Urban Water Innovation Network

Transitioning toward sustainable urban water systems

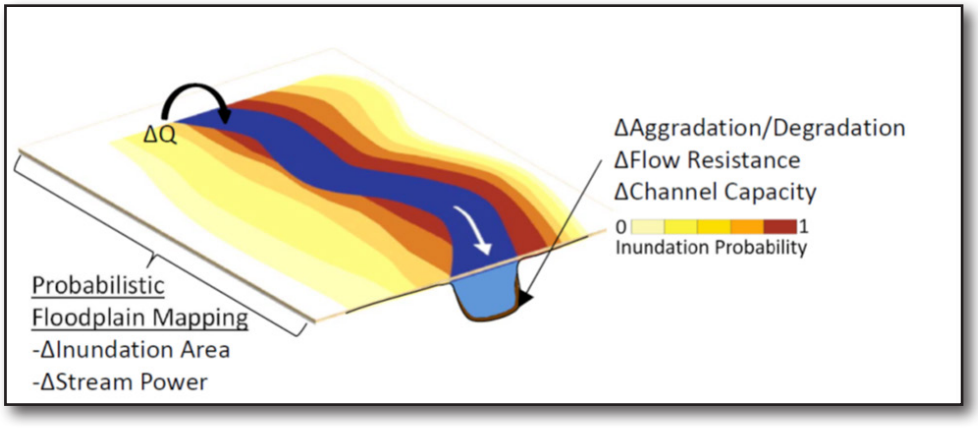
National Science Foundation
WHERE DISCOVERIES BEGIN

Project B2-2b
Hydrology and Hydraulics of Urban Floodplains

Novel techniques for analyzing and designing urban drainage and floodplain systems for increased resilience to extreme events can ultimately provide an expanded footprint and palette for design of floodplain-greenspace networks that improve water quality, increase biodiversity, moderate temperatures, cleanse air, and enhance human well-being.

Current research efforts seek to better understand the interactions between flood flows and urban channels, floodplains and riparian zones as influenced by urban infrastructure and efforts to mitigate impacts of urban development, green infrastructure (GI), low impact development (LID), and sustainable urban drainage systems (SUDS) on flood response and other environmental consequences.

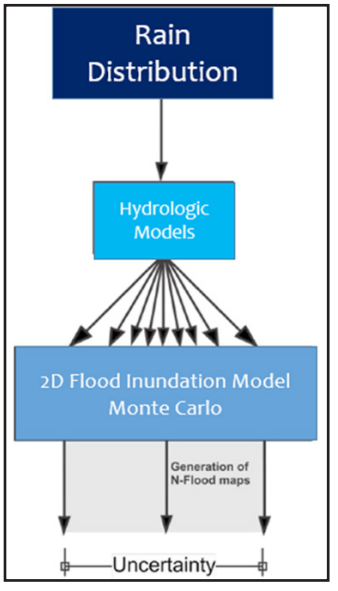
Flood characteristics to be studied include propagation of flood waves, inundation depth and areal extent, velocity and shear stress distributions, hydroperiod, and associated risks to life, property and infrastructure.



We expect to improve our current understanding of magnitude and frequency of flood peak discharges across the diverse range of watersheds within our study domain. We will identify regional thresholds and nonlinearities, and assess the sensitivity of peak discharge to upstream as well as local mitigation efforts within the channel and riparian zone.

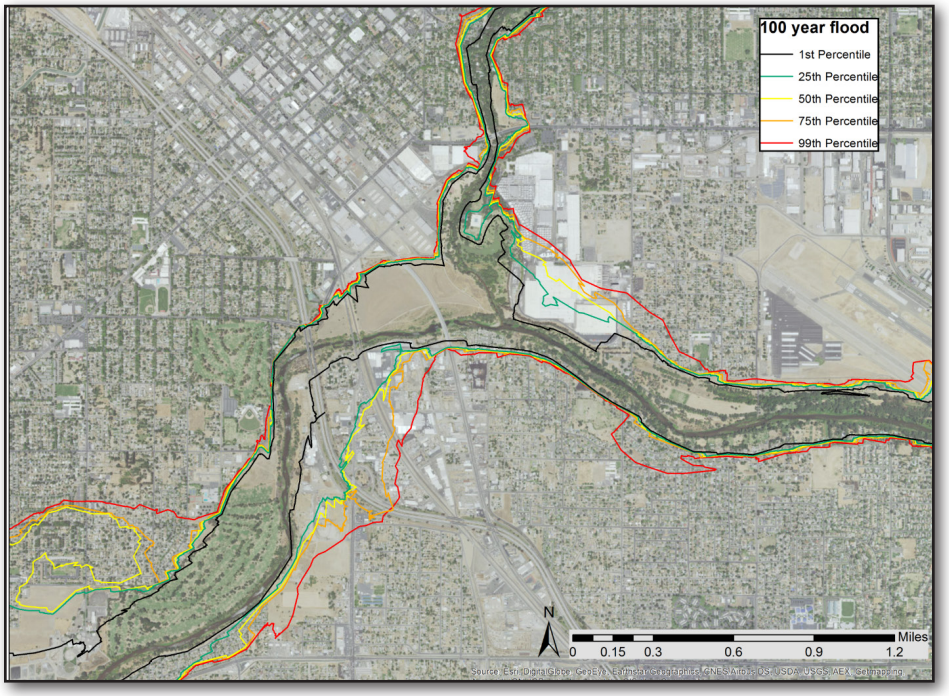
FLOODPLAIN MAPPING

Floodplain mapping assisted by modeling of flood hydraulics will represent baseline, development, and various conservation scenarios to examine how integrated GI, LID and SUDS can be strategically designed and positioned to simultaneously enhance flood resilience while providing multiple co-benefits.



The resulting floodplain inundation maps will be probabilistic and reflect uncertainty quantified through Monte Carlo analysis of model inputs and parameters, competing methods of linking precipitation and land use scenarios to generate flood frequency distributions, and innovative techniques for portraying channel morphodynamics and erosion hazards.

MODELING FLOOD HYDRAULICS



We plan to model flood hydraulics utilizing HEC-RAS 5.0.3, a 2-dimensional finite-volume code that solves the shallow-water equations using either a diffusion-wave option or the full St. Venant equations with eddy viscosity coefficients utilized in the turbulence closure.

The primary output data include georeferenced time series of flow depth and x- and y-components of velocity. Model results will be used to delineate inundation extents, spatial and temporal patterns of shear stress, Froude number, and measures of flood-wave attenuation vs translation along a study reach.

Ultimately, the model will generate flood hazard maps that provide a means for comparative analysis among competing mitigation and hydro-meteorological scenarios while explicitly communicating the uncertainty associated with flood hazard mapping.

These results can be used by the broader community to guide individual homeowner and management decisions regarding future development, mitigation strategies, and risk assessment.

Involvement and collaboration is possible through incorporation of existing hydraulic models and/or digital terrain models, flood documentation, infrastructure surveys (i.e. identification of critical, vulnerable, or failing infrastructure). Additional involvement can be facilitated by incorporating information on stakeholder and public perceptions of urban flooding and flood hazard assessment.

DATA REQUESTS

We intend to use the following data for model development and risk assessment:

- **Existing hydrologic and hydraulic models**
- **Digital terrain models**
- **Surveys of in-stream structures (bridges, culverts, etc.)**

PRODUCTS

We will produce metrics for assessing multiple dimensions of flood risk and to compare the relative sensitivity of these metrics to future climate scenarios, future development scenarios, and alternative mitigation scenarios.

This effort will provide insight on how novel techniques for designing urban drainage and floodplain systems for increased resilience to extreme events can ultimately provide an expanded footprint and palette for design of floodplain-greenspace networks that simultaneously provide flood resilience, increase biodiversity, moderate temperatures, cleanse air, and enhance health and happiness.

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