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Discussions

Interactive comment on "Effectiveness of distributed temperature measurements for early detection of piping in river embankments" *by* Silvia Bersan et al.

Anonymous Referee #2

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The article describes firstly a test carried out in the framework of the project IjkDijk to investigate an impact of the development of the piping in the foundation of a small-earth-damming-structure on the thermal-field of this structure and, secondly, it attempts to interpret the results of this test. Thirdly, it presents the results of numerical modelling that are not directly related to this test. The modelling was carried out to examine the temperature gradients that could be generated by internal erosion. The authors did not presented the relevant literature background related to the impact of the internal erosion including particularly the piping influence on thermal field of soil/damming structures. The conclusions from literature could be helpful in the interpretation by the authors of results of their test. Some of the presented conclusions are already

described in the literature. The chapters should have more logical sequence and arrangement. In my opinion this is interesting paper in terms of the verification of the suitability of thermal method in application to piping detection. However, the article requires significant adjustments before publication in HESS.

The order of chapters should be changed. Description of model and theory concerning the geothermal Péclet number should be presented before the trial test description.

The authors presented in the introduction some information about previous research concerning mechanical aspect of piping process and failure criteria. However they did not mentioned the existing research results concerning main goal of the paper, i.e., about the thermal influence of internal erosion on soil/damming-structure temperature field, and particularly of the backward erosion and piping thermal influence. Relevant information can be found in a thesis of Guidoux (2008), a thesis of Radzicki (2009), two papers of Radzicki and Bonelli from 2010 and Bonelli and Radzicki (2012). Moreover, a similar test, like described in this paper, was carried out in 2009, also in the framework of the IjkDijk project that gave some interesting and important results. This test is not mentioned in the reviewed paper.

The title of chapter 2 "Early detection of internal erosion" should be changed. It does not correspond well to the content of this chapter.

The chapter 3.3 contains some information that could have been presented] in chapter 3.4, and conversely]. I suggest to merge them in one chapter.

The authors use often the words "erosion" or "internal erosion". It would be more clear if there be an explanation what the internal erosion is and that piping (backward erosion piping) is one of the internal erosion processes.

p.1, rows 9-11 "This work investigates the effectiveness of DTS for dike monitoring, focusing on early detection of backward erosion piping, a mechanism that affects the foundation layer of structures resting on permeable, sandy soils." Remark: Reader

may think that the piping always affects the foundation layer only. I propose to write for example “...focusing on early detection of backward erosion piping for the case of a mechanism that affects the foundation layer. . .”

p.3, row 8 "The use of DTS for early detection of internal erosion is nowadays common practice in dam monitoring” Remark : Bibliographic references to confirm this conclusion should be included

p.3, rows 23-27 "Among these are electrical resistivity, selfâĂŘpotential and temperature (Sheffer et al., 2009). These methods have a common feature: they provide spatially distributed measurements. Unfortunately they also have a common shortcoming: they measure quantities that are influenced by a large number of variables besides the occurrence of internal erosion, which makes data interpretation not straightforward and ambiguous.” Remark: Indeed, the electrical resistivity and selfâĂŘpotential measure quantities that are particularly influenced by a large number of variables. Contrary, the thermal method is influenced mostly by humidity variation and water flow.

p.3, row 30 "Because of conduction....” Remark: It would be more precisely to write “In the case of only conduction heat transport in the soil (without water flow) ...”

p.4, rows 1-2 "While moderate seepage flow occurring in the soil does not affect the temperature field determined by heat conduction, significant seepage (rates higher than 10-7 - 10-6 m/s) produce variations in the soil temperature.” Remark: Temperature distribution in soil, including changes of temperature field generated by seepage depend not only on water velocity but also on length of the seepage path, so we can say as well that temperature distribution depends on Péclet number that contains both these variables. The same water velocity results in different temperature field variation depending on the scale of a damming structure. In consequence, the authors should better explain their conclusion, referring it for example only to a limited range of the scale of damming structures.

p.4, rows 4-6 "Johansson and Sjödal (2009) observed that, in dams, the regions af-

fected by internal erosion are typically characterized by a temperature similar to the reservoir water, while the temperature in the other regions of the flow domain is nearly unaffected by the reservoir temperature.” Remark: It is not clear what the authors explain by this paragraph. If it is an example to confirm the previous sentence that “Since internal erosion promotes the formation of zones of higher permeability and, consequently, a local increase of seepage rate, it is expected that it also causes a local variation of the temperature field ”they should add “for example Johansson and Sjödal (2009) observed that, ...” There are different possible results of internal erosion development on temperature field. Research results of Radzicki and Bonelli (2012), Radzicki and Bonelli (two papers in 2010) explained that the thermal influence of internal erosion depends on: - the permeability of the soil which surrounds the zone of internal erosion - the type of internal erosion process and level of its development (geometrical and/or mechanical) - the scale of a damming structure For example, one of possible results of internal erosion development is that the water reservoir temperature is transported only to the upstream side of the damming structure. In consequence, on one hand there is no effect of water reservoir temperature on the downstream side of damming structure temperatures. On the other hand, the transport of heat from the downstream slope into the body of the damming structure is affected by local acceleration of water flow due to the internal erosion development, which allows to detect leakages and internal erosion.

p.8, rows 22-26 "For this reason, the mechanism that promoted the formation of piping-induced thermal anomalies was not, as commonly found in the literature, the prevalence of advection in the eroded regions in opposition to the purely conductive behaviour of the regions unaffected by piping. This occurs because the assumption of conductive behaviour in the unaffected regions (Johansson and Hellström 2001; Johansson and Sjödal 2009) only applies to low permeability bodies such as dam cores..” Remark : The thermal effect of piping development in soil, comparing with the case of soil without piping, was analyzed for different value permeability of soil and for different advection transport intensity (Péclet value from 0.1 up to 100) in the thesis of

Radzicki (2009) and presented as well in Radzicki and Bonelli (2010).

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