



DREDGING IN THE MALDIVES

Copernicus Sentinel 2 data is being used in the Maldives to improve the efficiency of dredging for sand so saving ship time on site and reducing negative environmental impacts derived from damage to endangered coral reefs.



THE CHALLENGE

The Maldives comprise 26 atolls and over 1000 islands sitting on either coral structures or sandbars. It is the lowest lying country in the world with its highest point at 2.4m. Offshore, there are many further reefs sitting just under the surface. The atolls are separated by navigable channels which are subject to change as are the islands themselves as changing currents erode or deposit sand.

The low-lying islands are very vulnerable to damage from rising sea-levels and increases in the frequency of violent storms. Coastal protection and reclamation of land lost to the sea is a permanent process. There is an almost constant need for either the dredging of channels or the depositing of sand to protect island areas.



To avoid transport costs, wherever possible, engineering works for construction of barriers are made using sand obtained by dredging the sea-floor. Hence, up to date maps of the sea-floor are valued to help know where the sand can be found and extracted with good operational efficiency (ie the extent of the sand area) whilst causing minimal environmental damage (destructing coral reefs or disturbing important sea vegetation). The maps also help to navigate the ships with the knowledge of where they can move safely.

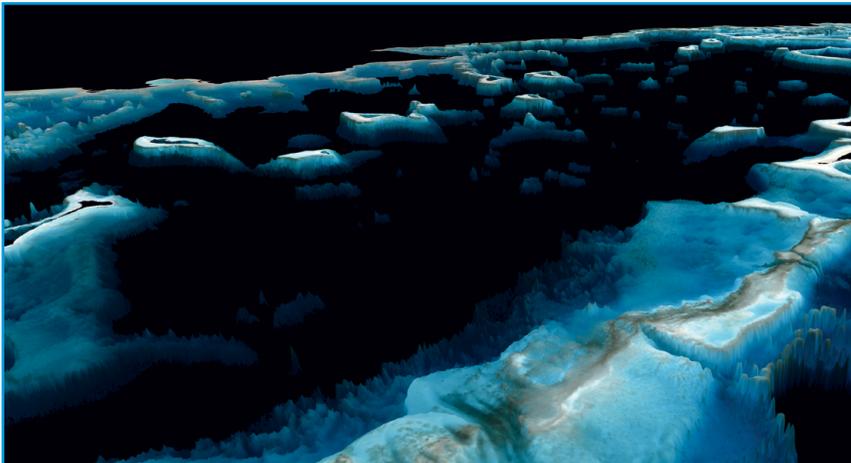
However, in many parts of the world, including the Maldives, the available hydrological maps are out of date or simply not accurate enough to give reliable guidance for modern dredgers. But now satellite data coming from Sentinel 2 can be used as a relatively inexpensive way to gather the necessary information and generate useable maps of the sea-floor.

HOW SATELLITES CAN HELP

In clear waters - as is the case in tropical regions - optical imagery acquired from satellites such as Sentinel 2 can “see” down to the sea bottom. Multispectral images allow experts to measure both the depth of the water and to map the sub-sea surface to place reefs, vegetation and the nature of the sea-bed. EOMAP, a service provider in Germany, makes use of Sentinel-2 data (and other satellite data) to derive the following products:

- Satellite-derived Bathymetry, that is a hydrographic chart of the sea depth down to around 25m in clear waters, but extending to 35m in exceptionally clear conditions; and
- Sea-floor classification services, providing information on seafloor habitats, benthic cover and geomorphology, using both official classification schemas (e.g. CMECS) or use-specified classes.

The key advantages of using satellite data are that remote and/or extensive areas may be accessed efficiently, that both historical and up-to-date environmental information can be provided, it is non-intrusive and may be used to monitor seasonal and long-term trends. Mostly, a chart generated within the previous 12 months is adequate but, in the territory around the Maldives, Sentinel 2 is providing images almost every other day meaning that a more up-to-date chart can be produced if required.



Satellite Derived Bathymetry overlaid with a satellite image of a coral environment. Courtesy of EOMAP.

The satellite data: Copernicus Sentinel-2



Sentinel-2 carries an innovative wide swath (290km) high-resolution (10m) multi-spectral imager with 13 spectral bands, providing unprecedented views of the Earth with frequent revisit times. The mission is mainly intended to support land monitoring: its images can be used to determine various indices related to the status of vegetation that are useful for e.g. agriculture and forestry. When imaging over crisis areas, Sentinel-2 contributes to disaster mapping, helping humanitarian relief efforts. Sentinel-2 imagery is also useful to monitor glaciers, lakes and coastal waters.

Copernicus Sentinels data are available under an open and free data policy.

Sentinel-2 data can be accessed at <https://scihub.copernicus.eu>

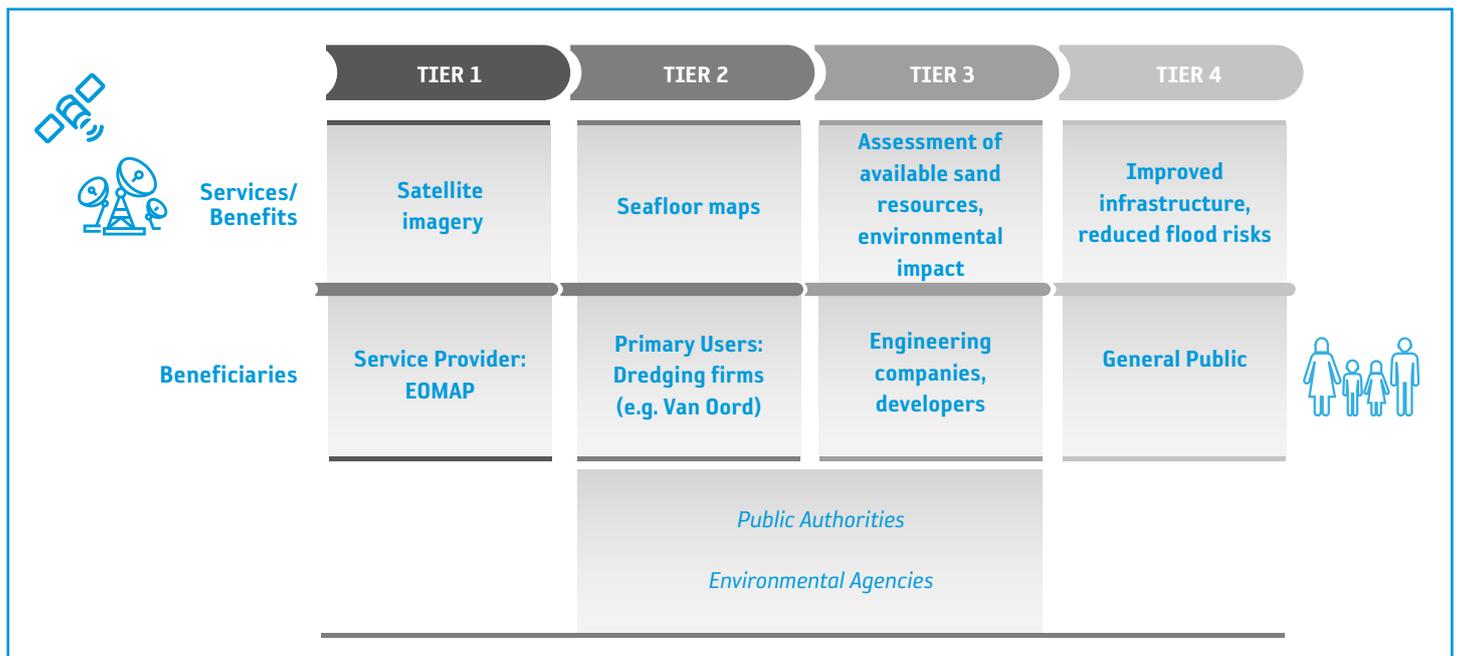
More info: <https://sentinels.copernicus.eu>

The Service Provider

The provider of sea-floor maps in this case is EOMAP, EO Services company located in Germany and Australia. EOMAP is a leading global service provider of satellite-derived hydrographic and aquatic environmental information, including Satellite-Derived Bathymetry, seafloor mapping and water quality monitoring. EOMAP delivers strategic, digital and geospatial insights for the offshore industry, hydrographic offices and governments worldwide. EOMAP's uses its proprietary and standardised, physics-based processing system that has been perfected over 30 years R&D.



www.eomap.com



Schematic representation of the main beneficiaries along the value chain, including the corresponding services and benefits provided.



A Maldivian atoll with a Van Oord dredger operating on the bottom-right. Courtesy of Van Oord.

WHO IS CONCERNED?

Hydrographic data produced by EOMAP are used by **Van Oord**, a major dredging company based in the Netherlands, to help plan and manage their operations. Van Oord, and companies like them, are specialists in dredging works for sand extraction as well as for clearing sea-ways leading to ports. They have many different specialist dredging vessels operating around the world to execute their global business. Van Oord seek contracts to supply construction companies with sand for engineering works normally commissioned by national authorities. They have a strong interest in the efficient extraction of the sand in order to keep their costs down whilst the constant need to reclaim land and to enhance coastal defences to protect against sea surges and storms leads to a strong demand for material. The most effective way to source the sand is from the local sea-bed which avoids shipping it over long distances and reduces its cost for local infrastructure work. Note that this sand is rarely used for building construction work due to the high salt content which produces poor and short-life concrete.

In the case of the work contracted by the **government of the Maldives**, much of the area is a protected environment. This is often true for tropical regions where the satellite technology is mainly deployed. Large areas of coral are often not mapped yet present a hazard to dredging operations both as a danger for ships as well as a liability if these are damaged. In some areas, sea-grass can be found where a dredging operation is planned. In this case, the sea-grass must be restored after work is completed. Knowledge of the presence of the sea-grass before operations start is a big advantage for controlling the cost of the operation and for controlling environmental damages.



Dredgers raising a Maldivian embankment with Van Oord dredging operations in the background. Courtesy of Van Oord.

The operating costs of a dredger run into several thousands of Euro per day and are the most significant cost for the provision of the sand. Better knowledge of the area can help Van Oord control their costs and reduce the risk to the ship of collision with coral reefs or grounding in shallow areas. Use of the satellite-derived charts can also reduce the up-front survey time otherwise necessary and to avoid the need to send survey teams out to the site before operations commence.

Knowing the characteristics of the sand but also its environmental footprint is important for international companies often operating in the eye of NGO's concerned for the environment. Protecting coral and acres of sea-grass can add significant cost to the operation and hence having an up-to-date and accurate map of the sea-floor enables Van Oord to be more aware of the risk before the contract starts and hence protect the company from consequential damages.

The **Maldives' government and the local citizens** have an interest to ensure that their islands and homes are safe. Barriers are constructed to protect them against rising sea-levels and storm-driven sea-surges; channels are kept clear to ensure the secure supply of shipped goods. Both require the removal of sand from the sea-bed whilst **NGO's and environment bodies** are watching carefully to see that sensitive areas are protected.

The Primary Users

The primary user of the EO services in this case is Van Oord, a Dutch family-owned company with more than 150 years of experience as an international marine contractor. Van Oord's background lies in the Netherlands' unique location on the North Sea and its battle against the water. The history of the company is entwined with the country's biggest marine engineering works, including the Nieuwe Waterweg Canal, the Delta Works, and the Port of Rotterdam Maasvlakte II expansion. These were projects that fuelled economic growth and kept the population safe from flooding.

During these projects, the company has grown into one of the biggest marine engineering companies in the world. Since the late nineteenth century expertise has also been supplied abroad. Van Oord dredged the Suez Canal, extended the port of Surabaya, and built the Palm Islands in Dubai and the Gemini offshore wind park – all projects that have put the company on the map worldwide.



www.vanoord.com

WHAT ARE THE BENEFITS?

The core beneficiaries coming from the use of the satellite-derived hydrographic data and maps are the dredging companies which can improve their operations and especially reduce the risk of being exposed to liabilities resulting from environmental damage. Their benefit is financial either through direct cost savings or through lower contingent liabilities which could arise from causing environmental damage. However, these benefits extend to others as well. The government benefits through improved defences and open sea lanes. The environment is protected better through NGO's which are watching for destruction or disturbance of sensitive ecological ecosystems. The main beneficiaries however, are the local citizens where sea-defences reduce the risk of flooding or storm damage to their homes and businesses.

The key benefits are:

- **Financial:** better control of the cost of operations in areas where there is a high environmental risk.
- **Construction:** costs are kept down through lower sand prices.
- **Efficiency:** more efficient operations for the dredgers with less up-front survey time required leading to faster project implementation.
- **Environmental:** reduced risk of damage to environmentally sensitive areas.
- **Quality of life:** reduced cost of development or coastal protection with consequent reduction in the risk of damage to homes.
- **Security of dredging operations:** Improved safety with better navigation and less risk of costly and dangerous grounding.
- **Co-operation:** The same data being shared amongst different actors enables a common operational picture and improves co-operation between the various stakeholders.

EXTENDED IMPACT

Over 40% of the world's population live in coastal areas (<150km from the sea) many of these in large cities. Even more, this proportion is increasing as people migrate from inland countryside to coastal cities so placing increasing demand for high(er) quality infrastructure and for more land. The materials for construction come from many sources, but in coastal regions and especially tropical ones, sand is often obtained from the sea-bed even if it can only be used for non-critical works which include, coastal protection and land reclamation from the sea.

Tropical storms and rising sea-levels pose a significant threat to coastal populations and infrastructure. Defences are necessary to protect them from this threat. The low-lying Maldivian islands have a particular need as do many other countries around the world also face similar threats and build defences which often use sand dredged from the sea-bed. Furthermore, ports need to dredge channels to keep them open to large ships.

Where good hydrological charts exist, the operations are easy to plan and execute but where they do not, the use of satellite imagery can be effective. Hence this satellite derived service is of value in all tropical regions where the sea is clear and the bottom is visible from satellite images.

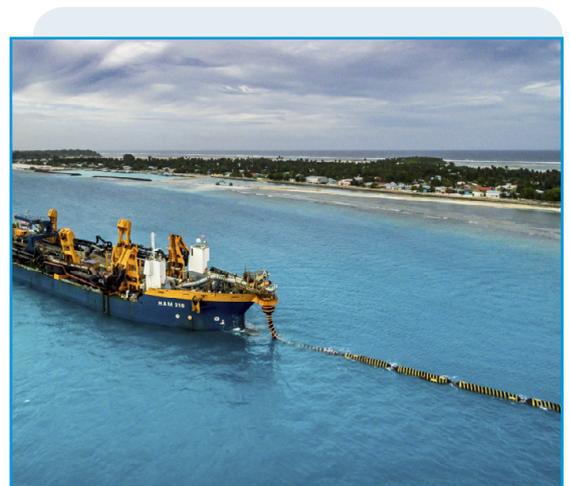
Protection of coral reefs and sea-vegetation is a key objective especially given the threat arising from global climate change. For the dredging company, knowledge of their location enables preventative measures. For local governments and environmental organisations, having the same information can provide re-assurance that the companies are not taking undue risks and that these valuable ecosystems remain protected.

ABOUT THE PROJECT

The Sentinel Benefits Study (SeBS) is conducted by EARSC (the European Association of Remote Sensing Companies) in partnership with The Greenland, IIASA (International Institute for Applied Systems Analysis) and Evenflow, on behalf of the European Space Agency (ESA) as part of the Copernicus Programme. The study aims at showcasing the benefits brought by the use of Copernicus Sentinel data along the full value chain. 20+ use cases are addressed in details as part of the study, but many more have been identified. The current report describes one of such cases that have not been (yet) investigated in details.



We acknowledge that the understanding of the case was supported by interactions with the following stakeholders: Mr Knut Hartmann from EOMAP, Mr Frans Pijpers and Mr Marcel Grethe from Van Oord. We thank them warmly for their availability.



Minimizing project risks and improving efficiency is crucial for activities in shallow or un-surveyed waters. Satellite derived information on seafloor and bathymetry allow for easy and more reliable planning and execution of shallow water projects.

*Dr. Knut Hartmann,
COO EOMAP*



Do you know an interesting case demonstrating the benefits derived from the use of Sentinels data?

Email info@earsc.org

More Information on Sentinels Benefits Studies:

www.earsc.org/sebs



The Sentinels Benefits Study is funded by the EU and ESA.
The views expressed in this study cannot be taken to reflect the official position of the EU or of ESA.