Unique permanent coastal observation detects minimal changes

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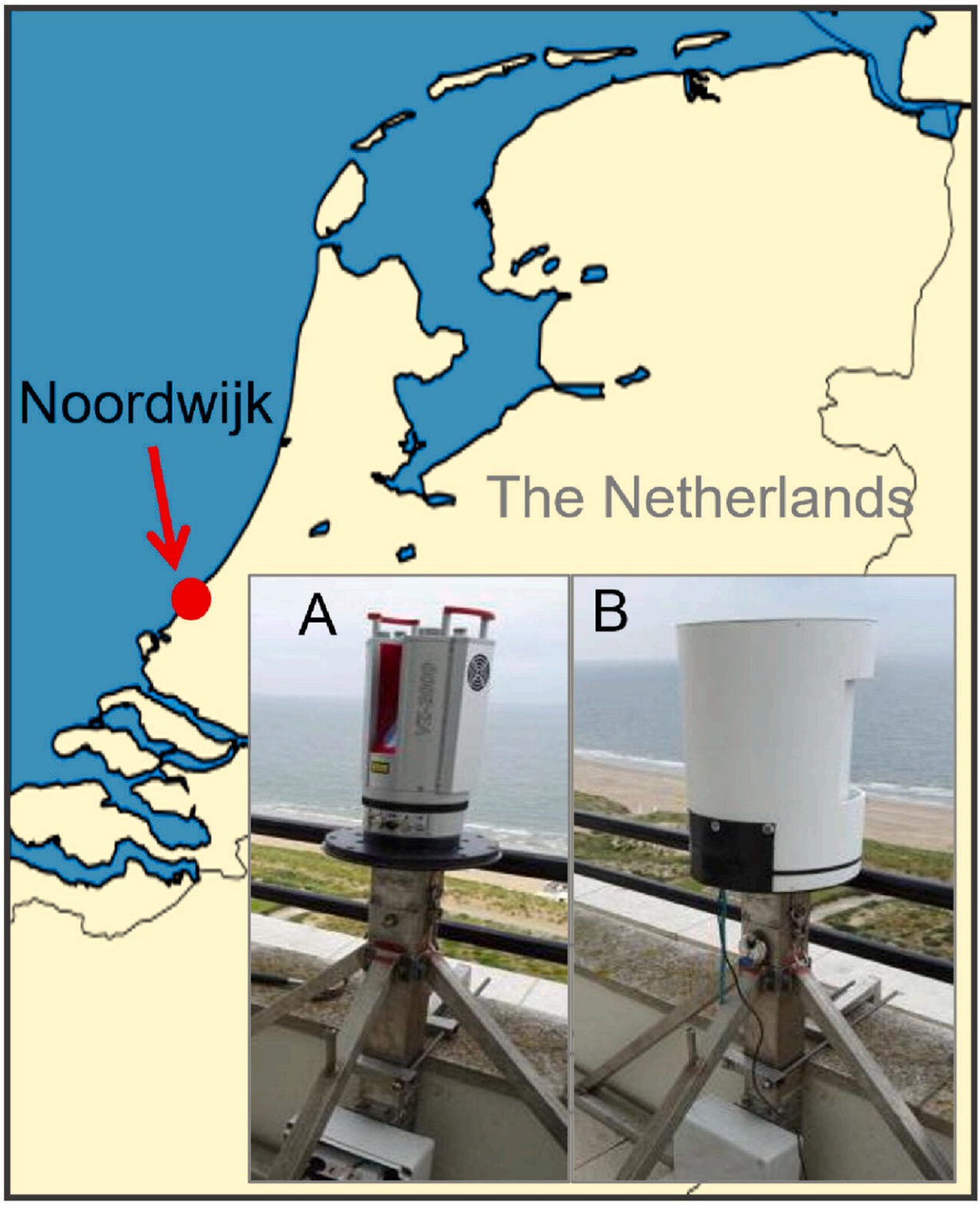

Location of the study site on the Dutch coast in Noordwijk, The Netherlands and picture of the laser scanner mounted on a hotel balcony without (A) and with (B) protective cover. Credit: *ISPRS Open Journal of Photogrammetry and Remote*

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A team of researchers from TU Delft has succeeded in long-term mapping of beach topography to within a few centimeters. The unique dataset provides insights into coastal changes for every hour, for three years. This data is important for dune maintenance and to keep the hinterland well protected. The methodology is also being used to monitor other coastlines and even glaciers. The data are open source and were published in *Scientific Data* in 2022. The new methodology was also recently published.

Until now, long-term measurements of the coast have lacked sufficient detail because the satellites used for this purpose do not have high resolution. And detailed measurement campaigns at the beach were only snapshots. A close collaboration of researchers from Geoscience & Remote Sensing and Hydraulic Engineering offered the solution. Using a permanent laser scanner at the beach in first Kijkduin and later Noordwijk, minimal changes were quantified over long periods of time.

Mieke Kuschnerus pioneered the new mathematical methodology to extract the smallest details from very long time series. This provided new insights, not so much on large instantaneous changes as caused by storms, but notably on small but persistent changes that take place over long periods of time. Her research was published at the end of December in *ISPRS Open Journal of Photogrammetry and Remote Sensing*. The methodology is now proving its value internationally for monitoring glaciers, landslides and tree canopy growth.

Physical and human influences affect the coast

Now it is also possible to determine which processes underlie the coastal

changes. A key insight is that the coastal morphology is not only influenced by physical processes, but also by human actions.

"If we want to better design future beaches, we need to understand the effects of a storm, and also the impact of permanent buildings such as beach pavilions, and the changes people make to prepare the beach for hordes of day trippers," says Roderik Lindenbergh. Together with Sierd de Vries, he is project leader of the nearly completed "CoastScan" project. Lindenbergh recently received funding for the follow-up project "AdaptCoast."

Designing future beaches

With AdaptCoast, the researchers are now venturing into predictions of coastal change. They create simulations of the coast by using models. These models take into account direct changes caused by physical factors such as wind and waves on a small scale. And will also take into account socio-economic aspects, which proved so important in the earlier research. "We also simulate indirect effects of, for example, nice sunny weather around Easter time, when beach bar owners put up an embankment to prepare for the many visitors," says Lindenbergh.

The simulations of the future coast provide good guidance for the planning of coastal protection, and how to reinforce this together with recreation and nature. It is therefore no coincidence that Rijkswaterstaat and several water boards are partners in the research project. The knowledge of coastal changes and the processes underlying them helps them to better manage beaches and design safer future beaches.

The project's first Ph.D. candidate, Daan Hulskemper, starts today. "What will he do first? Get his LiDAR drone diploma," says Lindenbergh. "Should there be storms, he can immediately grab the drone to start taking measurements on the beach."

More information: Mieke Kuschnerus et al, Statistically assessing vertical change on a sandy beach from permanent laser scanning time series, *ISPRS Open Journal of Photogrammetry and Remote Sensing* (2023). DOI: 10.1016/j.ophoto.2023.100055

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