PUMA

Underwater sound: dredging Maasvlakte 2

This article is based on an extended version that appeared in IADC's journal Terra et Aqua in September 2013, with additional material from the Maasvlakte 2 sustainable report

Maasvlakte 2 from the air... the port authority has monitored the sound produced during dredging at the site

The first phase of the 2000 hectare project on the Port of Rotterdam was finished in April 2013 and, once operational, the site will be rich in sustainable attributes such as initiatives for cleaner trucks and renewable sources of energy.

"Investing in sustainable innovation, the port authority will develop a new port and industrial area in Maasvlakte 2 that is based on the balance of ecological, social, and economic considerations," said Port of Rotterdam's Maasvlakte 2 sustainability report. Since the start of its construction in 2008, the port authority has worked in collaboration with scientists to map out its impact on the coastal area, the sea and the creatures that inhabit it.

One of the licensing conditions was the monitoring of underwater sound produced during construction, with an emphasis on the establishment of acoustic source levels of trailing suction hopper dredgers (TSHDs) during their various activities: dredging, transport and discharge of sediment. It is the first Dutch study to focus on how much sound is produced by sand extraction dredgers and how far this sound travels underneath the surface of the water. It considers how much of this sound is heard by fish and marine mammals and how they respond to it. "In virtually every impact prediction, the researchers have decided it is better to be safe than sorry and have taken a worst-case scenario as their starting point," said the port in the sustainability report.

To determine the effects of underwater sound generated by dredgers on fish and marine mammals, model calculations were made for the Environmental Impact Assessment (EIA) on the basis of the best knowledge available at the time. From these calculations it emerged that the sound level below the water in the vicinity of dredgers can exceed the hearing threshold of fish and marine mammals. However, at a distance of more than a few hundred metres away from the vessel, it was thought that the threshold for avoidance would not be exceeded.

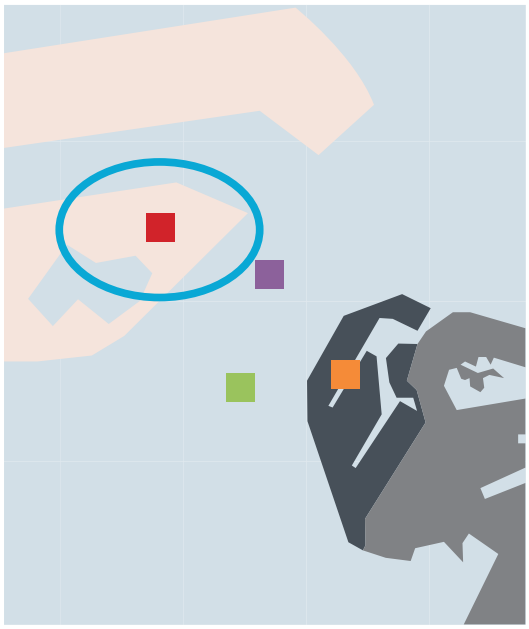
The port authority asked TNO (Netherlands Organisation for Applied Scientific Research) to carry out measurement and analysis activities for this monitoring. During an initial measurement campaign in September 2008, background measurements were performed in the absence of dredging. A year later, when dredging was under way, source level and background sound measurements were taken in the dredging area. In a final phase of the study, possible effects of underwater sound on marine fauna were considered for scenarios with and without dredgers.

Underwater sounds can affect marine organisms in different ways depending on the sound pressure level and the frequency. Literature written by Richardson et al, 1995, and Kastelein et al, 2008, generally distinguishes between zones of responsiveness, which range from a zone in which the sound is heard but where the animal does not respond, to a zone in which severe physical harm or death can occur. In between, there are zones in which behaviour is affected, with the animal swimming away from the sound or being attracted to it, and a zone where the animal's hearing may be affected temporarily or permanently: temporary hearing threshold shift (TTS); and permanent hearing threshold shift (PTS).

A new method has been developed for the analysis of the measured radiated sound associated with the various activities of the individual dredgers. TSHDs

- Existing Maasvlakte site
- Maasvlakte 2
- Approved sand dredging areas/ borrow areas
- The location where sand was dredged for the construction of Maasvlakte 2

Recording sites:
- Transport of sand
- Background sounds
- Sand dredging
- Construction area, including bottom discharge, rainbowing and pumping ashore



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produced most sound when they were travelling to and from the borrow and discharge areas at relatively high speed. The next loudest activity was sand dredging.

During pumping ashore and rainbowing, the source levels in the frequency range between 500Hz and 10kHz were comparable with the level of vessels dredging sand, but significantly lower at higher and lower frequencies. The lowest sound levels were produced during the bottom discharge of sand.

For the assessment of effects on animals, the criteria recommended by Southall et al (2007) were adopted. Relevant data to develop thresholds for effects of underwater sound on animal behaviour were not available and so it was decided to focus on the risk that animals experience a temporary hearing threshold shift. This risk is associated with the total underwater sound dose that animals are exposed to during 24 hours. TTS onset may occur when the cumulative weighted sound exposure level received by an animal exceeds a specified threshold level. It is likely that this is a safe choice because there are indications that, at sound levels below the TTS threshold, there are no changes in behaviour in some marine mammal species, including the seal.

To establish a picture of the possible maximum effect distances, calculations were made to determine where, in the area of 15 x 15km under study, thresholds for TTS onset would be exceeded by sound from ships in the area if an animal were to remain stationary there for a period of 24 hours.

The worst-case calculations for animals spending 24 hours at 1m above the seabed – which is not realistic for marine mammals because they have to breathe – produced the following results:

- For fish, the size of the area affected increases from 23km^2 to 72km^2 as a result of dredging activities. The areas affected for smaller fish are 68km^2 and 97km^2 for regular shipping only and shipping including dredging, respectively
- The area in which seals can suffer TTS is 10km^2 in the scenario with regular shipping traffic only and 72km^2 if there is also dredging activity
- For harbor porpoises, these areas are 0.0 and 0.5km^2 respectively

The areas are much smaller for animals closer to the surface. The threshold value for a permanent hearing threshold shift (PTS) was not exceeded in any of the cases studied, nor in any of the species in question.

In order to obtain an impression of more realistic effect contours, calculations were made to determine the extent to which fish, seals and harbor porpoises swimming once past a vessel dredging sand at a relatively low relative speed of 1m per second (3.6km per hour) may suffer TTS, or PTS. Seals swimming past a stationary vessel dredging sand will only suffer TTS if they are swimming 1m above the seafloor at a distance of 90m or less from the dredger. If they are swimming at 1m below the surface, they will suffer TTS at approximately 11m from the dredger. Harbor porpoises will not suffer TTS in any of the scenarios studied.

The distances at which fish are affected are larger at 1m above the seabed: 100m for fish weighing more than 2g and 400m for smaller fish.

In the case of fish swimming closer to the surface – at a depth of 1m – the criterion is not exceeded for fish weighing more than 2g and the distance will be 20m for smaller fish. Again, the threshold value for a permanent threshold shift (PTS) was not exceeded in any of the cases studied, nor in any of the species in question.

From this it can be concluded that the effect contours around a dredger calculated in this study are lower for harbor porpoises and seals than the 'few hundred metres' mentioned in the EIA and that they are of the same order of magnitude for fish.

In reality, marine mammals never stay at the same location for a long time in natural conditions; they are constantly swimming in order to feed and to move from one place to another.

Calculations were therefore made for the situation in which seals and harbor porpoises swam for a period of 24 hours at a realistic speed of 6km per hour along the north-south lines in the area measuring 15 x 15km. This equates to 9.6 transits in 24 hours. Again, a worst-case scenario was established with calculations conducted only for animals swimming 1m above the seafloor for a period of 24 hours. In this rather unrealistic scenario – marine mammals are unable to breathe underwater – less than 0.1% of the harbor porpoises and seals are exposed to the risk of experiencing a temporary hearing threshold shift (TTS), even in the presence of dredging activities representative for the construction of Maasvlakte 2. PH

MORE INFO: www.iadc-dredging.com; www.maasvlakte2.com