood damage reports**

Geospatial Predictors:
- Elevation
- Urban road density
- Profile curvature
- Proximity to streams
- Topographic wetness index
- Average annual maximum 3-day precipitation
- Combined 100-yr floodplain
- Percent hydric soils
- Potential channelization
- Land cover
- Height above the nearest drainage

Flood Damage Probability Map

4-fold cross validation test statistics: AUC and error rate

State Boundary
High
Low

Observed distribution
Land Cover   FEMA floodplain

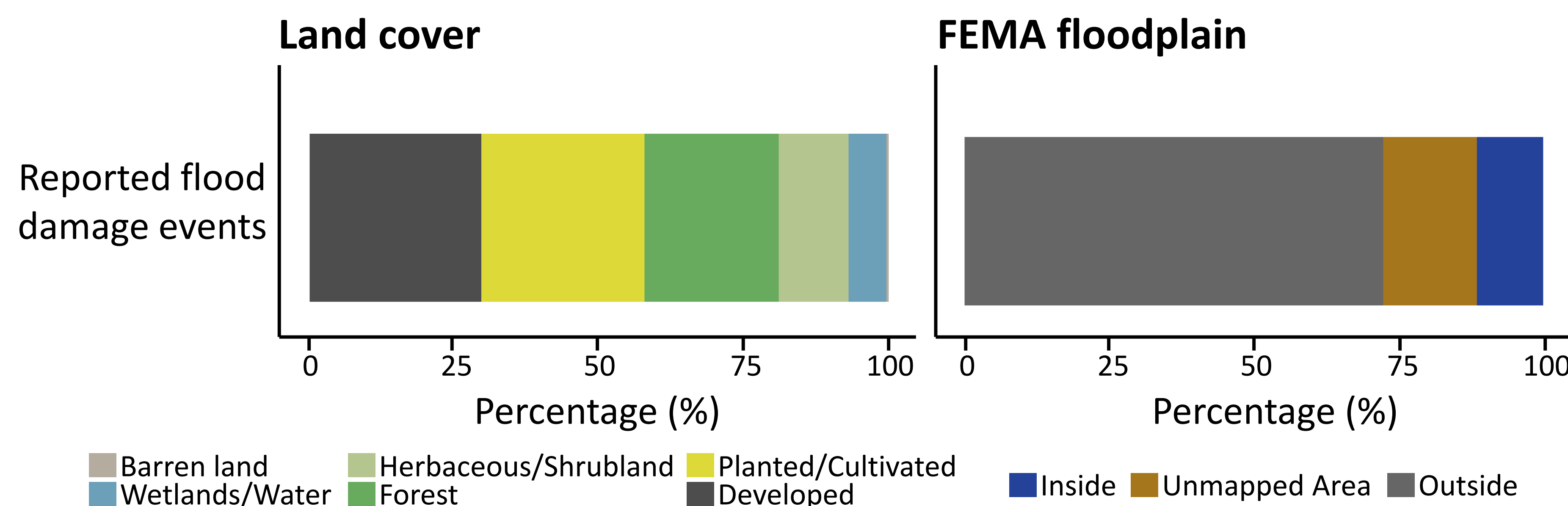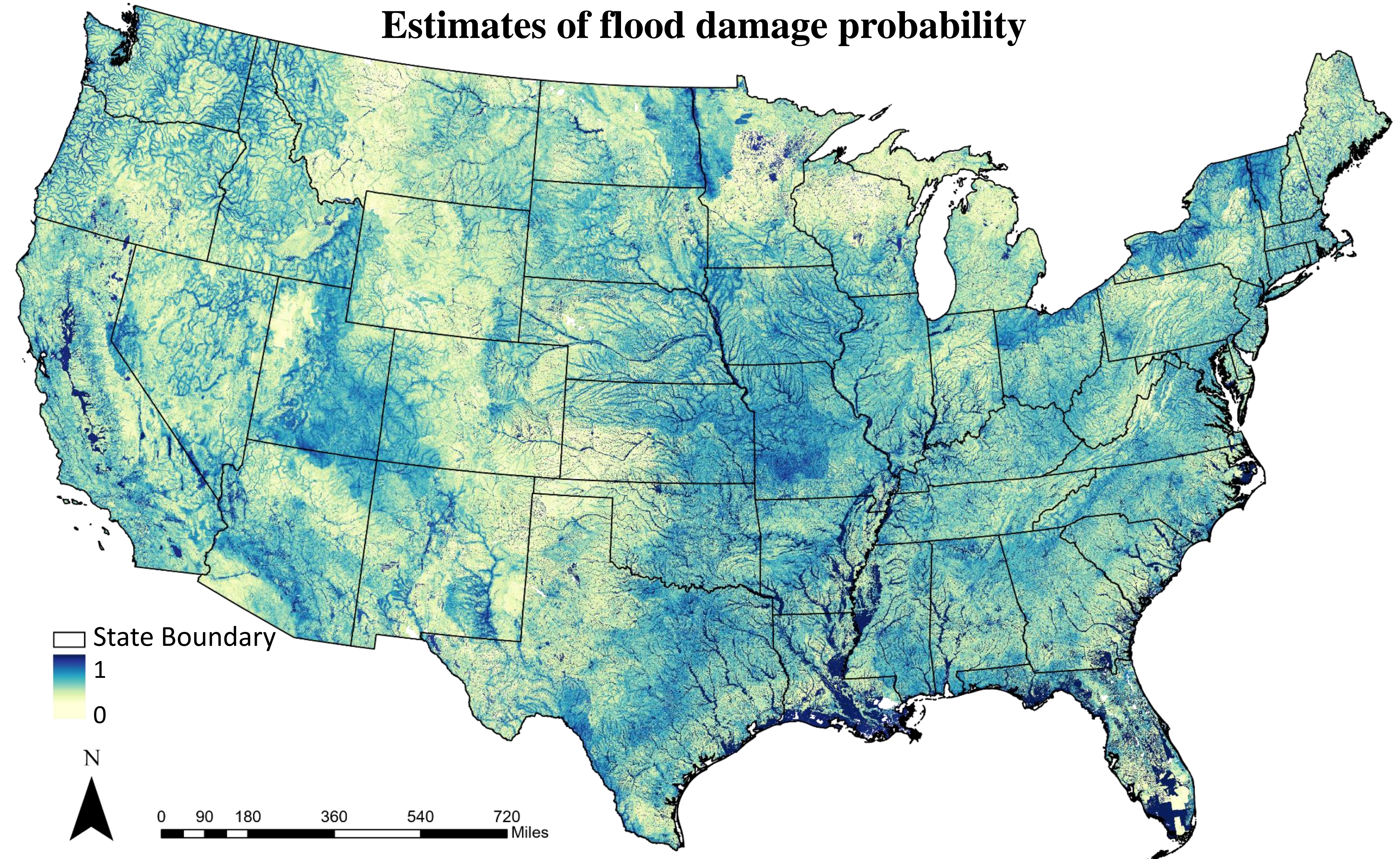Percentage of reports per land cover and floodplain class

Observed distribution

~85% of reported damage events between 2006-2020 were located outside of FEMA's high-risk zone
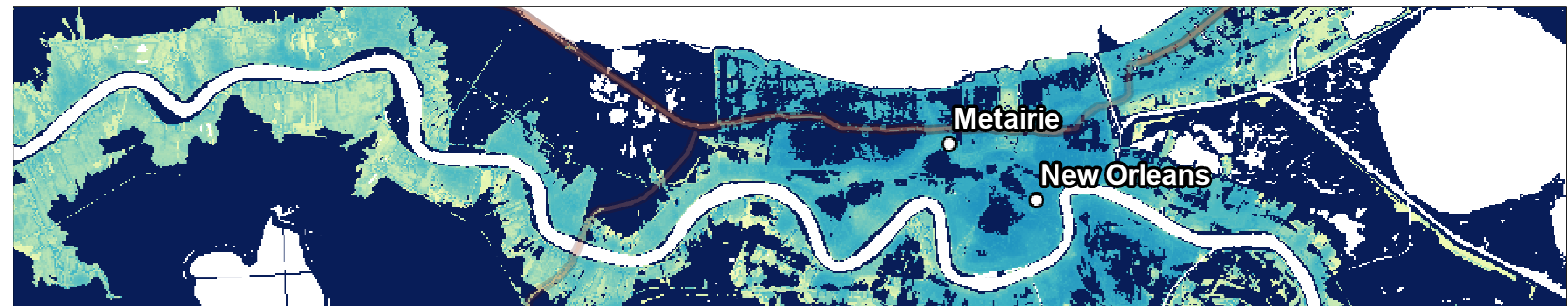
Most reported flood damage events were found in…
- Land cover: **developed** (29.6%) or **agricultural** (21.8%) areas
- FEMA floodplain: **outside** (68.3%) or in an **unmapped area** (16.2%)

Land cover / FEMA floodplain

Reported flood damage events

Percentage (%)

Barren land | Herbaceous/Shrubland | Planted/Cultivated | Wetlands/Water | Forest | Developed
Inside | Unmapped Area | Outside

Estimates of flood damage probability

State Boundary
1
0

N

0 90 180   360   540   720 Miles

A closer look at New Orleans, Louisiana…

Metairie
New Orleans

Findings published at: Collins et al. 2022. Predicting flood damage probability across the conterminous United States. Environmental Research Letters, 17(3), 034006.