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Piping and subsurface heterogeneity: A scale model

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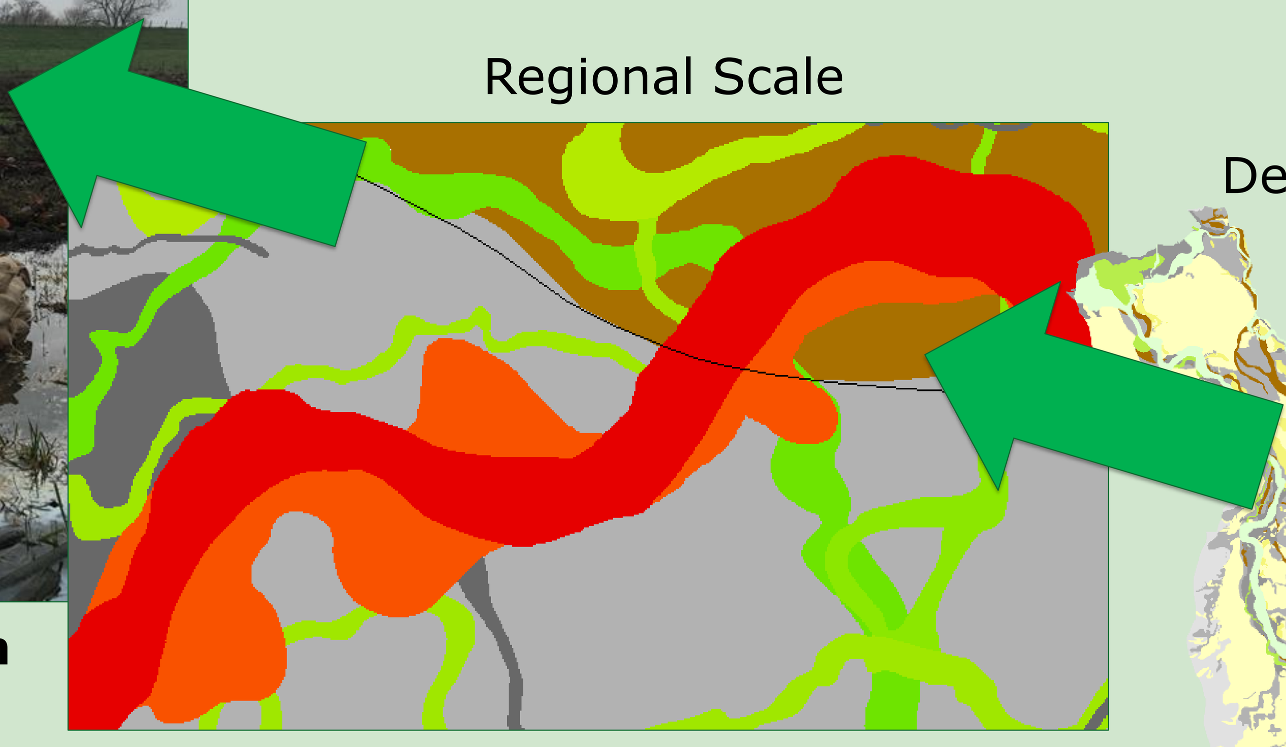
Piping on different scales

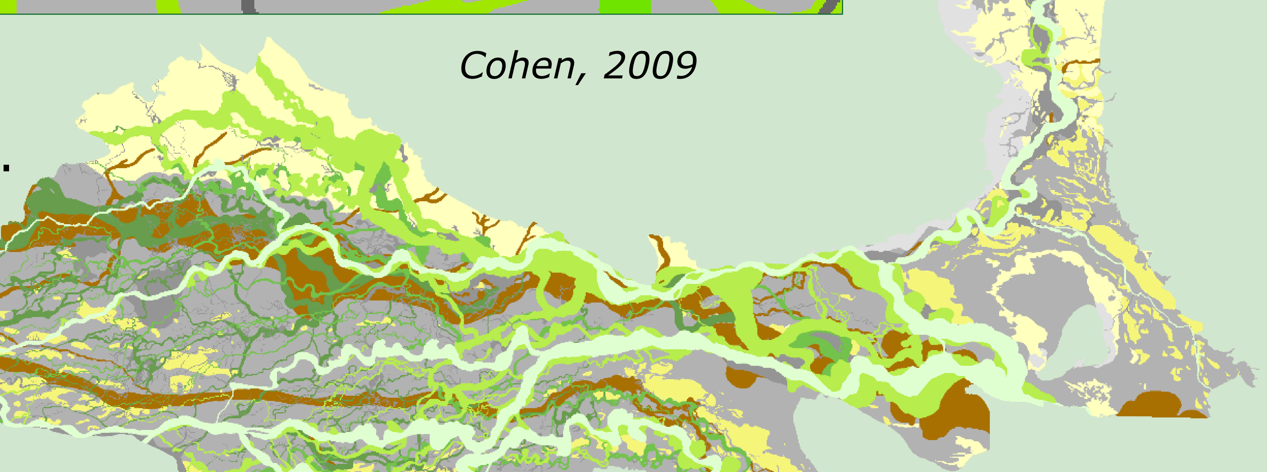
Process Scale

Regional Scale



Cohen, 2009

Delta Scale

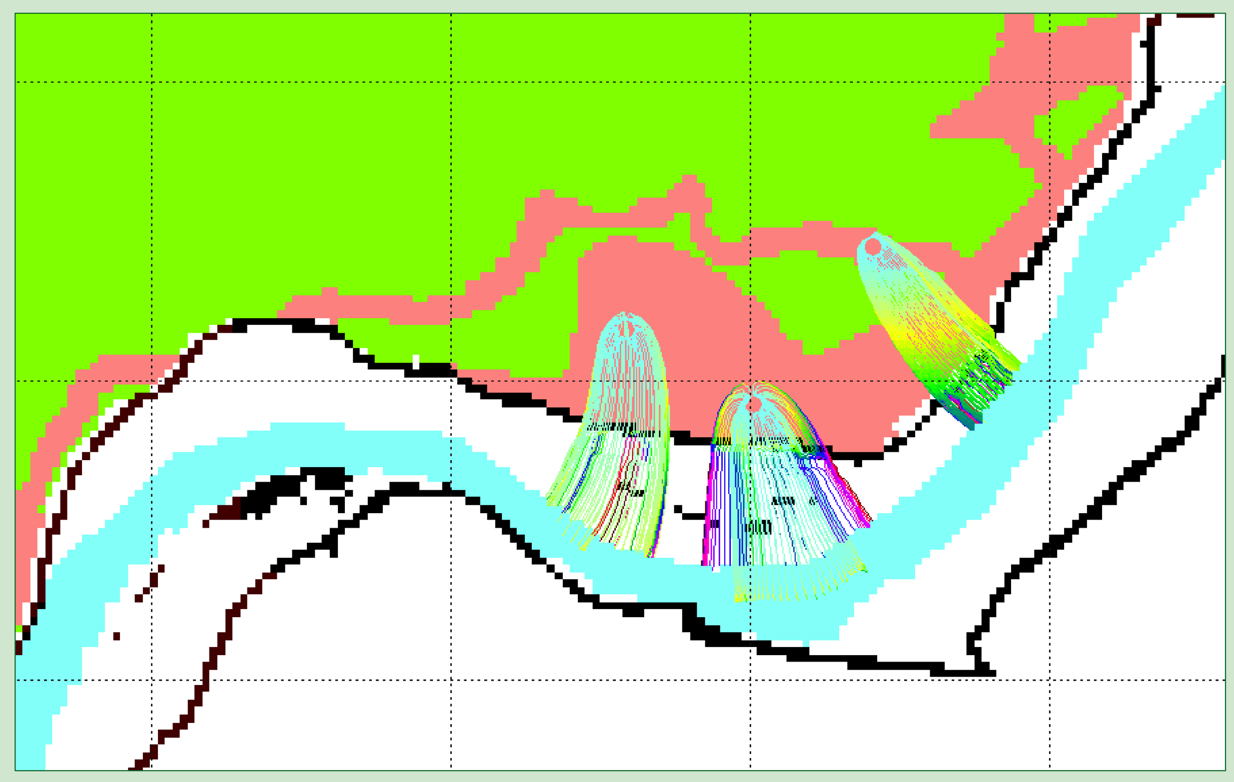


Winkels, in prep

Piping is the creation of a subsurface pipe as a result of seepage induced erosion (usually during high water events). This process can be approached from different scales. On the **delta scale** general delta wide trends can be used to predict **general piping conditions**. On the **regional scale** the position and orientation of individual channel belts **precondition piping potential**. At the **process scale** small scale subsurface variations determine if **piping is able to progress.**

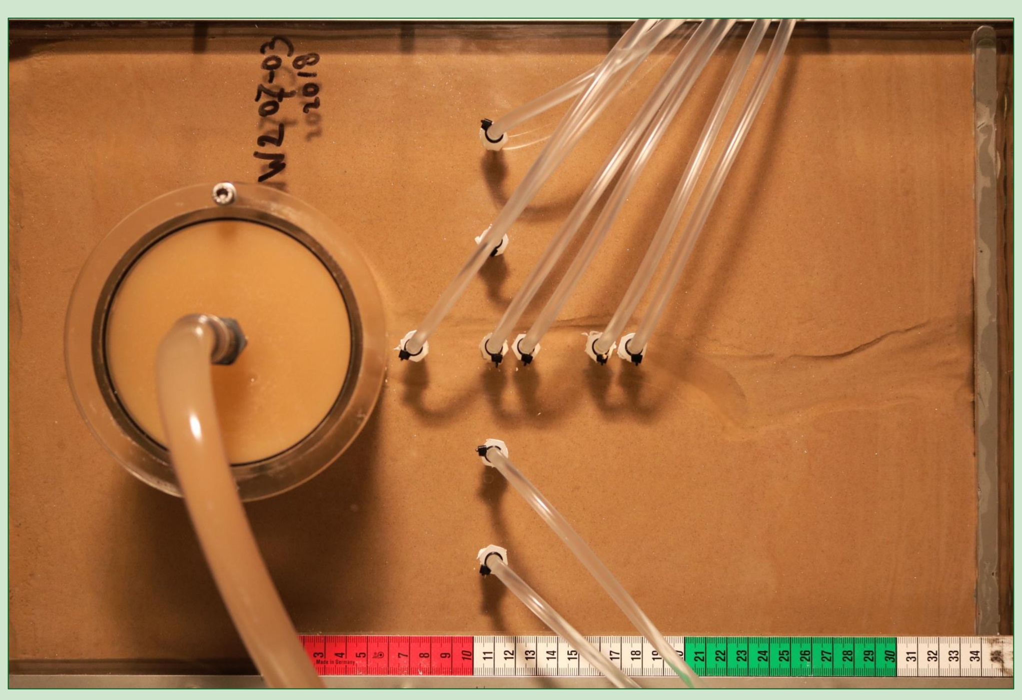
Regional scale model

The first scale at which modelling is possible is the regional scale. Here the locations of ditches relative to the river and levees precondition **regional hydraulic gradients**. These determine where the seepage through **upbursting** of the toplayer occurs, creating a **concentrated seepage outflow point.** Since such potential locations are fixed this predetermines the associated discharge and potential for piping to occur. Potential upburst and piping locations are thus fixed to the **position of channel belts** as they determine **regional flow paths**.

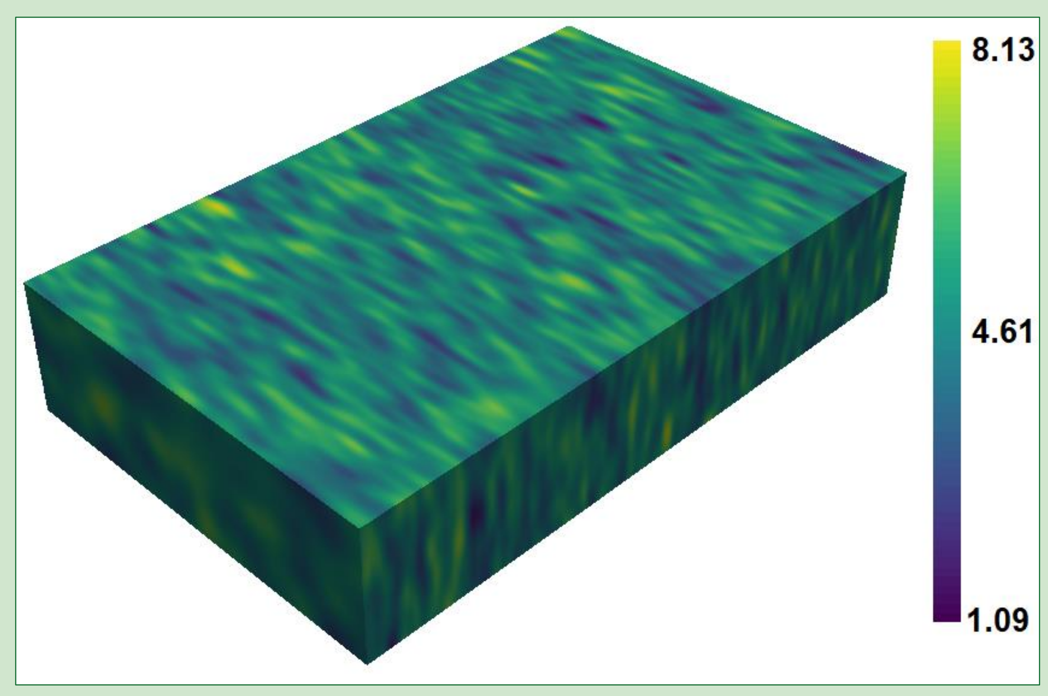


De Kock, 2019

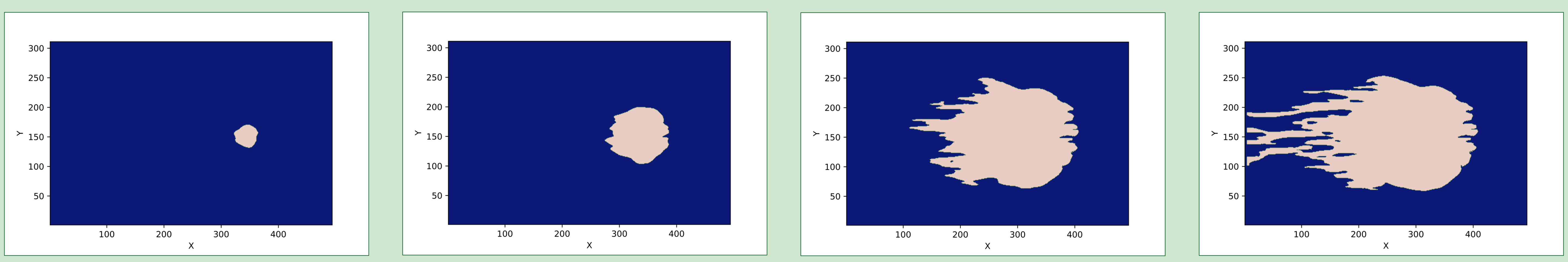
Process scale experiment



In a **laboratory setting**, several sand samples were mixed and subjected to a hydraulic head difference between an inflow filter on one side and a **single exit point on the top** of the experiment. As the top of the experiment was see-through the **progress of the pipe could be monitored visually** (left). The results of this experiment are used to calibrate a digital model (right). **See the QR code for an animated version**



Process scale modelling



A hydraulic flow field is calculated in the model **based on the gradient** between the entry surface for flow on the left hand side to the outflow point in the top of the model at three quarters of the length of the model. Per modelling step **the capacity for erosion is calculated** (beige area) and the field is updated for the next modelling step. Using this method critical gradients and potential erosional paths for the piping process relative to the stochastic build up of the subsurface can be determined. **See the QR code for an animated version.**

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