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COPERNICUS4REGIONS 2025

INNOVATIVE, SCALABLE SATELLITE SOLUTIONS FOR NOIRMOUTIER'S COASTAL RESILIENCE

Baptiste Le Mauff, Oualid Rahmani, Lisbeth Tangaa Nielsen, Mikkel Hoeegh Bojesen, Fabrice Gouaud, Imane Meziane, Martin Paillart

DHI | Communauté de Communes de l'île de Noirmoutier (CCIN) | France



> This project is a key step toward sustainable coastal management, helping us track sediment shifts and strengthen the island's resilience
>
> **Oualid Rahmani**
> *CCIN's Coastal Risk Protection Department*

Storm impact on western Noirmoutier Island - photograph of the western shoreline of Noirmoutier Island during Storm Christine (October 2023), where shoreline retreat locally reached up to 10 m. The proximity of buildings highlights the need for accurate sediment dynamics assessment to support risk management. Source: Communauté de Communes de l'île de Noirmoutier

Mapping Noirmoutier's shallow waters is complex due to the dynamic nature of its sediments and frequent tidal exposure. By harnessing Copernicus imagery and deep learning, we deliver accurate bathymetry and habitat classification. This scalable, cost-effective solution supports informed decision-making for coastal management and policy.

THE CHALLENGE

One of Europe's low-lying coastal regions, the island of Noirmoutier, faces rising sea levels, stronger storms, and escalating erosion. The Communauté de Communes, representing local municipalities, must plan for climate resilience to safeguard people, infrastructure, and habitats. Without up-to-date maps of shallow waters, they suffer from insufficient knowledge due to the costly and challenging nature of field surveys, which delays protective measures like dune reinforcement. Recognizing the urgency of climate change and obligations under national and EU coastal policies, they seek scalable, accurate data. By adopting Copernicus satellite imagery, they can track sediment shifts and fortify defenses while preserving vital habitats. DHI's satellite-based solution addresses these challenges by monitoring shallow seabed dynamics, thereby helping to secure Noirmoutier's dunes, beaches, and communities against future storms.

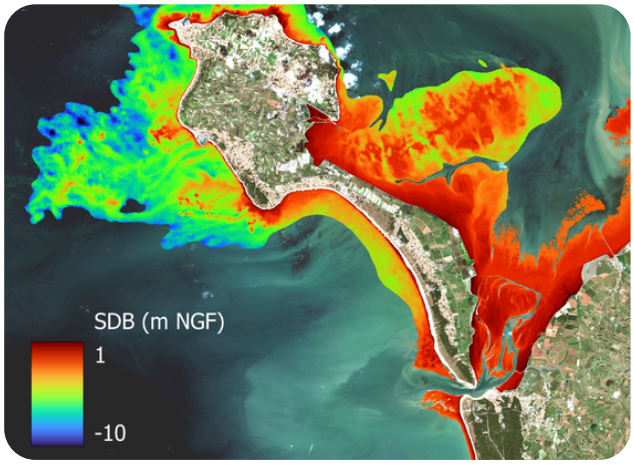
THE SPACE SOLUTIONS

The Copernicus-based solution uses data from Sentinel satellites to produce three key outputs: Satellite-Derived Bathymetry (SDB), Surface Water Frequency (SWF), and habitat mapping.

- SDB transforms light reflections into accurate underwater depth measurements, enabling close tracking of sediment shifts in shallow waters.
- SWF shows how often areas are submerged, revealing tidal patterns. Meanwhile, habitat mapping classifies zones as sand, rocky, or vegetated over time.
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Integrating these three approaches offers a comprehensive view of nearshore dynamics, illustrating how sediments and habitats interact around the island's coastal zone. A "human in the loop" workflow refines machine learning models with local feedback, enhancing accuracy. Processed maps are delivered at a resolution suited to shallow water conditions, capturing subtle changes.

Provided by DHI, a commercial water-focused research, technology, and consultancy company, the solution updates regularly with new satellite passes. This ensures authorities have updated data to plan interventions and protect coastal infrastructure. Deep learning algorithms also enable rapid scaling to other areas.



Satellite-Derived Bathymetry around Noirmoutier Island | 2024 bathymetric map of Noirmoutier derived from a collection of Sentinel-2 Level-2A images acquired throughout the year. The method retrieves depths down to -8 m NGF and highlights the seabed diversity: rocky and vegetated platforms, sandy and muddy intertidal zones with tidal channels, and dynamic sandbars. Areas not covered were affected by limiting environmental conditions (e.g., turbidity), preventing reliable depth retrieval. | Bathymetry: derived from Copernicus Sentinel-2 data [2024], Level-2A, processed by ESA. Background image: Copernicus Sentinel-2 (08/08/2024), Level-2A, ESA

By combining advanced remote sensing technology with local expertise, this system provides precise and up-to-date insights into physical and ecological processes, enabling reliable decision-making for coastal management.

THEMATIC AREA

Territorial Management and Urban Planning

REGION OF APPLICATION

Noirmoutier Island, Pays-de-la-Loire Region

SENTINEL MISSION USED

S1, S2, S3

COPERNICUS SERVICE USED

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THE BENEFITS AND THE BENEFICIARIES

Noirmoutier Island is a low-lying French coastal region facing intensifying storms, rising sea levels, and increased coastal flooding. The Copernicus-based solution provides vital, regularly updated satellite insights into shallow-water bathymetry, submersion frequency, and habitat conditions. By combining these datasets, local authorities can map sediment distribution and identify erosion hotspots. As a result, they can prioritize investments in dune reinforcement, beach nourishment, and other protective measures, mitigating potential damage to infrastructures.

By reducing the need for costly boat-based surveys, the solution lowers operational expenses and accelerates decision-making. Its historical analyses also provide a comprehensive picture of shoreline evolution, enabling planners to anticipate how future climate scenarios will impact this delicate balance between development and natural preservation.

Residents benefit directly from stronger, more targeted defenses against flooding, ensuring that roads, buildings, and essential services remain safeguarded during extreme weather events.

This integrated approach, delivered by DHI, aligns with national and European policies for sustainable coastal management and climate adaptation. Highlighting the evolution of local ecosystems, it broadens the scope of risk assessments and fosters strategic choices that respect the island's ecological integrity. Ultimately, this advanced Copernicus-based service empowers Noirmoutier to enhance its resilience, confronting the urgent challenges of rising seas and intensifying coastal hazards.

	TIER 1 SERVICE PROVIDER	TIER 2 PRIMARY USER	TIER 3 SECONDARY USER	TIER 4 END USER BENEFICIARIES
SERVICES AND BENEFITS	Sentinel-1 Sentinel-2 Sentinel-3	SDB maps SWF maps Habitats maps	Improved monitoring of shallow waters Optimized sediment management Reduced erosion risks Informed coastal planning to protect Noirmoutier island	Protected homes and infrastructure Greater public awareness of coastal hazards and local ecosystems
BENEFICIARIES	DHI	Communauté de Communes of Noirmoutier Islands	Local municipalities	Citizens

EU POLICY / DIRECTIVE

Other

TYPE OF SERVICE PROVIDER

Commercial Service

TYPE OF FUNDING SOURCE

EU Space Programme

USAGE MATURITY LEVEL

5



A FUTURE WITH COPERNICUS

DHI will expand this Copernicus-based solution with additional Sentinel passes for more frequent updates and extended trend analysis. Ongoing improvements in resolution and frequency will boost predictive models and enable scaling to similar regions. Enhanced machine learning will refine sediment mapping, even in areas with high turbidity. By integrating fresh data, DHI ensures timely insights that help manage erosion, address climate impacts, and protect coastal communities.



DID YOU KNOW?

The French DHI team collaborates with Danish colleagues, who developed advanced satellite algorithms, to tailor the solution to Noirmoutier's needs. While sophisticated processing ensures high-quality data, the French team's extensive local expertise refines and validates the outputs, establishing a robust Europe-wide partnership for sediment and shoreline management.

Acknowledgements

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Contacts

Baptiste Le Mauff | balm@dhigroup.com
Oualid Rahmani | resp.littoral@iledenoirmoutier.org
Lisbeth Tangaa Nielsen | litn@dhigroup.com
Mikkel Hoeegh Bojesen | mihb@dhigroup.com
Fabrice Gouaud | fabg@dhigroup.com
Imane Meziane | imane.meziane@iledenoirmoutier.org
Martin Paillart | martin.paillart@iledenoirmoutier.org

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