Water-sediment interactions during infiltration of monovalent partial desalinated water into different dune sediments

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Motivation and study site Langeoog

- Increasing global freshwater demand – need for groundwater protecting techniques
- Langeoog: 20 km² , Holocene [1] barrier island in east Frisia, North Sea/Germany [2]
- Freshwater lens acts as the island´s drinking water source[2]
- Higher water demand during summer months (tourism) [3]
- Freshwater resource endangered by erosion and flooding [2]
- Drinking water production area (Pirolatal) characterized by permeable sands (without soil development) [2]

Material and experiment

- Sediment extraction of dune sediments at three different site locations (in Pirolatal) → White dune (WD), Grey dune (GD), Brown dune (BD)
- Column experiments with salinated sediment of the White and Brown dune

→ Analysing the role of the different sediment characteristics on hydrogeochemical processes during infiltration with artificial monovalent partial desalinated water (PDW)

Table 1: Soil characteristics of the three different dune sediments.

Parameter		White dune	Grey dune	Brown dune
pH $_{current}$		9.24	8.05	5.83
pH $_{potential}$		7.44	7.14	3.73
Electric Conductivity [µS/cm]		36.43	16.11	20.06
Carbonate content [%]		7.2	0.12	0.07
Organic content [%]		0.54	0.17	0.61
Texture [%]	clay	0.92	2.40	0.72
	silt	1.15	0.28	0.51
	fine sand	71.12	38.83	42.90
	medium sand	20.66	58.26	55.79
	coarse sand	6.14	0.09	0.09

Case study Langeoog

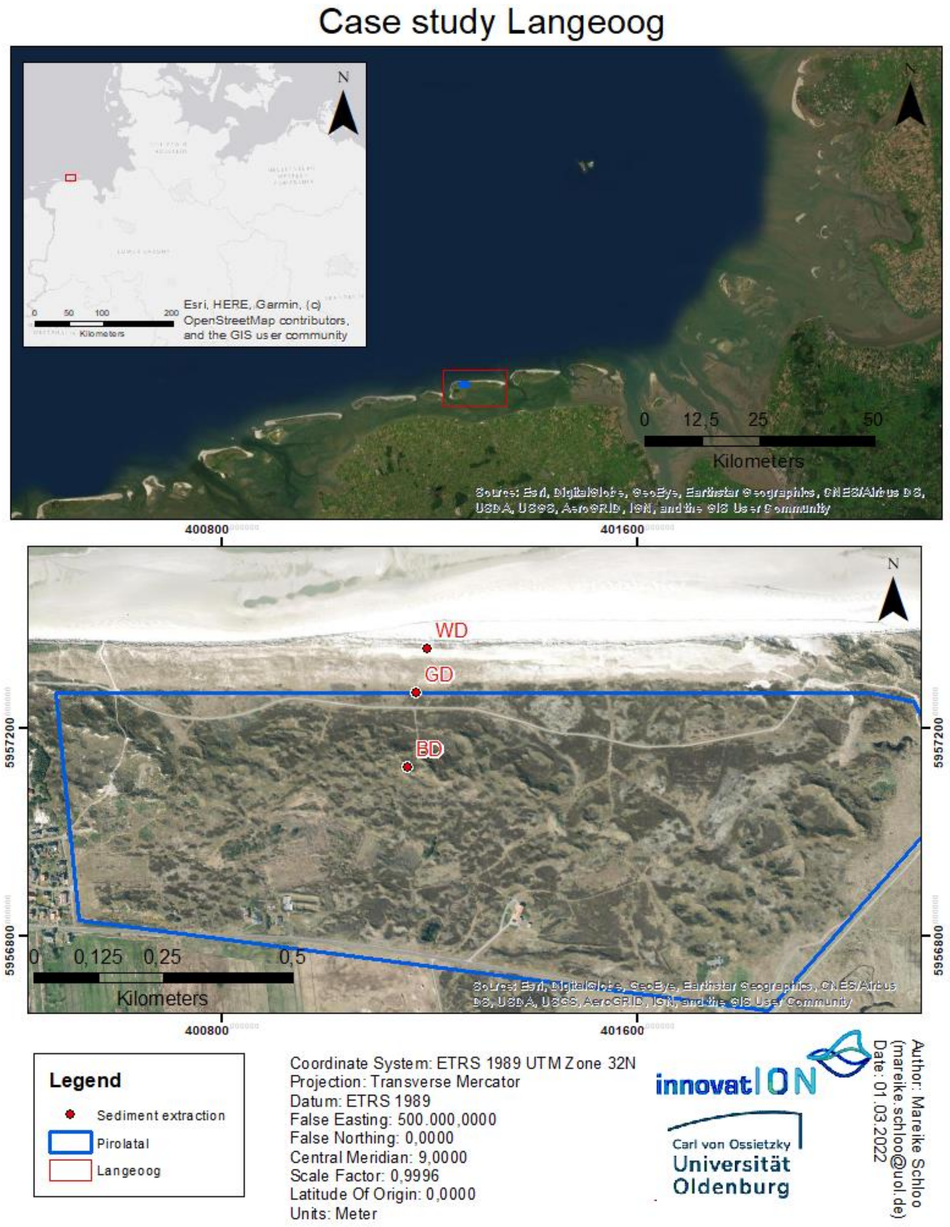

Fig. 1: Satellite picture of Langeoog and sample location.

Results and discussion

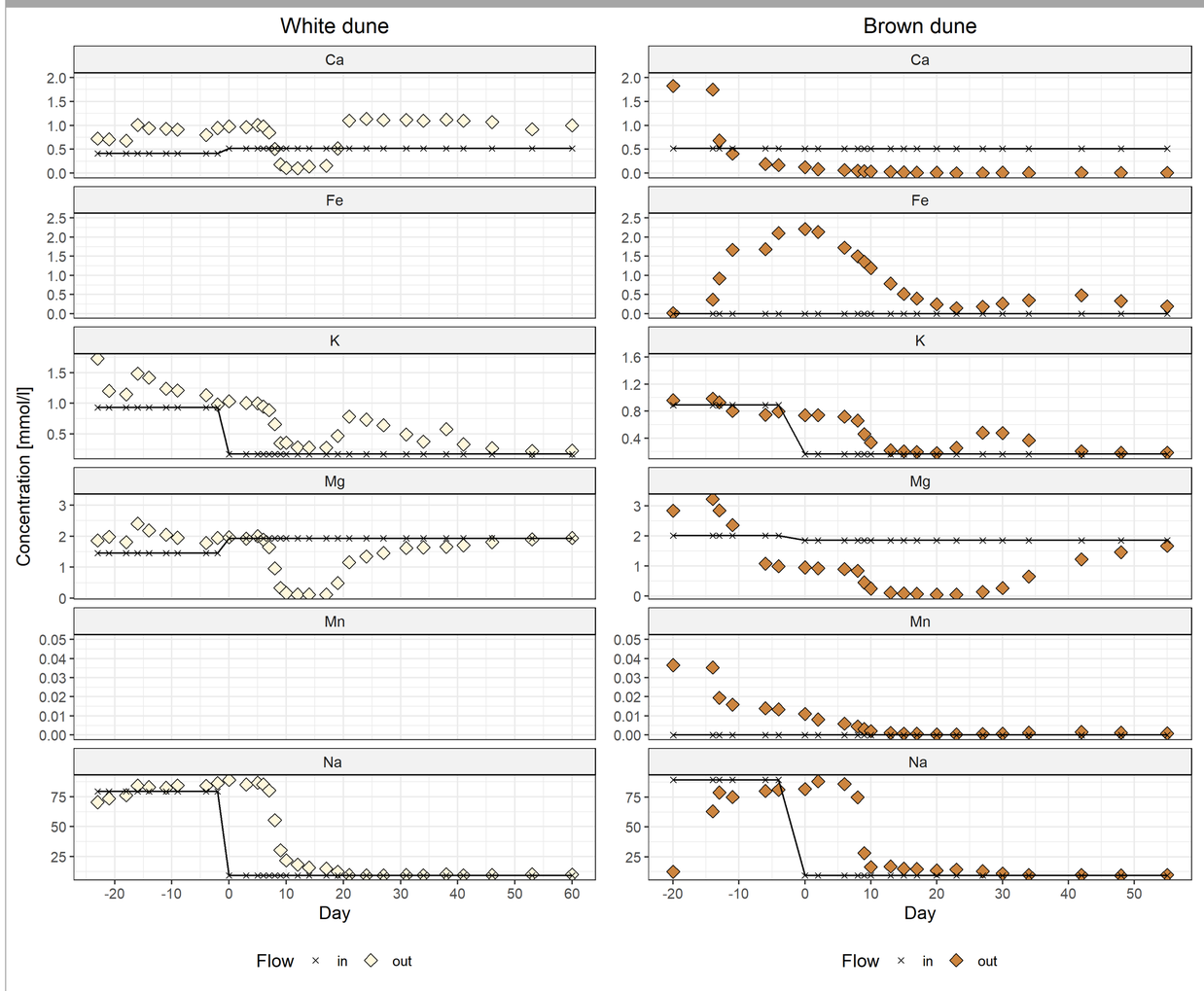

Fig. 2: Concentration of the cations during conditioning phase and changing water type infiltration (Day 0).

- PDW infiltrated from day 0 → Flushing of the initial pore water in the first ten days

White dune:

- Release of sodium from day 9 - 17 due to adsorption of calcium, potassium and magnesium, caused by affinity [4]
- potassium and magnesium gradually approach the input concentrations
- Calcium release around 50% higher than input → possibly calcite dissolution

Brown dune:

- Dissolution of calcium within the first ten days of conditioning
- Possibly adsorption of calcium and magnesium from day -10
- Desorption of iron and manganese
- Longer, but less strong release of sodium (day 10 - 30 compared to WD)

→ **Cation exchange processes are the dominant processes** (comparable to [5] and [6])

Soil characteristics:

- No calcite dissolution measurable by carbonate content in sediment after PDW infiltration
- Short term mineral dissolution plays a minor role in these sediments
- pH increase in the brown dune sediment after PDW infiltration can be attributed to the exchanges of calcium and magnesium against acidic-acting cations (e.g., H^+) [7]

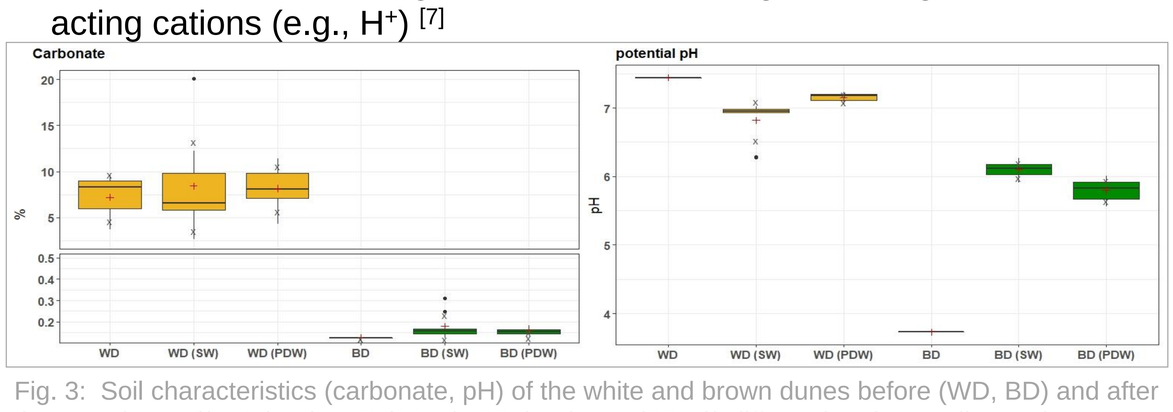

Fig. 3: Soil characteristics (carbonate, pH) of the white and brown dunes before (WD, BD) and after the experiment ((WD (SW), WD (PDW), BD (SW), BD (PDW)) differentiated according to the infiltrating water type .

Outlook

→ Analysis of trace elements might be essential
→ Modelling is important for further process understanding
→ Determination of potential influence of PDW infiltration on sediment characteristics

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innovatION
Selektive Entfernung monovalenter Ionen aus salzhaltigen Wässern