



Advancing Sentinel-1 use in Coastal Climate Impact Assessments and Adaptation – A Case Study from the Danish North Sea

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A Case Study from the Danish North Sea



Fig 1: Thyborøn location.

Attention matters

Low-lying coastal communities must respond to the increasing risks from climate change where land subsidence will, indeed, exacerbate future challenges.

At Thyborøn (Fig. 1 & background) on the Danish North Sea coast, a transdisciplinary & transnational collaboration embraces research and local interests in a mutual quest to map impacts and adapt to future conditions.

A novel approach

The municipality, the water and wastewater utility company, the Port, the national Coastal Authority, Central Region Denmark, private companies and consultants team up with universities to explore future outcomes – and to obtain data and gain common grounds:

Climate adaptation

Protected from sea floods today but flood prone in the future from storm surges, groundwater, precipitation and land subsidence (figs 2-3)

Planning and management

Working the sewers (Fig. 4), running Port business (Fig. 5), keeping citizens happy and coping, and caring for the environment.

Research

Utilizing data and integrating climate impacts factors into non-expert's concepts. Applying and customizing satellite data for common use and relate to datum network (Fig.6). Investigating time & space dependencies in S-1 signals, and exploring processing algorithm optimization for local area studies.



Fig 4: S-1 results provide the local utility company with a good business case for incorporating subsidence in pipe maintenance and renovation.

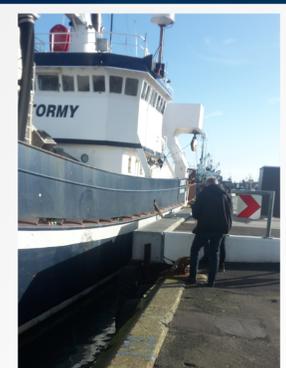


Fig 5: Renovated quayside shows 0.5 meter of subsidence in 50 years. Not a new phenomenon!



Fig 6: Locally produced and deployed corner reflector.



Fig. 2: Potential flood extent now and in 2100 for a 50 years' storm surge event including sea level rise and future subsidence.

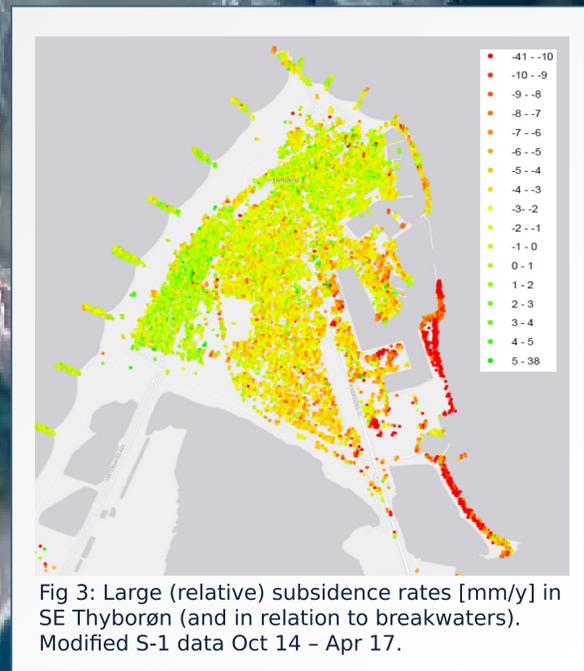


Fig 3: Large (relative) subsidence rates [mm/yr] in SE Thyborøn (and in relation to breakwaters). Modified S-1 data Oct 14 - Apr 17.

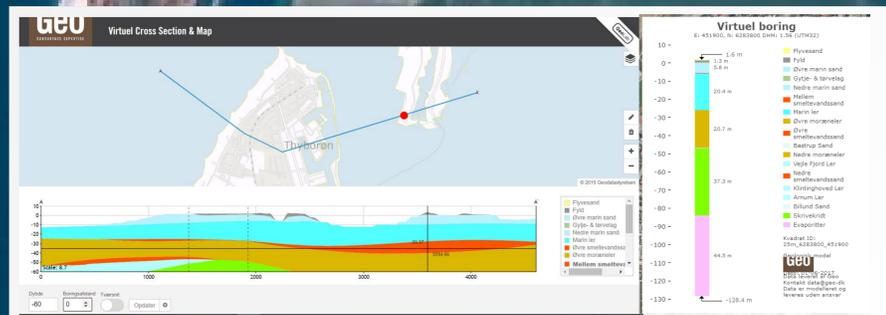


Fig 7: The API based geological model provides the opportunity to create detailed virtual cross-sections and borings with just a couple of 'mouse clicks'.

Approaching target

Water-related climate impacts are modeled in MIKE by DHI (a hydrodynamic modeling tool) to reveal potential future floods from precipitation, sewer stow, high groundwater levels and storm surges. These results are being merged with regularly updated S-1 results, a 3-D geological model and infrastructure in an API or web-GIS (figs 7-8) solution to provide a common framework for adaptation and planning. In addition, real-time data of groundwater levels (10 locations) and sea levels (three locations) are being incorporated into an early warning system for water management.

Not quite there yet

The 2½ year S-1 time series together with concurrent measurements of groundwater and sea levels, the water modeling setup, and the detailed geological model provide ample opportunity to further explore the S-1 signal; and to e.g. relate groundwater and sea levels to variations over time in the detected vertical displacements rates. In addition, the one meter resolution of the geological model may detail our understanding of the local mechanisms of subsidence. The explicit aim for further research is to explain the subsidence encountered by use of S-1 data.

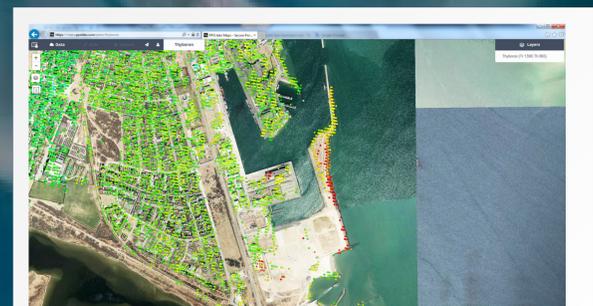


Fig 8: A web-GIS solution (provided by PPO.labs) provides detailed S-1 results to end-users.