Study finds flooding damage to levees is cumulative—and often invisible

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Recent research finds that repeated flooding events have a cumulative effect on the structural integrity of earthen levees, suggesting that the increase in extreme weather events associated with climate change could pose significant challenges for the nation's aging levee system.

"Traditionally, levee safety inspections are based on visible signs of

distress on the surface," says Rowshon Jadid, a Ph.D. candidate at North Carolina State University and first author of a paper describing the research. "What we've found is that as a levee goes through repeated flood events, it gets weaker—but the damage may be invisible to the naked eye."

"This is particularly relevant now, since we're seeing severe flooding more often," says Brina Montoya, co-author of the paper and an associate professor of civil, construction and environmental engineering at NC State.

The study draws on data from the Princeville levee in North Carolina, as well as flooding associated with hurricanes Floyd and Matthew.

Levees are earth embankments that protect against flooding—and there are a lot of them. According to the U.S. Army Corps of Engineers, there are 45,703 levee structures in the United States, stretching for 27,881 miles. On average, they're 56 years old.

"Because these levees are aging, and we have limited resources available to maintain them, we need to determine which levees should be prioritized for rehabilitation efforts that will reduce their risk of failure," Jadid says.

"There are inspection regimes in place, where officials look for signs of distress and structural damage," says Mohammed Gabr, co-author of the paper and Distinguished Professor of Civil Engineering and Construction at NC State. "However, some of these visual signs can be missed and, in many cases, by the time we can see the problem, it's either too late or too expensive to fix.

"The work we've published here demonstrates the increased risk of levee failure with the repeated flooding cycles and serves to help the

profession with identifying levees with the highest risk of failure before signs of distress are visually observed."

Researchers are in the process of using this study's findings, as well as additional data, to develop tools that can facilitate more accurate identification of levee damage and the development of more accurate failure criteria.

The paper, "Effect of repeated rise and fall of water level on seepage-induced deformation and related stability analysis of Princeville levee," is published in the journal *Engineering Geology*. The paper was co-authored by Victoria Bennett of Rensselaer Polytechnic Institute.

More information: Rowshon Jadid et al, Effect of repeated rise and fall of water level on seepage-induced deformation and related stability analysis of Princeville levee, *Engineering Geology* (2019). DOI: 10.1016/j.enggeo.2019.105458

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