Identification & estimation of groundwater inflow to a brackish coastal lagoon: Field observations & numerical steady-state modeling

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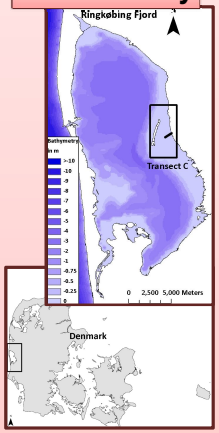
Area of Study



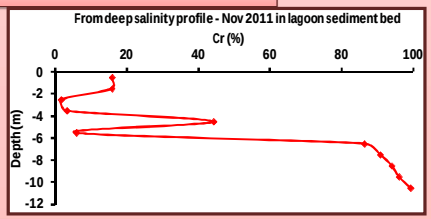
Objectives

- To understand interaction between groundwater and lagoon at Eastern shoreline
- To understand differences that winter and summer impose to this interaction and finding the driving factors
- To locate and estimate groundwater discharge into the lagoon

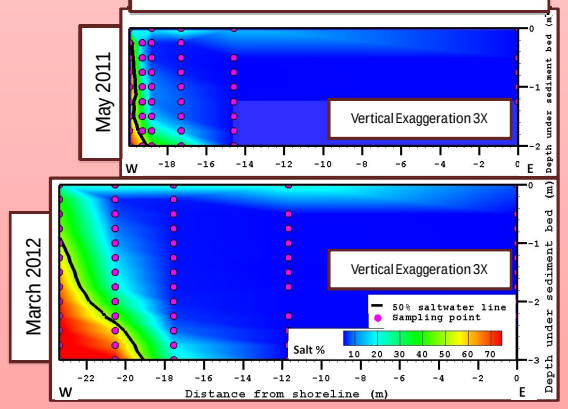
- A brackish lagoon with <0.25 m water level
- 5-11 permil salinity (Max. in summer)

Field Observations

- Deep Salinity profiling indicates max. salinity sitting under lagoon bed
- Modeling matches with field observations



Observed Salt Distribution (%) at Transect C

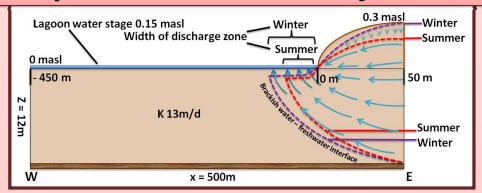


Note the displacement of 50% salt line (black) between May and March observations of brackish water-freshwater interface

Methods

- **Field techniques:** Slug test, electric conductivity– depth and temperature – depth profiling, direct Seepage,, etc
- **Numerical Modeling:** Using Hydrogeosphere code for coupled density-dependent flow and transport modeling

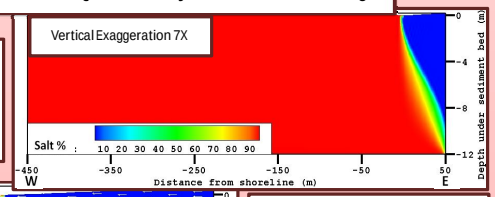
Conceptual Model & Boundary Conditions

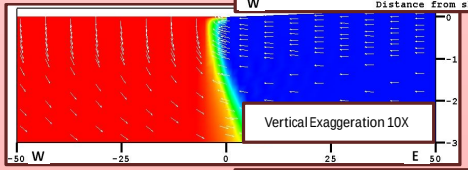


Numerical Modeling

Summer vs Winter: Quasi-steady Numerical Modeling

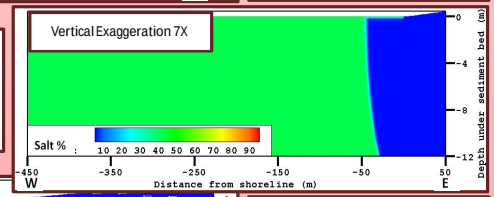
Summer Scenario : Maximum salinity in lagoon, minimum head in landside

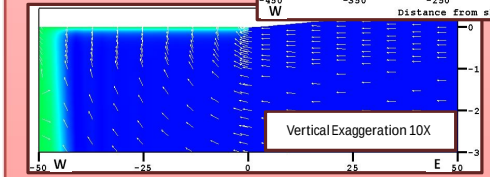




Brackish water intrudes inland in summer and fits well with observed deep salinity profile

Winter Scenario : Minimum salinity in lagoon, maximum head in landside

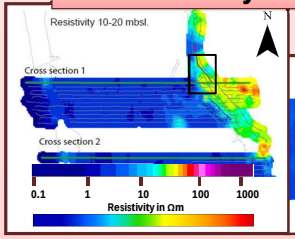


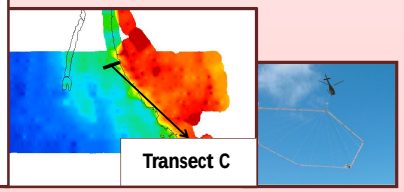


Brackish water pushed back by fresh water in winter time with wider width of discharge zone than in summer

Salinity in lagoon and head on landside control groundwater discharge into the lagoon and width of discharge zone

Past Study & Study Area Selection

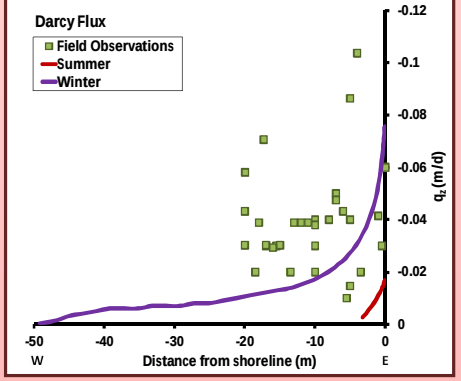




- An Air-borne **T**ransient **E**lectro-**M**agnetic (SKYTEM) survey conducted in summer of 2008 showed maximum discharge near the eastern shoreline
- Study area selected on the basis of this survey

Observations vs Simulated Discharge

- Simulated discharge (0.005-0.08 m/d) matches well with field observations (0.01-0.11 m/d)
- The significant width of discharge zone (WDZ) is between 20-50 m.
- Discharge & WDZ varies between seasons



Main Findings & Future Work

- Groundwater discharge into the lagoon (Average = 0.04 m/d) is maximum at the shoreline with slightly decreasing exponential pattern
- Simulated discharge and width of discharge zone match well with field observations
- Salinity of lagoon water and head on landside driving factors for the interaction between groundwater and lagoon water
- Transient simulations are required in future to help understand seasonal dynamics

*Reference: Kirkegaard, C ., T. O. Sonnenborg, E. Auken, and Jørgensen, F. , 2011, Salinity Distribution in Heterogeneous Coastal Aquifers Mapped by Airborne Electromagnetics: Vadose Zone Journal, 10, 125-135