Life risk modeling for Lower San Joaquin River in California's Central Valley supports emergency response planning

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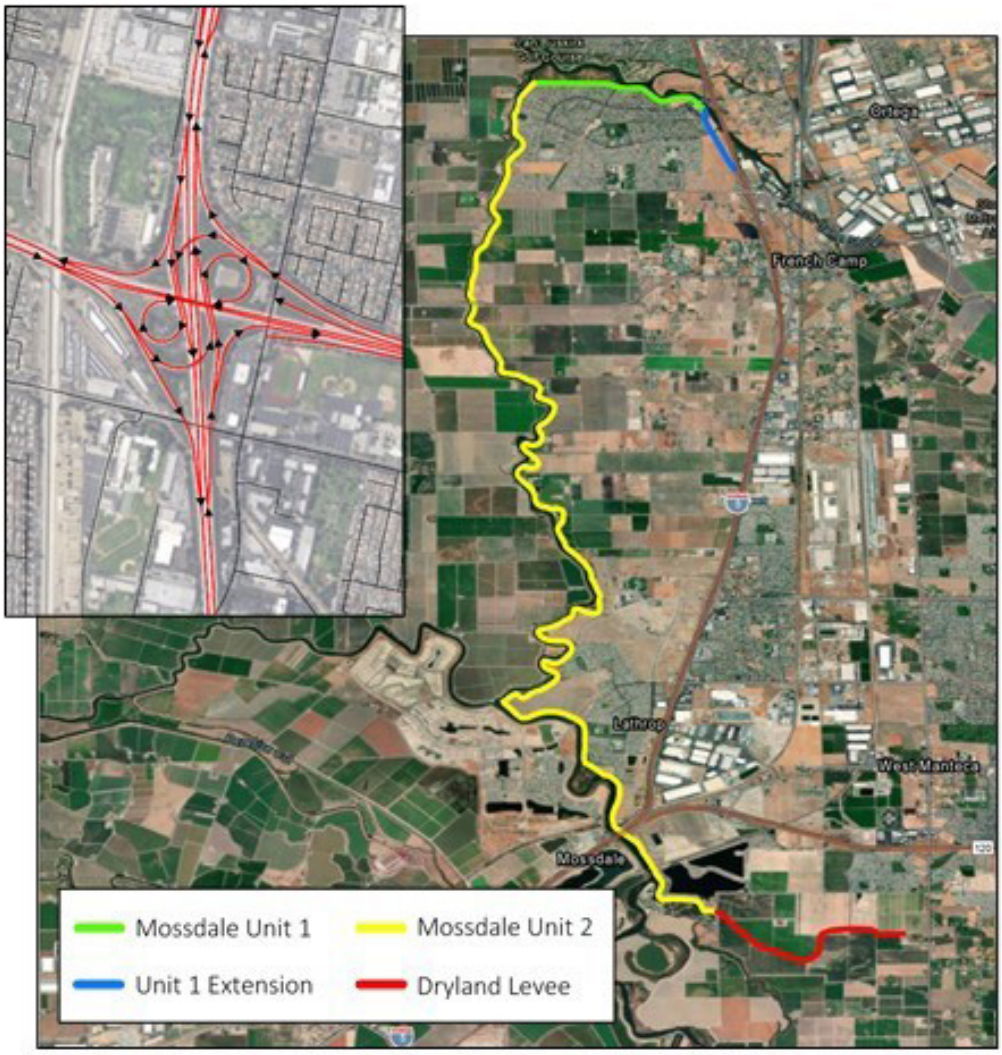
Along the Lower San Joaquin River in the Central Valley of California, emergency response managers in Reclamation District (RD) 17 have a new tool in their toolbelts: results from a life risk assessment conducted by the U.S. Army Corps of Engineers (USACE).

Through the Flood Plain Management Services (FPMS) program, USACE brought together federal, state and local representatives to complete a study looking at potential life loss in RD 17 under both present-day and future conditions. In the past, flood risk assessments within the district have sought to quantify economic damages and structural deficiencies. The RD 17 Risk Assessment, however, is the first study to focus exclusively on life risk. RD 17 includes the southern portions of the city of Stockton, the eastern portions of the city of Lathrop, the western portions of the city of Manteca and areas of unincorporated San Joaquin County.

The RD 17 study employed the USACE Hydrologic Engineering Center's Life Loss model, HEC-LifeSim 2.0. Model inputs for HEC-LifeSim 2.0 allow the user to enter three key pieces of information: (1) magnitude of a flood, (2) likelihood of infrastructure failure, and (3) resulting human behaviors. Five different scenarios were modeled for the RD 17 basin. Two were for future conditions, essentially turning the input "knob" responsible for flood size. Three were for present-day conditions, turning both the "knob" for infrastructure by adding levee improvements as well as the "knob" for human behavior by increasing floodplain development.

Much like life itself, life risk modeling is nuanced. "You can't tell this story with a single number," said Jesse Morrill-Winter, USACE technical lead for the RD 17 study. In an effort to capture some of the complexities involved in modeling life risk, Morrill-Winter and the USACE technical team met with RD 17 emergency managers and emergency responders. "We wanted to understand the procedures they had in place for warning and evacuation," Morrill-Winter said, "so we could build those input parameters into our model."



The Reclamation District 17 Levee System includes four levee segments, as illustrated in the map above. An elicitation with local partners informed the warning and evacuation relationships used in the RD 17 LifeSim 2.0 consequences model. The team simulated evacuation in LifeSim 2.0 to identify impacts to key egress routes using a road network similar to the inset photograph above. (Geographic Information System map of RD 17 Levee Segments and Road Network, 2020)

Results from the HEC-LifeSim 2.0 model show that current life risk for RD 17

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is relatively high. With climate change expected to increase flows coming down the San Joaquin River, this life risk for the existing population and critical infrastructure in RD 17 will continue to rise without levee improvements in place. However, RD 17 emergency managers now have a more complete understanding of these risks. They can better put their fingers on how flood size is tied not only to infrastructure but also to human behavior. Eric Nagy, who served as the non-federal RD 17 study project manager, put it this way: "You can predict with reasonable certainty when a levee is going to overtop but often can't predict when a levee is going to fail." He points out that overtopping of a levee and failure of a levee create two very different emergency response scenarios. "For one, you might encourage people to get in a car and evacuate. For the other, you might tell people to get on the roof of their house," said Nagy. In the latter case, residents may not have time to sit in traffic.

Emergency response planning falls under the umbrella of nonstructural risk mitigation. While time and resources are required to develop emergency action plans, to educate community members and to encourage evacuation readiness, these nonstructural mitigation measures are much less expensive than pricier structural improvements. Without adopting nonstructural mitigation measures, "We are leaving a lot of life risk reduction potential on the table," said Jason Needham, a USACE advisor and reviewer for the RD 17 Risk Assessment. "Nonstructural measures may cost some money. Yet, while their economic benefits are pretty minimal, the life risk benefits tend to be really significant."

Other areas of northern and central Stockton along the Lower San Joaquin River were included in a January 2018 USACE feasibility study, determining remediation measures most appropriate for flood risk reduction. However, due to questions around the application of Executive Order 11988 to RD 17, RD 17 was deferred from the first phase of the feasibility study. The RD 17 Risk Assessment has begun to prepare the partners for a subsequent feasibility study by providing needed collaboration and additional analysis around this previously controversial issue. "We are very grateful," said Chris Elias, executive director of the San Joaquin Area Flood Control Agency (SJAFCA), which requested the FPMS study.

Above, a dryland levee in the southern section of Reclamation District 17 illustrates the current conditions of flood control infrastructure along the Lower San Joaquin River corridor. (Photo courtesy of Manteca Bulletin, 2020)

The RD 17 Risk Assessment allowed USACE to act as an objective third party and "review both the system and the human plans to react to the system," said Scott Shapiro, general counsel for SJAFCA.

Now, with the results in hand, emergency managers in RD 17 are more equipped to reduce life risk. "We have to sharpen our pencils when it comes to evacuation plans," Elias said. SJAFCA is seeking federal funding for the subsequent feasibility study. If funded, this subsequent feasibility study would be able to place life risk and economic risk in RD 17 side-by-side and, ultimately, inform future levee system improvements.