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Opinion

Monitoring of Earthen Levees in Urban and Agricultural Areas

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Flooding of urban and agricultural lands due to earthen levee breaches may persistently affect soils, crop productivity, water quality and land use, causing economic and social damages.

In addition to overtopping and slopes instability, internal erosion phenomena (i.e. backward piping erosion, concentrated leaks erosion, contact erosion, suffusion) triggered by seepage flow process through the embankments represent the main causes (approximately 40 percent) of earthen levees failures.

The detection of these dangerous, often hidden, phenomena is difficult. In addition to "conventional" instruments (e.g. piezometers, seepage discharge readings) only allowing local/punctual measurements, among the available methods for monitoring internal erosion processes, distributed (or linear) thermal sensors, based on fiber optics, recently became popular.

Temperature measurements can provide information about seepage flow velocities, allowing the identification of the development and evolution of erosion channels (pipes) and zones of higher permeability, in turn induced by internal erosion processes. Moreover, linear measurements technologies (e.g. DTS, Distributed Temperature Sensing) allow real-time and continuous spatial monitoring along all the earthen hydraulic structure, with higher spatial accuracy, and are often endowed by automatic alarm systems.

Their reliability in the detection has been ascertained through field and laboratory (at the large and small scales) experiments, as well as numerical analyses of the coupled seepage and heat transfer processes within embankments.

However, few earthen structures currently under operation are endowed by these monitoring systems based on DTS (e.g. Ajaure dam, Sweden).

To control the safety of these defence hydraulic structures, which may be compromised by the reaching of serviceability (change of discharge, turbid water) or ultimate limit states (local or global instabilities, piping, structural collapses), water flood management strategies associated with levee-protected agricultural systems should thus be dominated by policies focusing on the development of more reliable and appropriate monitoring instruments networks, possibly including thermal (fiber optics) sensors together with "traditional" piezometric heads and seepage discharge readings.

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