

Supporting information for the paper: “Evidence of an emerging levee failure mechanism causing disastrous floods in Italy”

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1. Introduction

In section 4.3 of the paper, it is reported that numerical modeling of the system considered in hypothesis 3 reveals that no critical soil saturation around the den chamber is obtained by applying separately one of the two components of the observed hydroclimatic forcing, namely river stage and direct rainfall on the levee. The present document provides supporting information by illustrating the results obtained from the numerical modeling mentioned in the paper.

2. River Stage Only Forcing the Levee

The response of the system considered in hypothesis 3 (section 4.3 of the paper) to river stage only (no direct rainfall on the levee) is illustrated in Figure S1. The

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11 saturation front does not reach the den chamber.

12 **3. Direct Rainfall Only Forcing the Levee**

13 The response of the system considered in hypothesis 3 (section 4.3 of the paper)
14 to direct rainfall on the levee only (no river stage) is illustrated in Figure S2. The
15 saturation front does not reach the den chamber.

16 Figure Captions

Figure S1. Simulated response of the levee of the Secchia River at San Matteo to river stage (Figure 3b of the paper) in the case sketched in Figure 10 of the paper (hypothesis 3). The simulation period started at time 12-22-2013 0:00 to mitigate memory effects on the reconstructed levee status. The reconstructed fields of volumetric soil water content and pressure are reported at times 01-18-2014 22:00 (Figures S1a and S1d), 01-19-2014 0:30 (Figures S1b and S1e), and 01-19-2014 4:00 (Figures S1c and S1f). The term “saturation” reported in the legend of Figure S1a is used in the FEFLOW program to denote the volumetric soil water content. The white line denotes the phreatic (zero pressure) surface. In Figures S1d–S1f, white levee portions are obtained where the soil water pressure is below the minimum value reported in the legend.

Figure S2. Simulated response of the levee of the Secchia River at San Matteo to direct rainfall on the levee (Figure 2b of the paper) in the case sketched in Figure 10 of the paper (hypothesis 3). The simulation period started at time 12-22-2013 0:00 to mitigate memory effects on the reconstructed levee status. The reconstructed fields of volumetric soil water content and pressure are reported at times 01-18-2014 22:00 (Figures S2a and S2d), 01-19-2014 0:30 (Figures S2b and S2e), and 01-19-2014 4:00 (Figures S2c and S2f). The term “saturation” reported in the legend of Figure S2a is used in the FEFLOW program to denote the volumetric soil water content. The white line denotes the phreatic (zero pressure) surface.

17 Figures

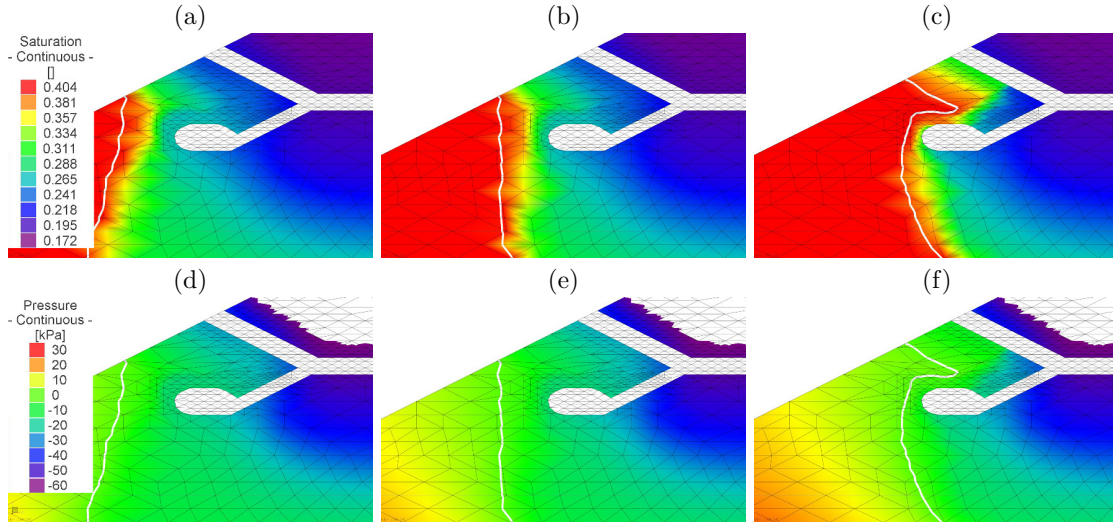


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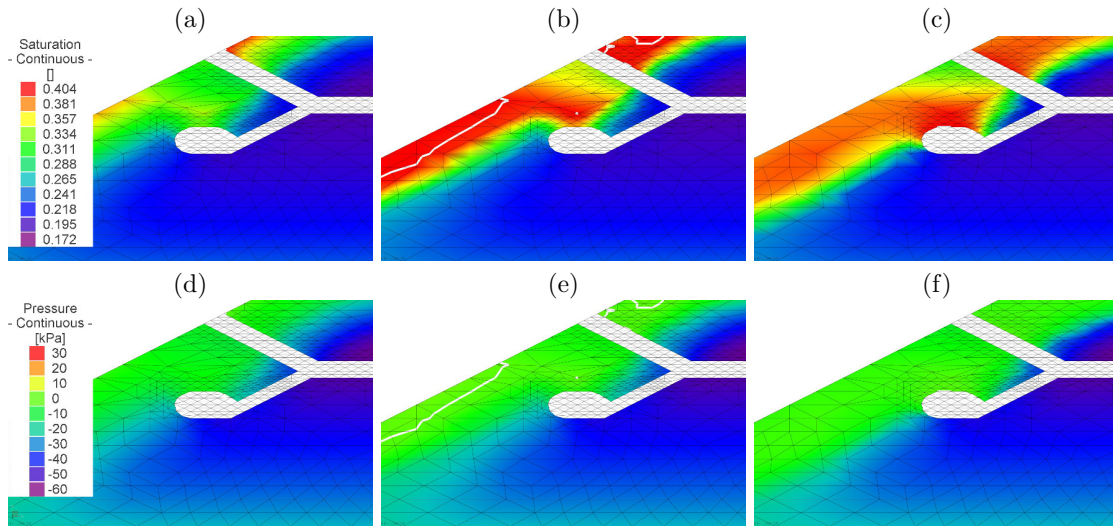


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