Influence of geological heterogeneity on the saltwater freshwater interface position in coastal aquifers – physical experiments and numerical modeling

A.S. Chowdhury¹, L. Stoeckl² and G. Houben²
¹ Institute of Water Resources and Environmental Management, Leibniz University, Hannover (e-mail: Leonard.Stoeckl@bgr.de)
² Federal Institute for Geosciences and Natural Resources (BGR), Hannover

**Example: Coastal zone of Bangladesh**
- Highly heterogeneous geological formation (delta)
- Coastal groundwater is under serious threat of saline water intrusion
- Projected sea level rise of 30-50 cm by the year 2050

**Objectives**
- Influence of different length scales in geological heterogeneity on the saltwater-freshwater interface position
- Effects of sea level rise on saltwater intrusion in heterogeneous porous aquifers

**Experimental Set-up**
- Trapezoidal shaped aquifer: bottom length 1.18 m, top length 0.62 m, height 0.35 m
- Freshwater recharge rate of 1.8 l h⁻¹
- Different tracer dyes (Indigotine-blue, Uranine-yellow and Eosine-red) for visualization (concentration 0.3 g l⁻¹)
- Three different sands with different hydraulic conductivities: fine (165 m d⁻¹), medium (355 m d⁻¹) and coarse (1229 m d⁻¹)
- Identical compartment height (3.5 cm) but variable compartment length (9 cm, 18 cm, 27 cm)
- Four seawater levels of 0.210 m, 0.245 m and 0.280 m and 0.315 m

**Numerical modeling**
- FEFLOW 6.1 used for numerical simulations
- Variable density (and unsaturated) flow and mass transport model
- Homogeneous equivalent modeled for comparison

<table>
<thead>
<tr>
<th>Sand Type</th>
<th>Hydraulic Conductivity (m/day)</th>
<th>Permeability</th>
<th>Longitudinal dispersivity (m)</th>
<th>Transverse dispersivity (m)</th>
<th>Van Genuchten Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>1229</td>
<td>0.41</td>
<td>0.01</td>
<td>0.001</td>
<td>30 3</td>
</tr>
<tr>
<td>Medium</td>
<td>355</td>
<td>0.45</td>
<td>0.005</td>
<td>0.0005</td>
<td>25 2.5</td>
</tr>
<tr>
<td>Fine</td>
<td>165</td>
<td>0.47</td>
<td>0.001</td>
<td>0.0001</td>
<td>20 2</td>
</tr>
</tbody>
</table>

**Conclusions**
- Physical models and numerical simulations of interface geometry show good fit for all sea level studied
- With greater compartment length, saltwater intrusion reaches further inland
- Homogeneous equivalent generally shows further sea water intrusion and might therefore be used as first estimation (when pumping is not included)

**References**