

Mapping and Studying Changing Coral Reefs: Is the Saba Bank still growing?

Researchers aboard the Pelagia research vessel have been collecting invaluable data on the Windward islands in the Caribbean during the sixth leg of the “Netherlands Initiative Changing Oceans (NICO)” marine expedition organized by the Royal Netherlands Institute for Sea Research (NIOZ Sea Research) and NWO-Science (ENW). They mapped for the first time the seabed of the windward sides of Saba and St. Eustatius and further investigated what is believed the richest biodiversity area in the entire Dutch Kingdom: the Saba Bank.

NICO expedition

During the NICO expedition 100 scientists spread out over 7 months from a wide range of research disciplines studied five ocean provinces (North Sea, Atlantic Ocean, Caribbean Sea, Gulf of Mexico and Bay of Biscay) with the aim to get a better understanding of our changing seas and oceans. This information is essential to make decisions on how to respond to climate change impacts such as rising sea levels and temperatures and ongoing acidification and eutrophication (NIOZ, 2018).

In March 2018 the research vessel arrived at the Dutch Caribbean Windward Islands (Saba, Saba Bank and St. Eustatius) where the last NICO expedition projects in the Dutch Caribbean took place.

Studying the Windward Islands

Fleur van Duyl (NIOZ Sea Research) and Erik Meesters (Wageningen Marine Research (WMR)) were the chief scientists of the sixth leg of the NICO expedition. An advantage was that their research team gained already much experience from previous expeditions to the Saba Bank.

Saba Bank

The Saba Bank is a submerged carbonate platform rising from a depth of 1.5 km. As a known biodiversity hotspot, the Saba Bank is of special interest to scientists because it has remained relatively pristine thanks to its remote location. Since 2011 several research expeditions by WMR and NIOZ Sea Research took place to assess the state of the fisheries, coral reef health and shark populations (Bos et al., 2016; DCNA, 2017).

Growing or eroding?

Saba Bank’s coral reefs have suffered as well in recent decades from elevated seawater temperatures induced by global warming which resulted in Caribbean-wide bleaching events. During the bleaching event in 2005 the Saba Bank lost over 50% of its coral cover. In combination with ocean acidification and increased marine pollution, these environmental changes have reduced the capacity of corals to compete with other benthic organisms such as algae,

cyanobacteria and sponges which can rapidly invade dead or weakened coral surface (Webb et al., 2018). The research team aims to understand the interaction between the environment and coral reef functioning and determine if and how a community shift changes the balance between calcium-carbonate accretion and eroding processes. In other words: Is the Saba Bank growing or eroding and which factors can explain these processes?

The carbonate budget

To answer these questions, different experiments and (long-term) measurements were taken by NIOZ Sea Research and WMR since 2011. During the NICO expedition the research team further investigated the carbonate budget –that is the coral growth (carbonate production) versus coral breakdown (carbonate erosion) budget of the overall Saba Bank (Webb et al., 2018).

To do so, they measured the chemistry of the seawater overlying the reef (including dissolved inorganic carbon concentrations and alkalinity, nutrients, phytoplankton, virus, salinity and oxygen levels) with CTD units and a new type of water sampler called Pumpy which can take simultaneous measurements from 2m to 10 cm above the bottom. The method is based on the principle that coral growth (calcium carbonate production) locally extracts dissolved carbon from the seawater surrounding the coral. On the other hand, bio-eroding organism such as sponges and

worms break down the coral’s carbonate skeleton which results in carbon release into the seawater. The measured dissolved carbon concentrations in seawater above the reef provides information on the overall reef growth/erosion rate and allows to quantify spatial and temporal variations (Webb et al., 2018).

Different benthic communities

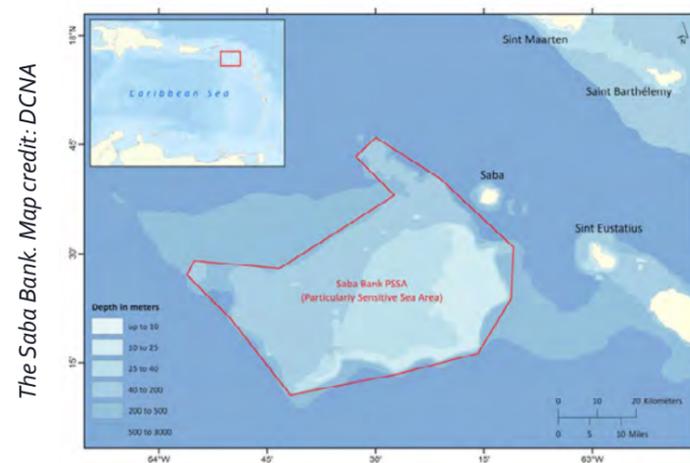
On the Bank the chemistry dynamics were measured at seven stations with different reef habitat types including coral-, macroalgae-, crustose coralline algae (CCA) - and sand dominated communities located between 15 and 34m depth. The researchers further investigated the benthic-pelagic (seabed-ocean water) coupling of the different benthic habitats by taking measurements on organic matter (bio) deposition, mineralization, marine microbe community and oxygen dynamics in the benthic boundary layer (van Duyl and Meesters, 2018). This will provide insights in the processes influencing the community shifts from corals and CCA to more fleshy algae, cyanobacteria and benthic suspension feeders.



Photo by: © Alice Webb

Mapping the seabed

Maps of our marine environment provide important information on the location of different ecosystems and help to identify areas of high conservation value. The remote windward sides of Saba and St. Eustatius have not been mapped before. The research team mapped for the first time the largely unknown benthic communities and bathymetry (topography of the seabed) on the windward sides with video transects and the multibeam echo sounder (see BioNews 13 for more information on bathymetry). Because of its high exposure the ecosystems here mostly thrive in the mesophotic region (more than 30 meters depth). Also the researchers expanded the mapping of different habitats (from 10 until 100m depth) and bathymetry on the Saba Bank with the aim to link the benthic habitat descriptions that result from the mapping to benthic metabolism (van Duyl & Meesters, 2018).



First findings

Hidden landscapes

The total of 25 km of photos and videos that were recorded on the Windward Islands show a large variety of habitat types including areas with patches of seagrass and coral-, algae- and (volcanic) sand dominated communities (van Duyl & Meesters, 2018).

Very excited were the researchers about the first journey of exploration into two deep sinkholes at the northern part of the Saba Bank called the Luymes Bank. The large holes in the carbonate bottom have been created during periods that the bank was above sea. These holes range from 100m to several kilometers in diameter and are 100-300m deep. The researchers sent video equipment down these sink holes. At the bottom a mysterious landscape was encountered: a large community of calcareous algae that consists of thousands of little pillars that are between hundred and thousand years old (van Duyl & Meesters, 2018; Heinsman, 2018).

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The Saba Bank might be the most special nature park of the Kingdom of the Netherlands and we have to be extremely careful to safeguard it.

Erik Meesters (WMR)

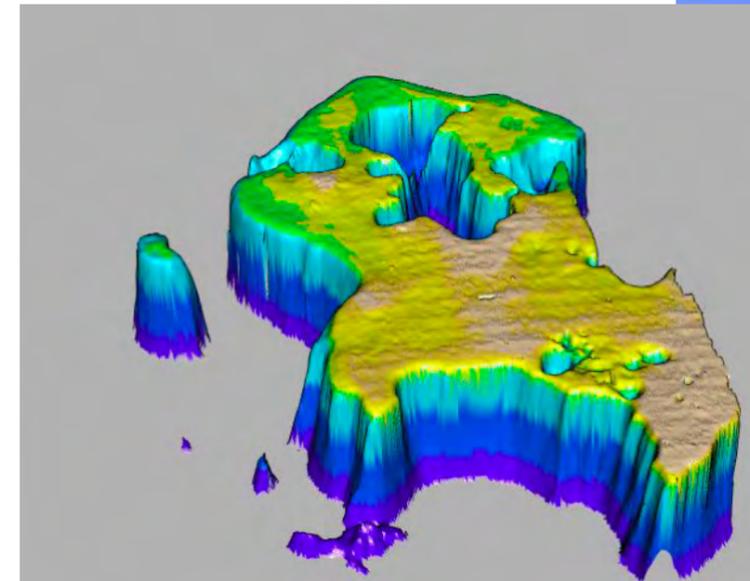
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Healthy reefs

The researchers also discovered an extreme healthy reef in the southern part of the Saba Bank at 30 meters depth. A hopeful finding that there are still healthy reefs thanks to the Saba Bank's remote location.

For safeguarding Caribbean reefs action is urgently needed. Local stressors have been identified as the most significant drivers of reef degradation throughout the Wider Caribbean, particularly overfishing, introduced species, coastal development and pollution associated with increases in tourism visitation and local populations (Jackson, 2014). With effective conservation measures in place and management of the island's marine resources in the hands of dedicated professionals, there appears to be good prospects for their survival particularly if there is a political willingness to continue to protect them from harm.

The need to increase the resilience of our coral reefs has never been more pressing. Coral reefs are marine biodiversity hotspots that are not only invaluable for coastal protection but also have a high economic value through associated tourism and fisheries. The Dutch Caribbean islands are particularly dependent on the health of the coral reefs due to our economic dependence on nature-based tourism.



Three-dimensional picture of the Luymes Bank at the northern part of the Saba Bank. The top of the bank is around 80m deep.

Map credit: NIOZ Sea Research /WMR



Calcium carbonate pillars made up from calcareous algae on the bottom (app. 100m) of a sinkhole on the Luymes Bank.

Photo by: © Erik Meesters and NIOZ.

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The Saba Bank

The Saba Bank is a large flat-topped seamount rising from a depth of 1.5 km. The upper area of the Saba Bank covers an area of +/- 268.000 hectares, an area roughly the size of the Dutch part of the Wadden Sea or, more evocatively, about the same size as Luxembourg (DCNA, 2017).

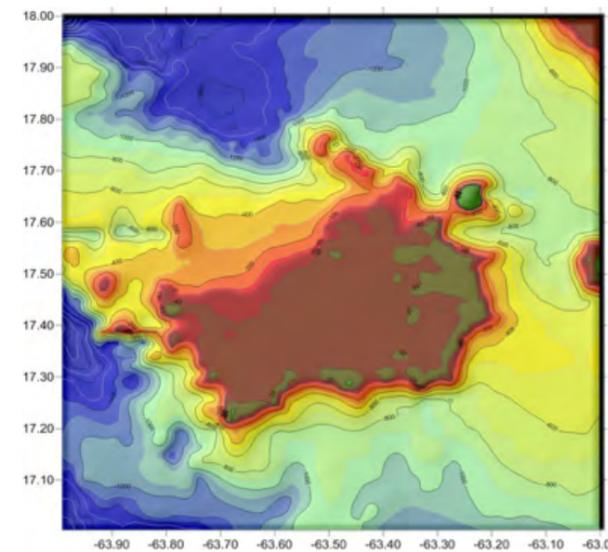
Most of the Bank lies at depths of 20 to 50 meters, but a considerable area to the east lies between 10 and 20 meters and has extensive reef development (Meesters et al., 1996). It reaches a plateau at a depth of about 15 m (Klomp and Kooistra, 2003).

Van der Land firstly explored the Bank in 1972. In 2010, after the constitutional change, the Saba Bank became the direct responsibility of the Netherlands. Since that time considerable resources have been spent on the Saba Bank including several research expeditions by Wageningen Marine Research and NIOZ Sea Research to assess the state of the fisheries, coral reef health and shark populations (Bos et al., 2016; DCNA, 2017).

Considered to be one of the world's marine biodiversity hotspots (Church and Allison, 2004), the Saba Bank is recognized under the Convention of Biological Diversity (CBD) as an Ecologically and Biologically Significant Area (EBSA). The Saba Bank was listed as a protected area of regional importance under the SPAW-protocol (Protocol Concerning Specially Protected Areas and Wildlife of the Wider Caribbean) and designated as the world's

13th Particularly Sensitive Sea Area (PSSA) by the International Maritime Organisation (IMO) in 2012. In the same year it was officially declared a National Park, making it the largest National Park in the Netherlands (DCNA, 2017; DCNA, n.d.).

More information on the Saba Bank and previous expeditions can be found in the special edition of BioNews:
<https://www.dcnanature.org/wp-content/uploads/2018/09/BioNews-SabaBank-2.pdf>



Map of a large submerged carbonate platform: the Saba Bank. The island Saba is the "green dot" on the right. Image credit: Gerard Duineveld (NIOZ Sea Research)



Photo by: © Milou Arts

More information on the NICO expedition:

www.nico-expeditie.nl



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