Geophysical Research Abstracts
Vol. 14, EGU2012-5102, 2012
EGU General Assembly 2012

DTS monitoring of boil seepage in deltas

K.P. Hilgersom and N.C. van de Giesen

Delft University of Technology, Faculty of Civil Engineering and Geosciences, P.O. Box 5048, 2600 GA Delft, The Netherlands (k.p.hilgersom@tudelft.nl)

In many coastal lowland areas, the exploitation and drainage of fresh water induces an upward seepage discharge from the salt groundwater layer. The seepage has different appearances, of which boil seepage often accounts for the largest salt flux into polder systems (De Louw et al., 2010). A boil is a very local salt water upconing that mainly occurs in polder ditches where the pressure gradient often is larger compared to the adjoining land. The large corresponding salt flux makes measuring boil seepage of specific interest.

Many current methods to measure seepage discharge into streams use heat as a tracer. Most of these methods require penetration of the stream bed with several temperature sensors to derive the seepage flux from the bed's temperature profile. Our aim is to measure this flux inside the water body: this makes the equipment easy to install and prevents disturbing the bed.

With the introduction of Distributed Temperature Sensing (DTS), measurement of temperature profiles is possible with the use of a single fiber optic cable. Westhoff et al. (2007) used this method to measure the groundwater-surface water interaction in a small first order stream. Because the cross-section was small and the flow velocity high, he could assume a well-mixed temperature over the cross-section and use a 1-D model to find the interacting fluxes with the stream bed. This assumption does not apply to polder ditches that only have a significant discharge when excess water is being pumped out of the system. In these situations, a fiber optic cable deployed along the stream can only locate groundwater sources (Hoes et al., 2009).

To this end, we created a measurement setup that measures the temperature profile above the boil inflow in three dimensions. From this temperature profile, the local seepage discharge can be deduced.

References

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