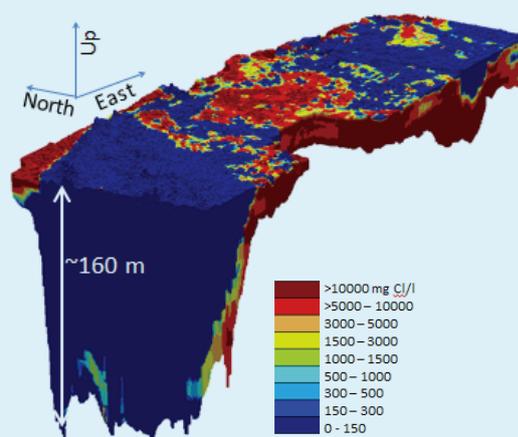


Depth of the agricultural fresh-saline boundary of 1500 mg/l chloride concentration



Example of 3D result showing a dune with a fresh groundwater lens (blue) and saline seepage (red)

TREASURE HUNT FOR FRESH GROUNDWATER

The Province of Zeeland in the Netherlands consists of islands and peninsulas bordered by salt-water estuaries and the North Sea. The groundwater system is mainly saline due to marine transgressions in the past. Agriculture and tourism are thriving and putting pressure on the freshwater resources. The sustainable management of water resources requires a detailed mapping of the available fresh groundwater resources.

One way to map the fresh groundwater on a regional scale is to use a helicopter fitted out with an electromagnetic (EM) device. Airborne EM mapping provides a detailed image of the conductivity of the subsurface down to a depth of 200 metres, with conductivity being measured as a combination of groundwater salinity and subsoil composition. The FRESHM project mapped out 1,800 km² of the Province of Zeeland in this way with a total of 9,600 flight-line kilometres. Deltares, TNO and BGR cooperated to collect the data and convert it to detailed probabilistic 3D information about groundwater salinity.

An approach was developed in FRESHM to quantify both the salinity of the groundwater and uncertainty levels using lithological models, soil samples, lab analysis and different inversion methods. The differences with chloride analyses were most pronounced for brackish concentrations. Validation with ground-



truth 1D geophysical measurements identified a difference of only about half a metre in the thickness of the freshwater lens.

The FRESHM results were welcomed by the stakeholders: the Province of Zeeland, Scheldestromen water authority, Evides water company, Rijkswaterstaat Sea & Delta, the municipalities of Zeeland, VNSC, ZLTO and the Delta Fund. The results and the visualisations were made available to the public. Stakeholders were able to handle the uncertainty in the results well, after receiving guidance. They used the results immediately, for example as guidance for farmers about how to use their fresh groundwater resources. The results also served as the basis for the demarcation of new groundwater extraction zones for water

managers and as a baseline for the monitoring and modelling of salinisation and freshening over time in locations where there are plans for infrastructure construction, nature development and nourishment dunes.

The success of FRESHM was followed by another EM helicopter survey in Flanders, Belgium implemented as a European TOPSOIL project by Deltares, Ghent University, SkyTEM, TNO, De Watergroep and Inagro. One of the goals is to prepare a plan for one or more pilot projects to improve the availability of freshwater. Clients are VMM, MOW department Maritime Access, Port of Antwerp, Left Bank Company and the Agency for Nature and Forests.

The combination of data acquisition, mapping and modelling provides insights into possible measures to improve freshwater availability. The large-scale survey in combination with modelling and measures is therefore one step towards the sustainable management of water resources. 

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Further reading:

<https://kaarten.zeeland.nl/map/freshem>