

Report on the flume experiments: Italian tests

Deliverable D_3.2.2

Contributing partners:

LP – UNIPD DICEA

Laboratory physical model

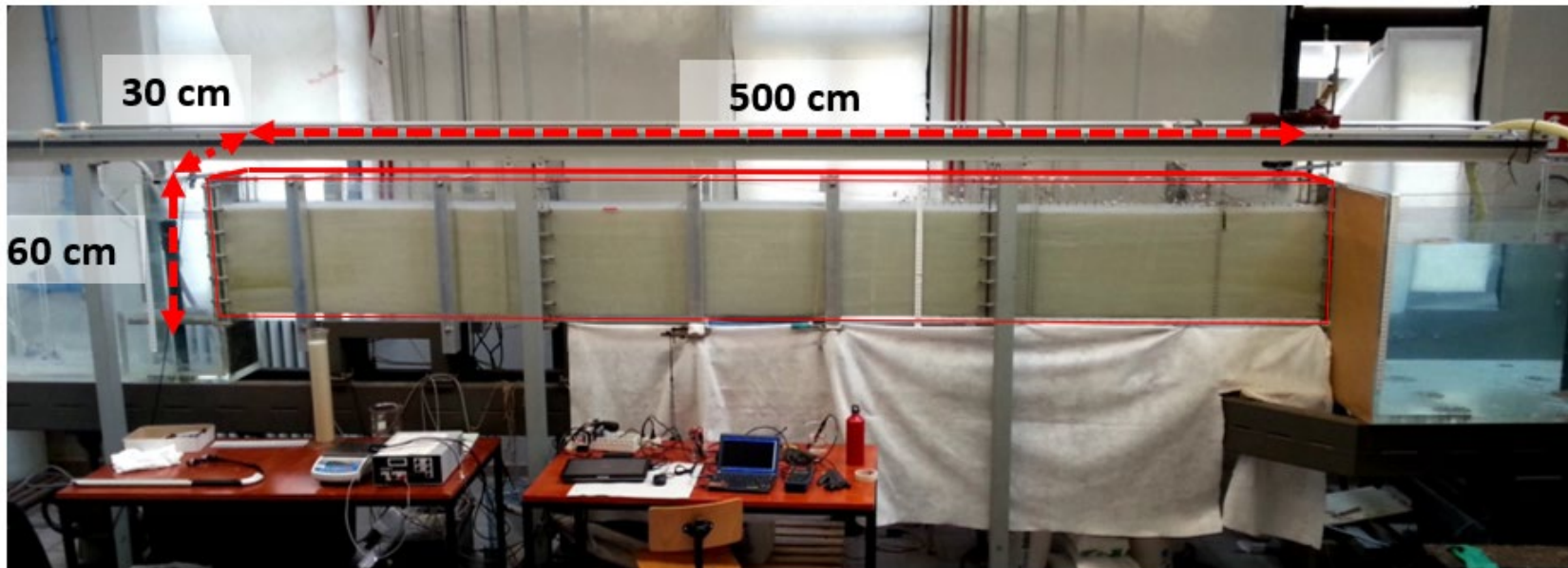
Why a physical model?



What kind of physical model?

- to realize benchmarks for numerical model assessment in several non common situations
- as simple as possible, with redundant and reliable measurements
- not simplistic at the same time, able to simulate the evolution of the salt wedge, the effect of a freshwater withdrawal or underground barriers in homogenous or heterogeneous media

The sand-box



A SPECIFICALLY DESIGNED PLEXIGLASS CANAL
IN THE HYDRAULIC AND HYDRAULIC WORKS LABORATORY OF PADOVA

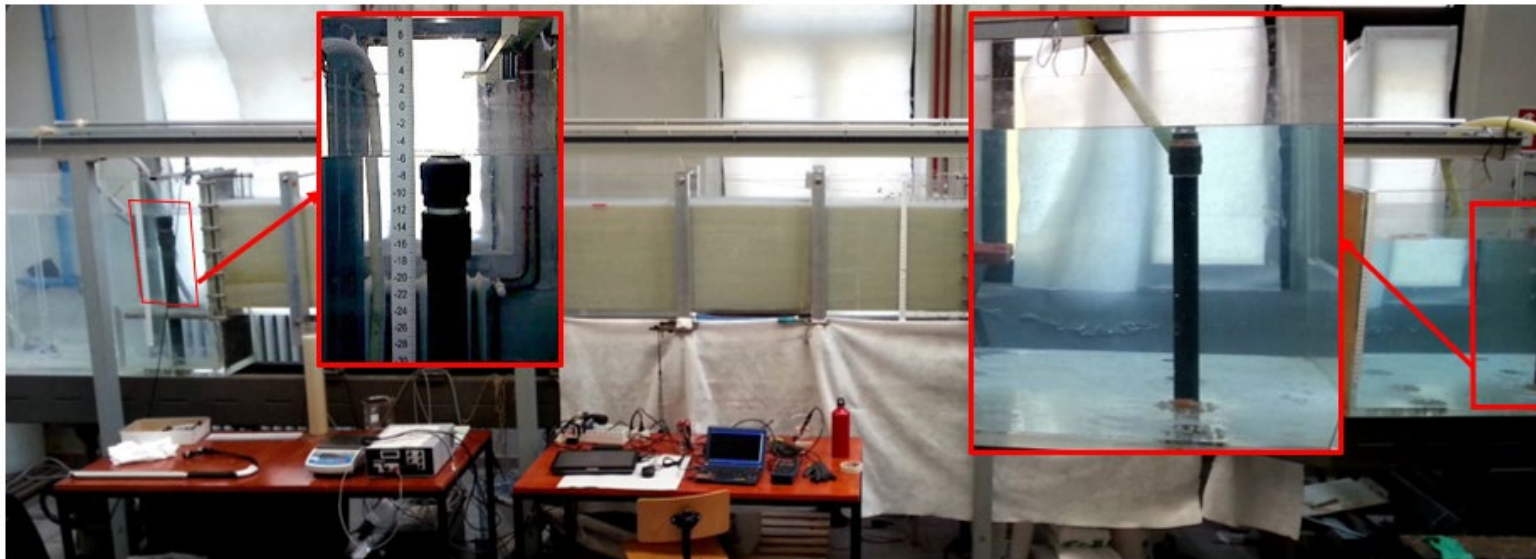
The sand-box



$$V \approx 0.32 \text{ m}^3$$
$$\rho \approx 1000 \text{ kg/m}^3$$

$$V \approx 1.57 \text{ m}^3$$
$$\rho_s \approx 1025\text{-}1030 \text{ kg/m}^3$$

The sand-box



$V \approx 0.32 \text{ m}^3$
 $\rho \approx 1000 \text{ kg/m}^3$
 $H_{\text{ups}} \approx 42\text{-}46 \text{ cm}$

$V \approx 1.57 \text{ m}^3$
 $\rho_s \approx 1025\text{-}1030 \text{ kg/m}^3$
 $h_{\text{downs}} \approx 40\text{-}44 \text{ cm}$

The sand-box



AUXILIARY UPSTREAM TANK FOR
RECIRCULATION AND CONSTANT
SUPPLY DELIVERY

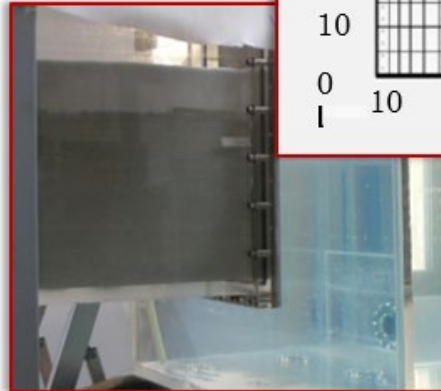
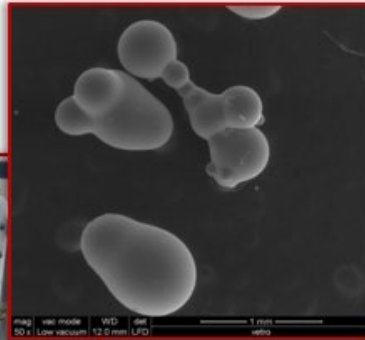
AUXILIARY DOWNSTREAM TANKS
FOR VOLUMETRIC DISCHARGE
MEASUREMENT

The glass beads

- Sodium-calcium glass beads
- $d_{50} \approx 0.6 \text{ mm}$
- $C_u = d_{60}/d_{10} \approx 1.5$

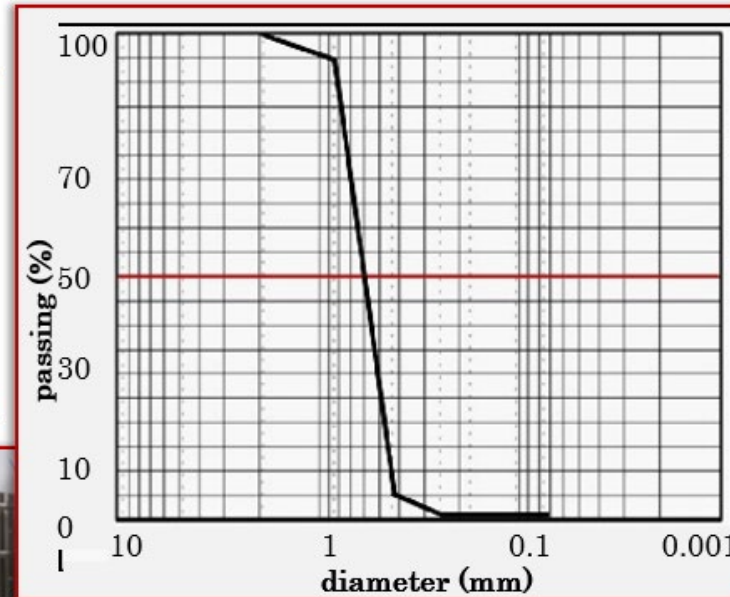


Sieving and compaction by impact (thickness of layers: 5 cm)

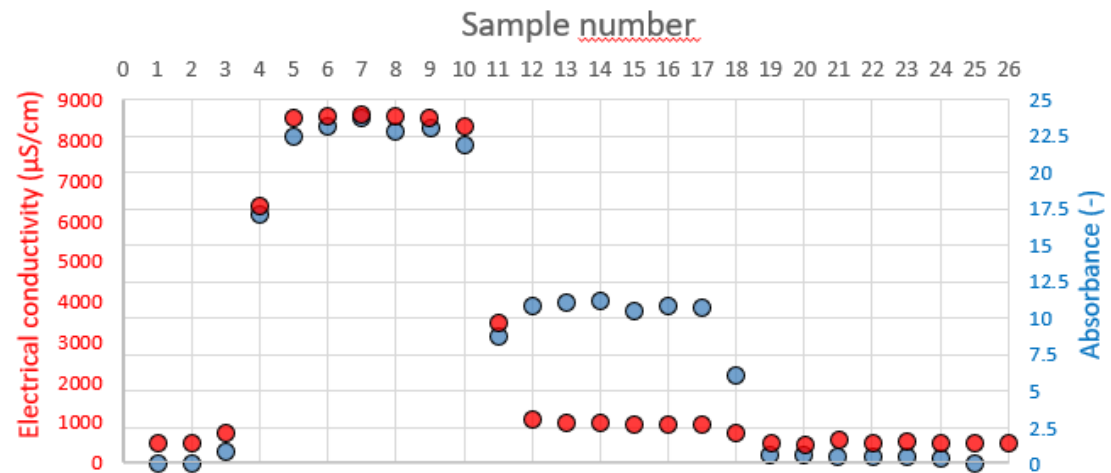


almost a uniform medium...

Slow saturation of the porous medium to avoid air bubbles



Food dye as saltwater tracer

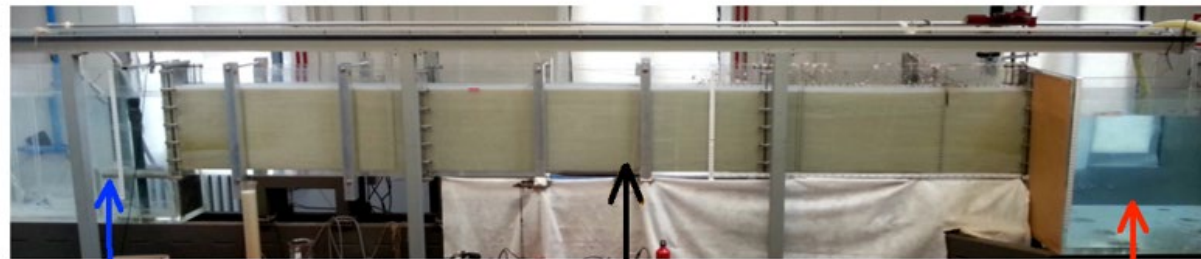


Electrical conductivity (conductivity meter) and absorbance (spectrophotometer) of the colored salt water have the same trend



The color intensity is proportional to the salt concentration
(no color means no salt in the water!)

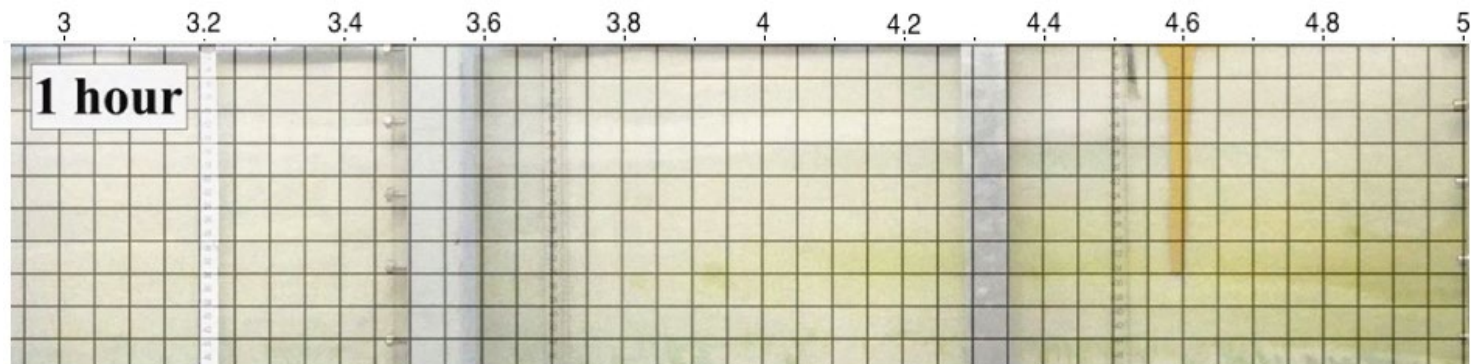
The cut-off wall in the homogenous media



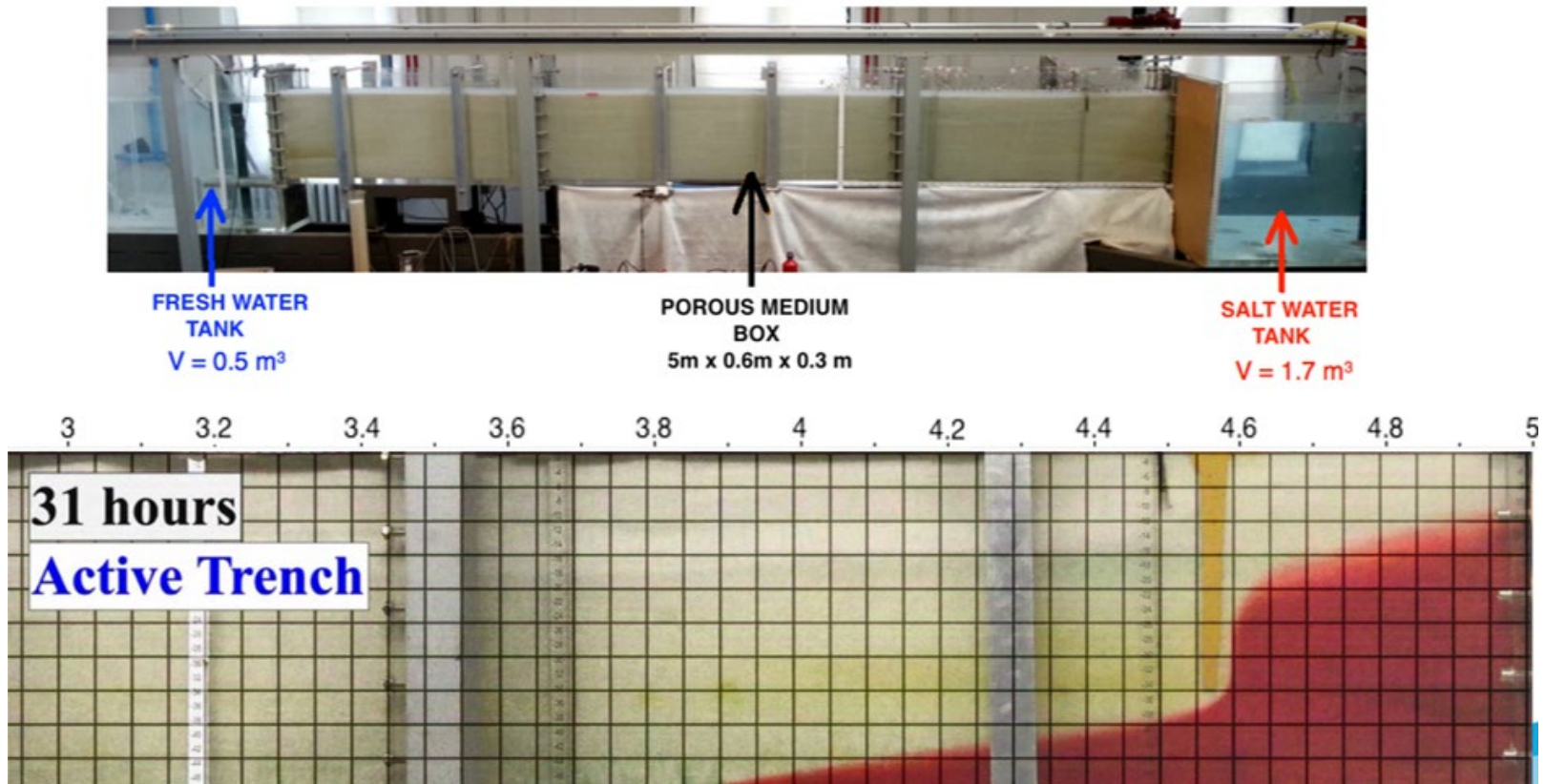
FRESH WATER
TANK
 $V = 0.5 \text{ m}^3$

POROUS MEDIUM
BOX
 $5\text{m} \times 0.6\text{m} \times 0.3\text{m}$

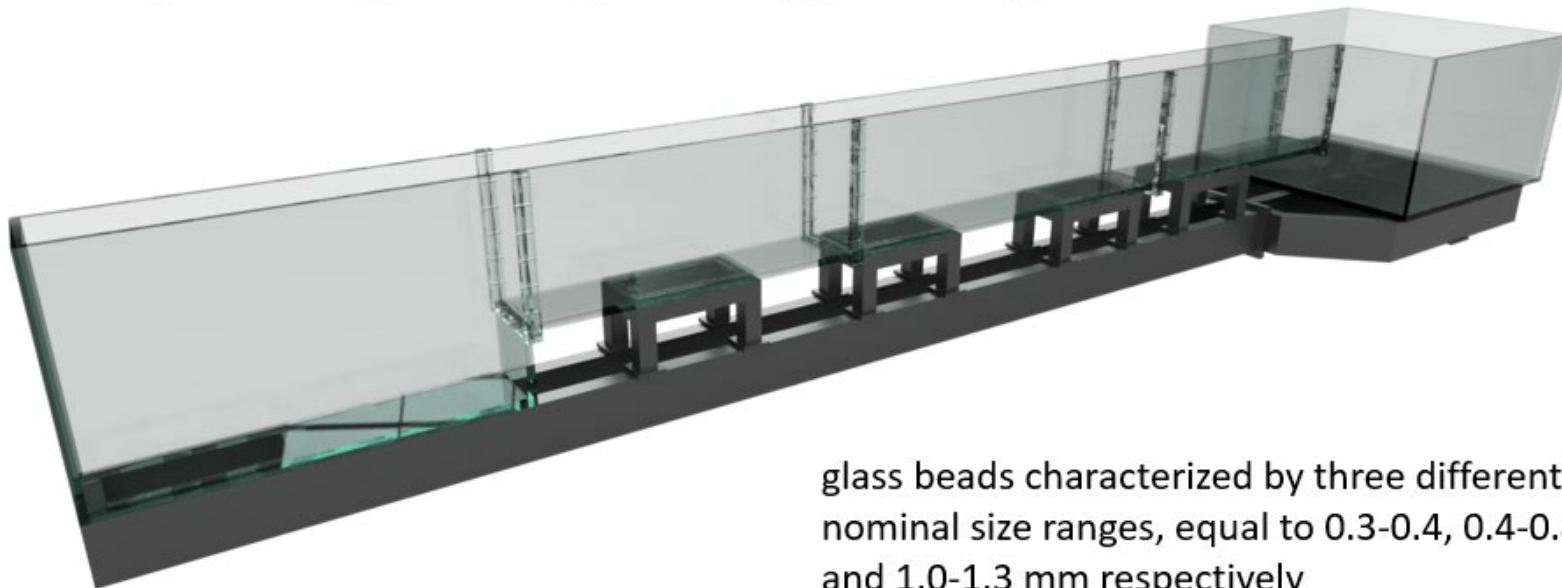
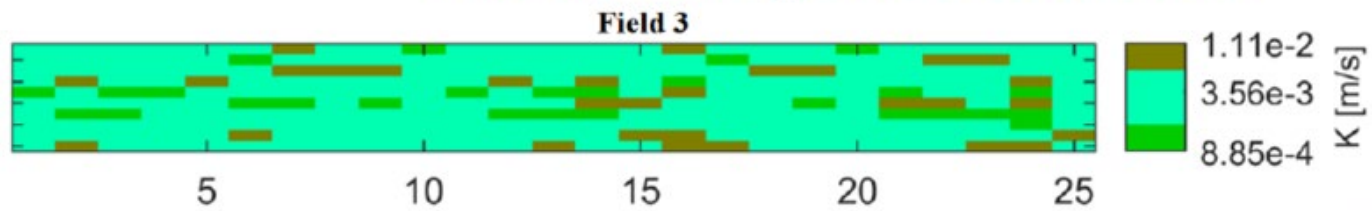
SALT WATER
TANK
 $V = 1.7 \text{ m}^3$



The cut-off wall in the homogenous media

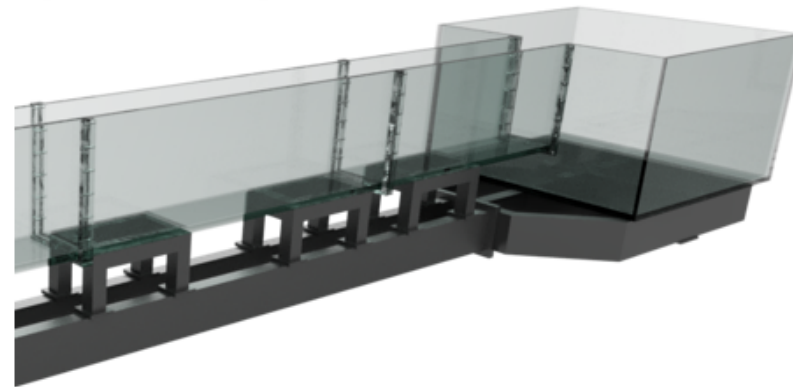
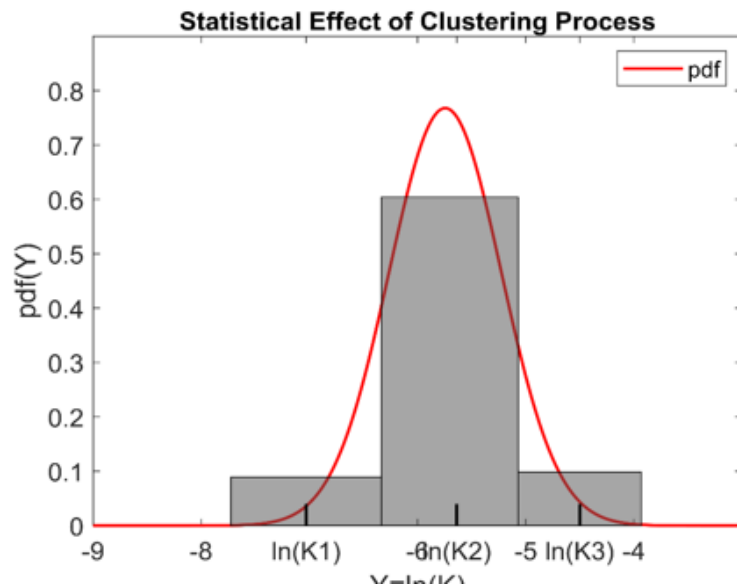
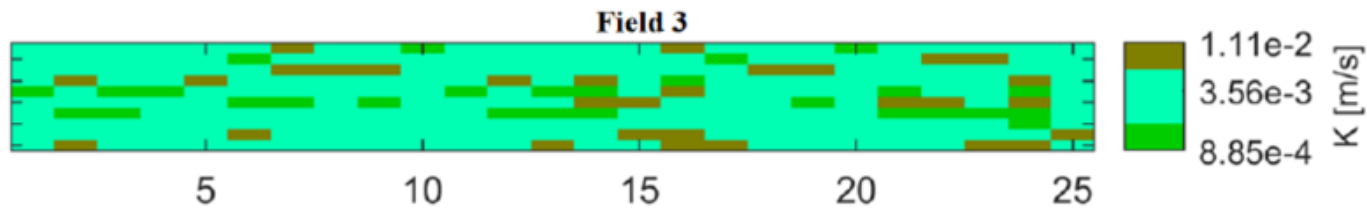


The heterogeneous media



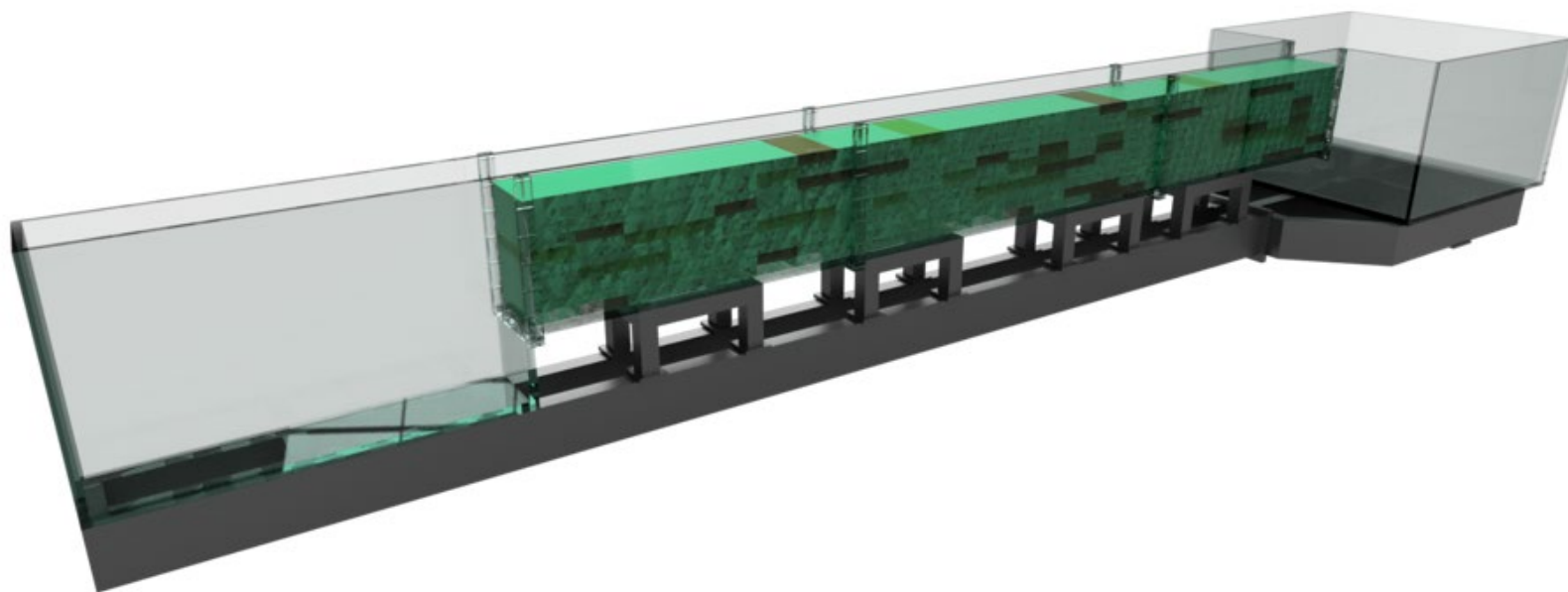
glass beads characterized by three different nominal size ranges, equal to 0.3-0.4, 0.4-0.8 and 1.0-1.3 mm respectively

The heterogeneous media



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The heterogeneous media

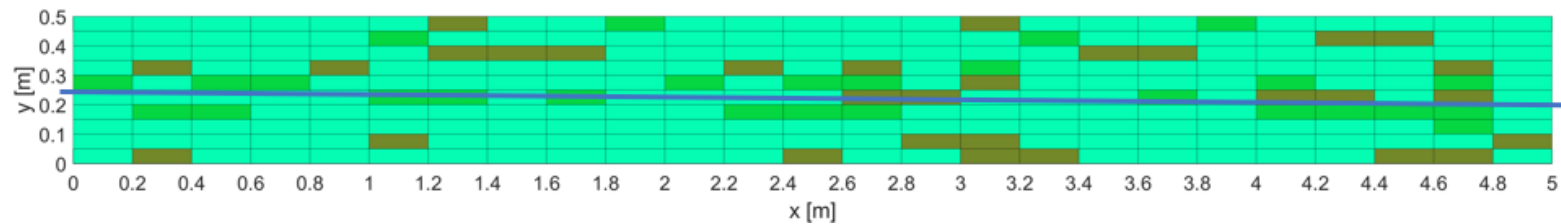


The heterogeneous media

Hydraulic characterization of the heterogeneous formation

Developed considering the filtration process that affects different thicknesses of the aquifer (10, 20, 30, 40 cm) forced by three upstream-downstream head differences (2, 4 and 6 cm)

An example: aquifer thickness 20 cm, head difference 4 cm

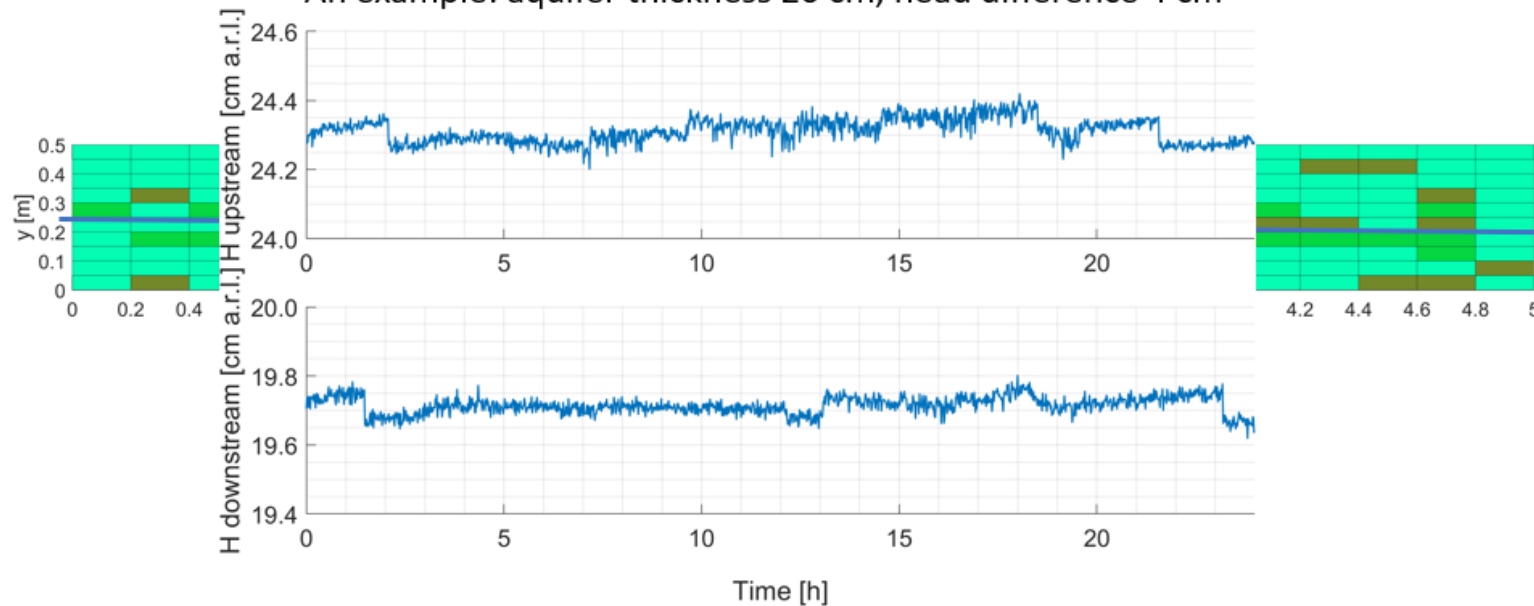


The heterogeneous media

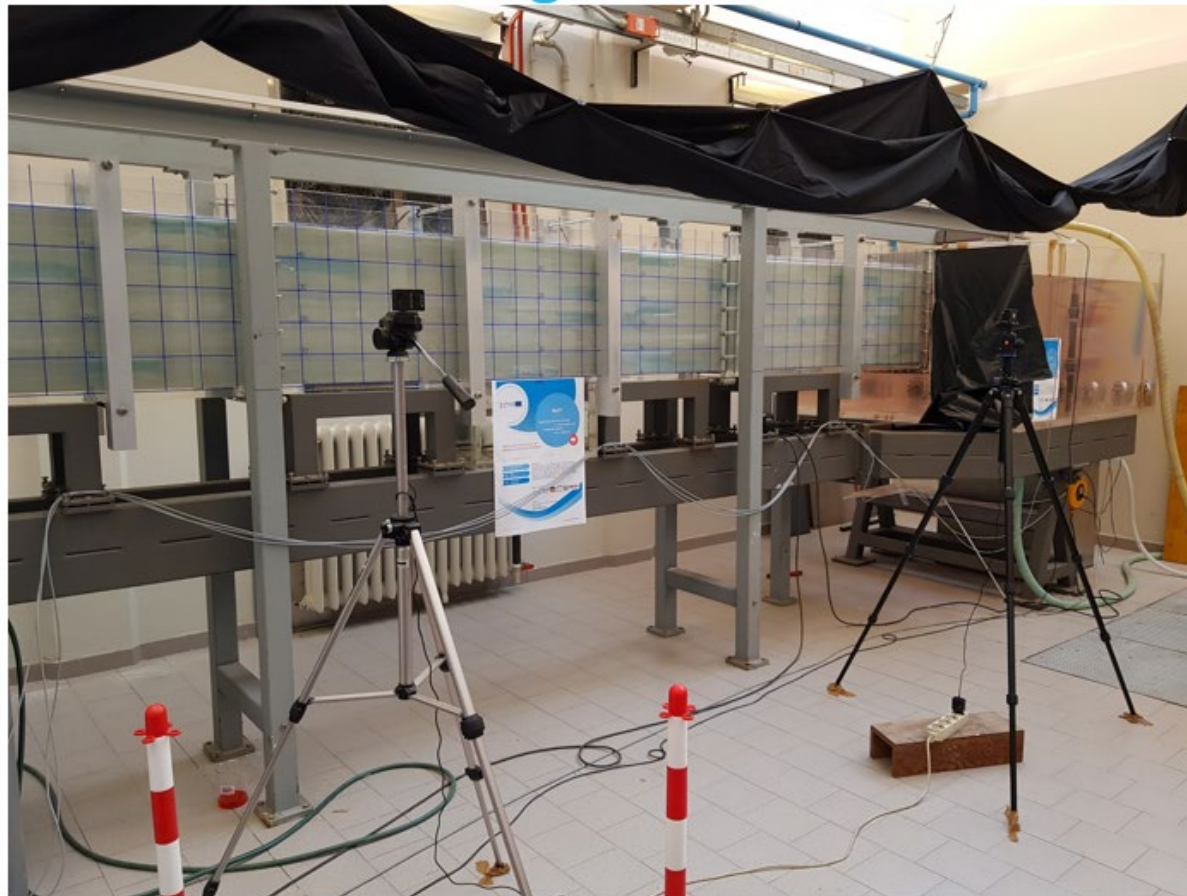
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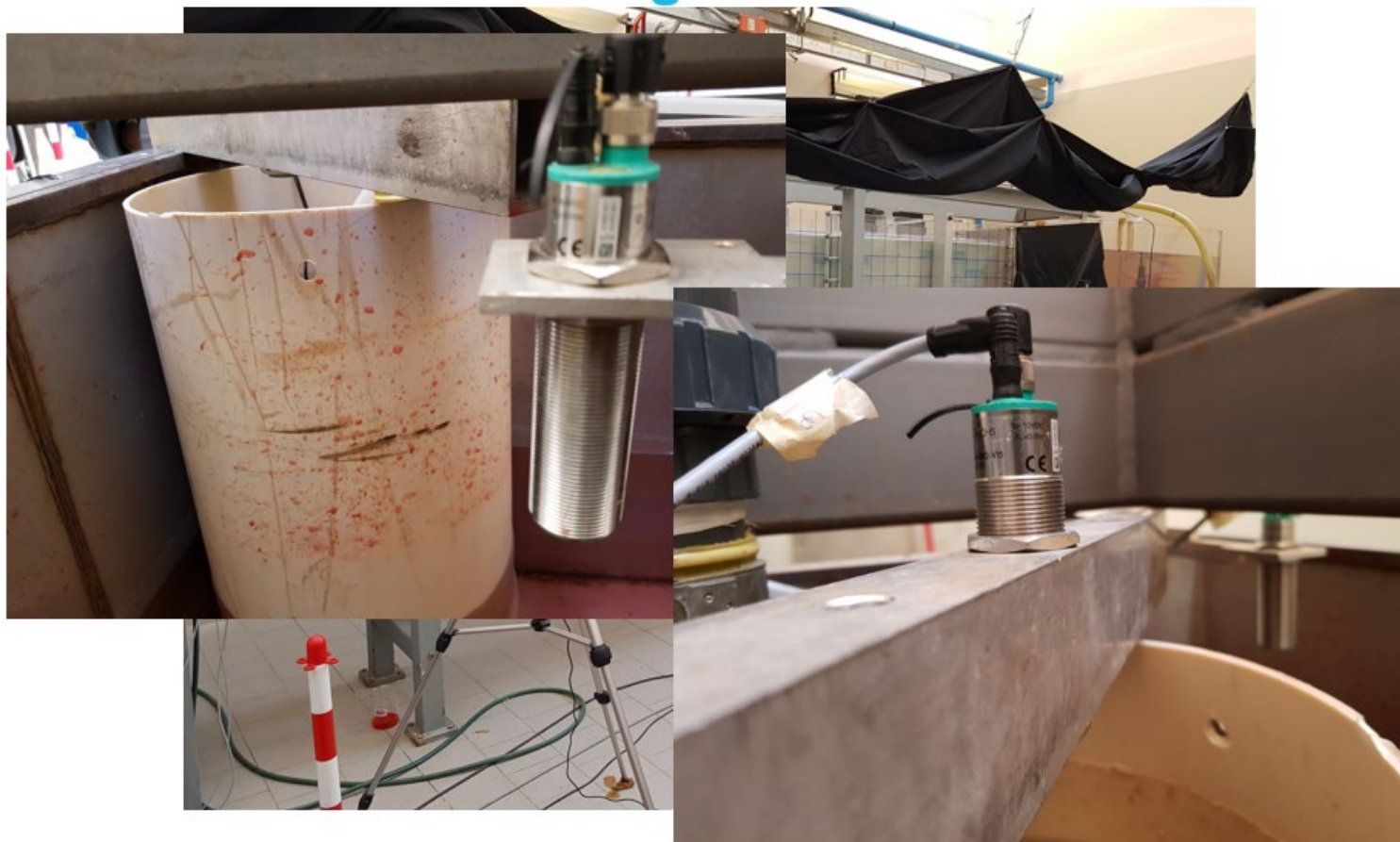
An example: aquifer thickness 20 cm, head difference 4 cm



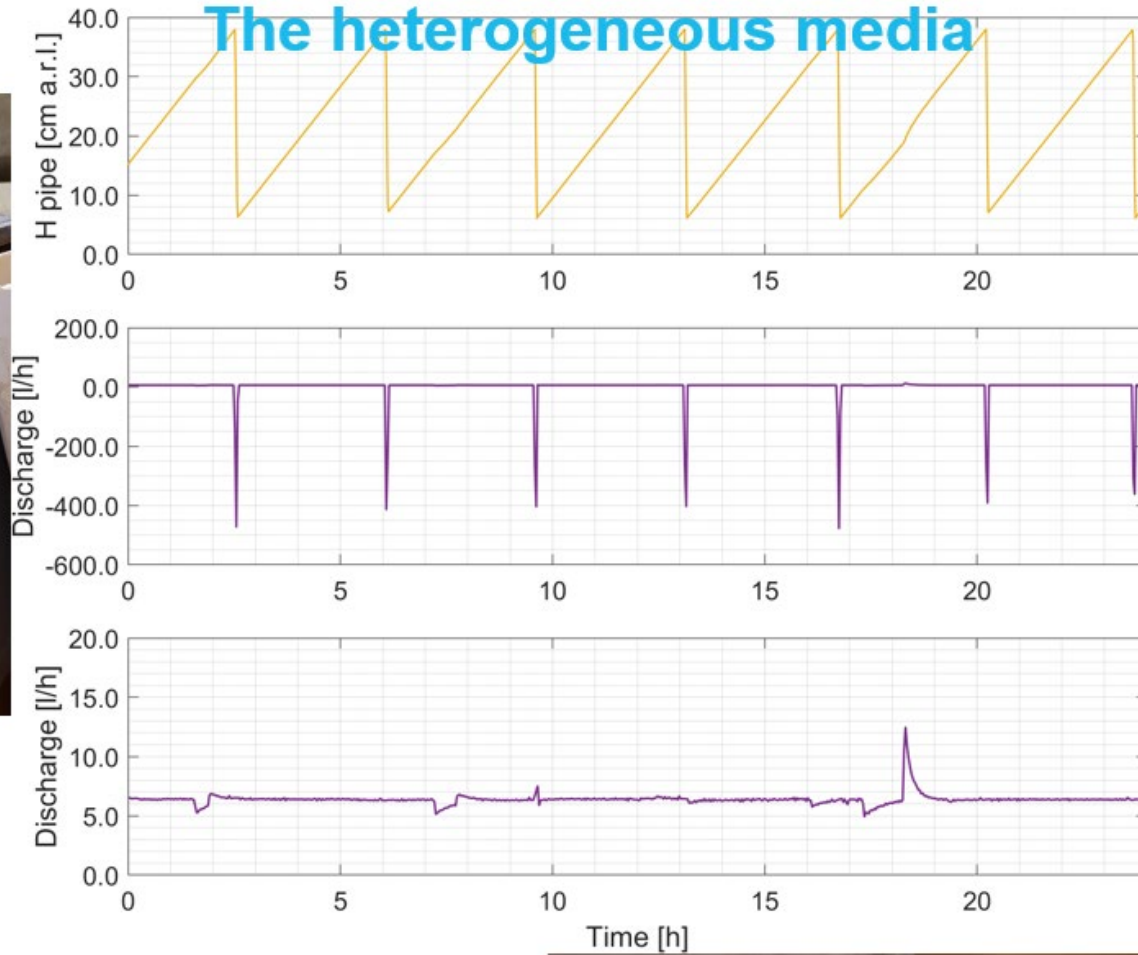
The heterogeneous media

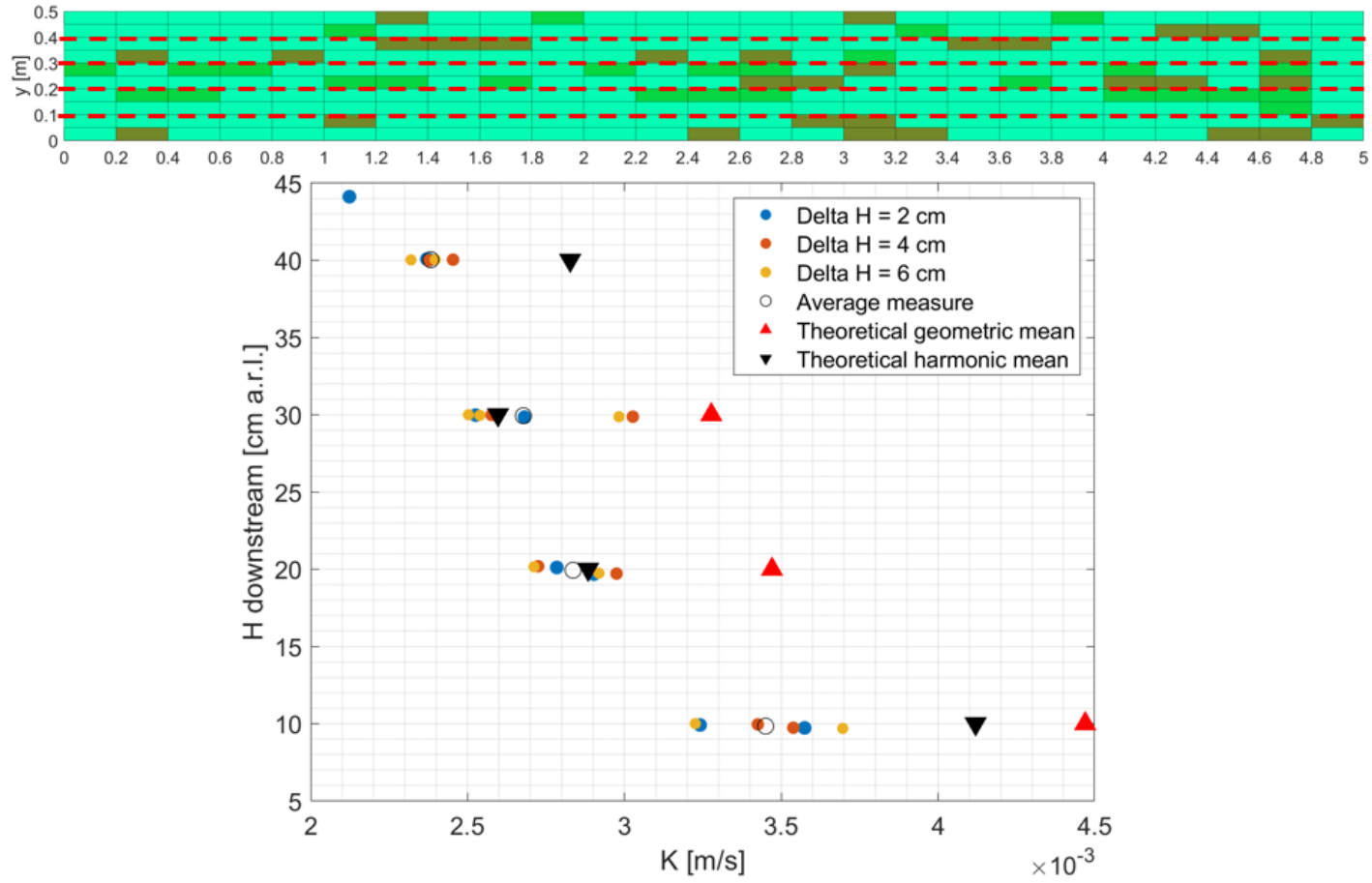


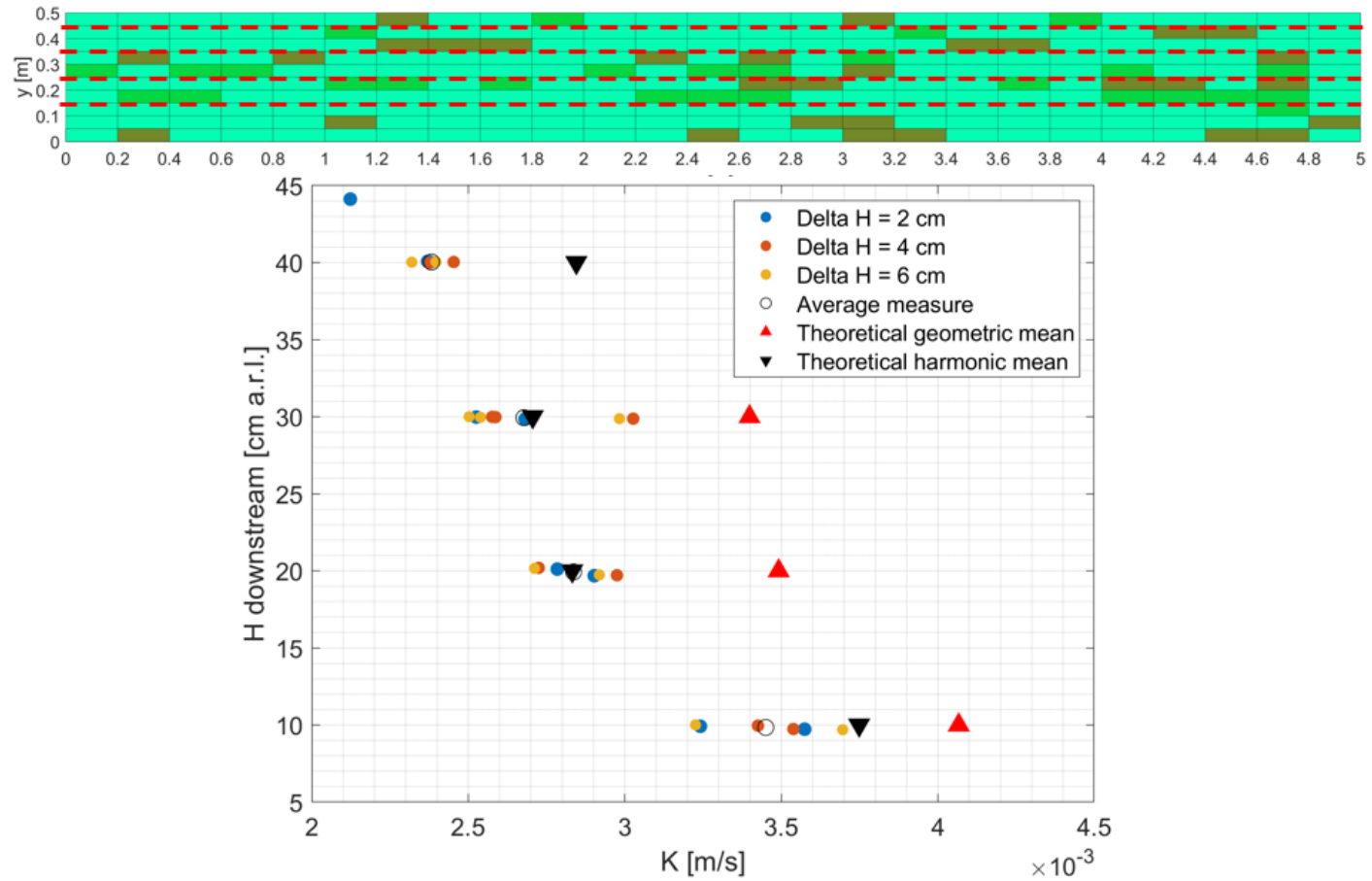
The heterogeneous media



The heterogeneous media



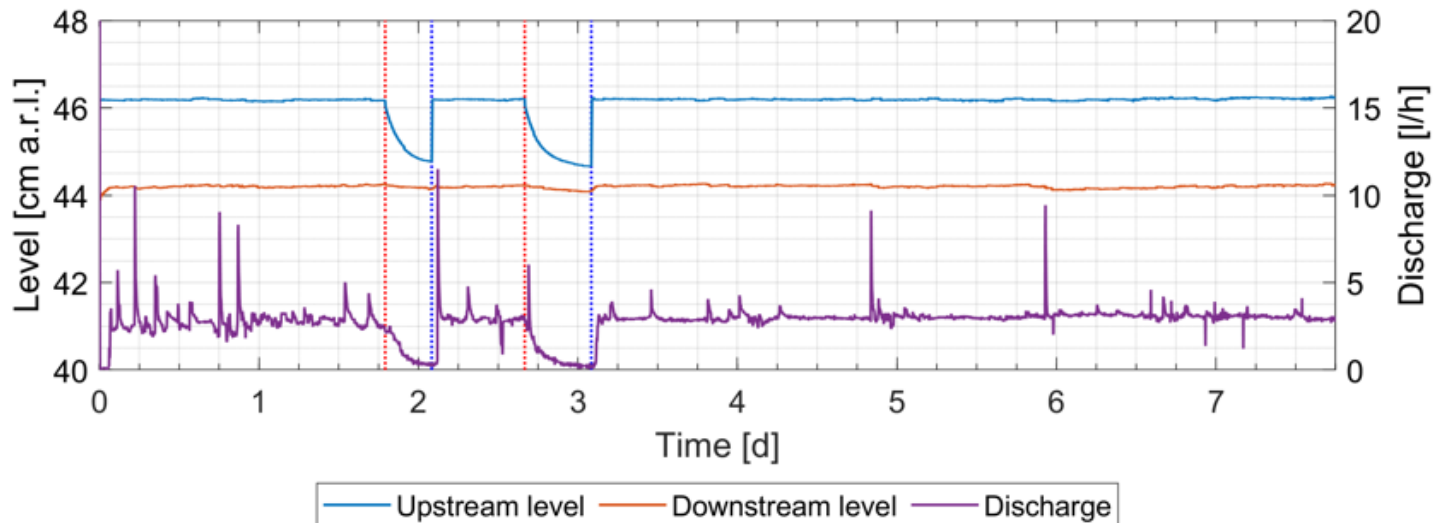




Drought experiment in the heterogeneous media

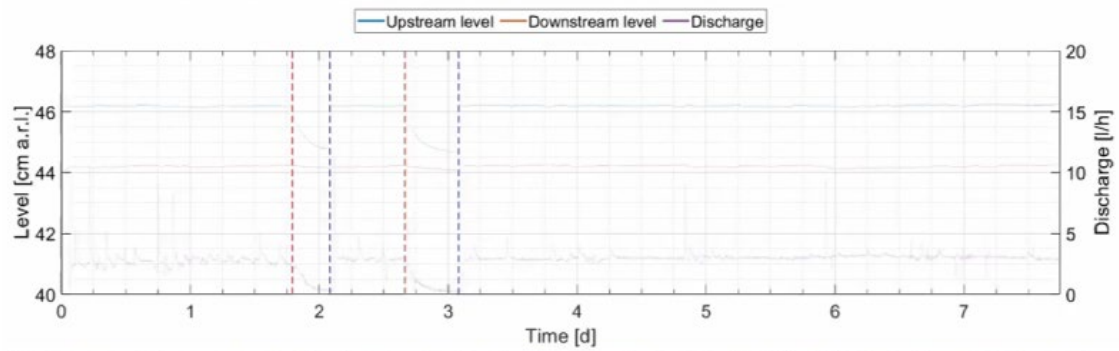
The saltwater intrusion experiment

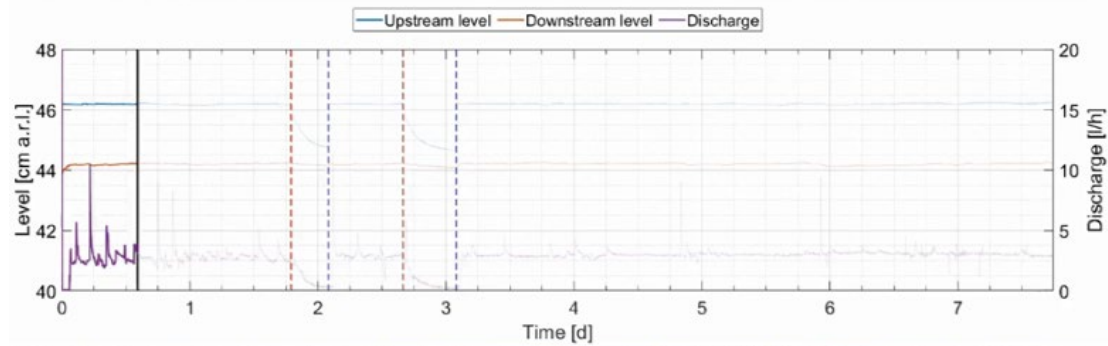
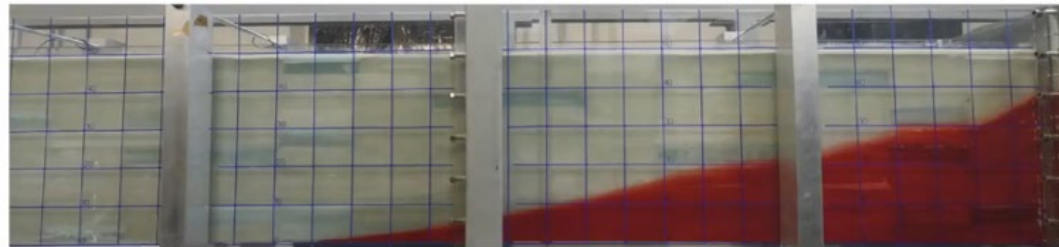
Water level difference upstream - downstream of 2 cm maintained 8 days with two separate drought period (about 8 and 10 hours) at the end of the second and of the third days respectively. Saltwater density 1028.8 kg/m^3 , conductivity $66.7 \text{ }\mu\text{S/cm}$

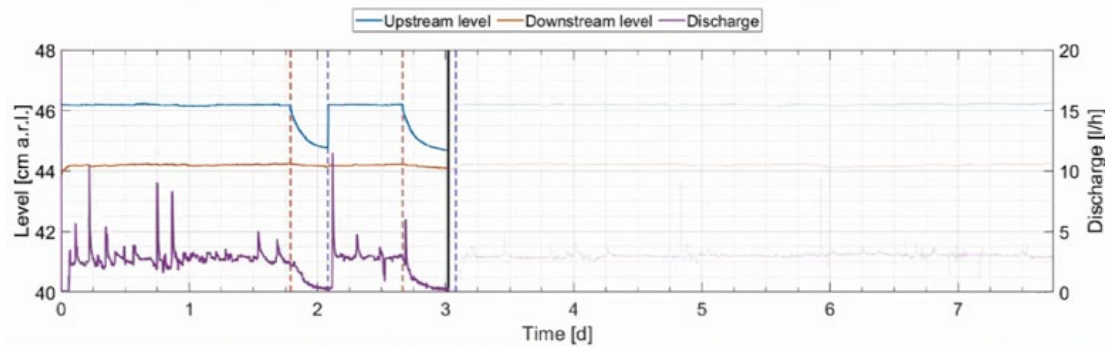
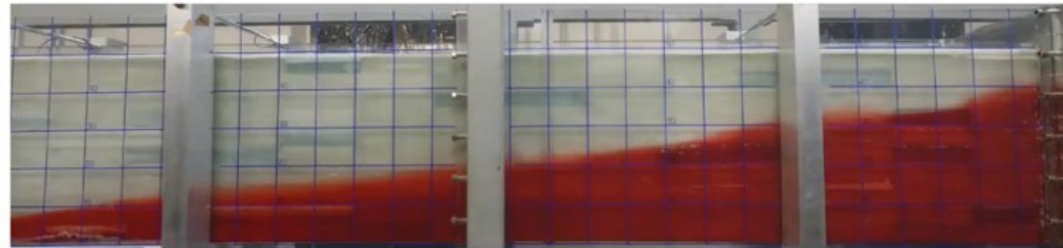


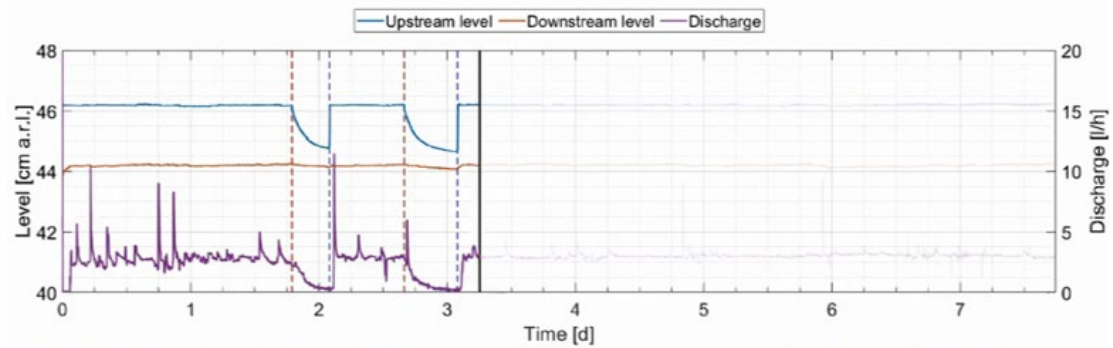
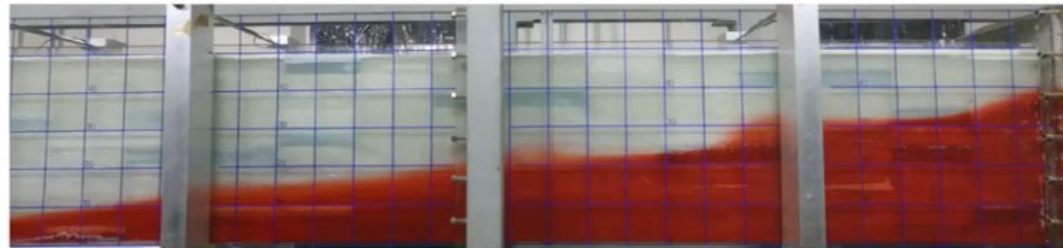
Drought experiment in the heterogeneous media

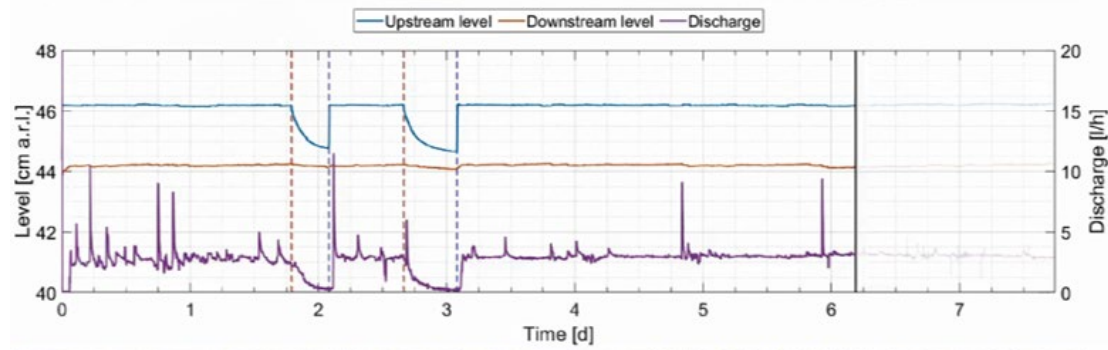
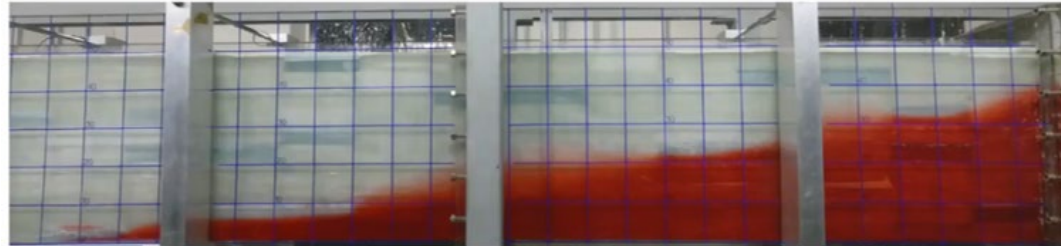












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