LEARNING FROM THE DEEPWATER HORIZON OIL DISASTER

Oil in troubled waters

In an effort to limit the damage caused by the huge oil disaster in the Gulf of Mexico, the disaster response team resorted to desperate measures. It is now thought the remedy did more harm than the original problem, says Professor Tinka Murk. She is working on a model that predicts the impact of an oil disaster and suggests the best approach to damage control.

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At the end of April 2010 there was a blowout under the Deepwater Horizon oil platform in the Gulf of Mexico not far from New Orleans. From the deepest oil field in the world – going nine kilometres below the seabed and only reached by the drills a few months earlier – gas and oil started leaking from 1200 metres below sea level through the pipe to the platform. An explosion followed and fire broke out, costing 11 rig workers their lives. The platform sank and the drill pipe broke, causing water to gush out of the well on the seabed.

Technicians were unable to stem the leak or close the numerous small holes. The blow out preventer, a sort of lid on the well, had not been functioning for weeks. For almost a month, 800,000 litres of oil poured into the sea every day. The spill response workers tried everything: injecting drilling fluid into the leak, covering it with a metal dome, and stuffing the hole with all kinds of debris such as cement-covered tennis and golf balls. Nothing worked. In the end they managed to put a funnel in place and mid-June – three months after the explosion – all the leaks were finally plugged.

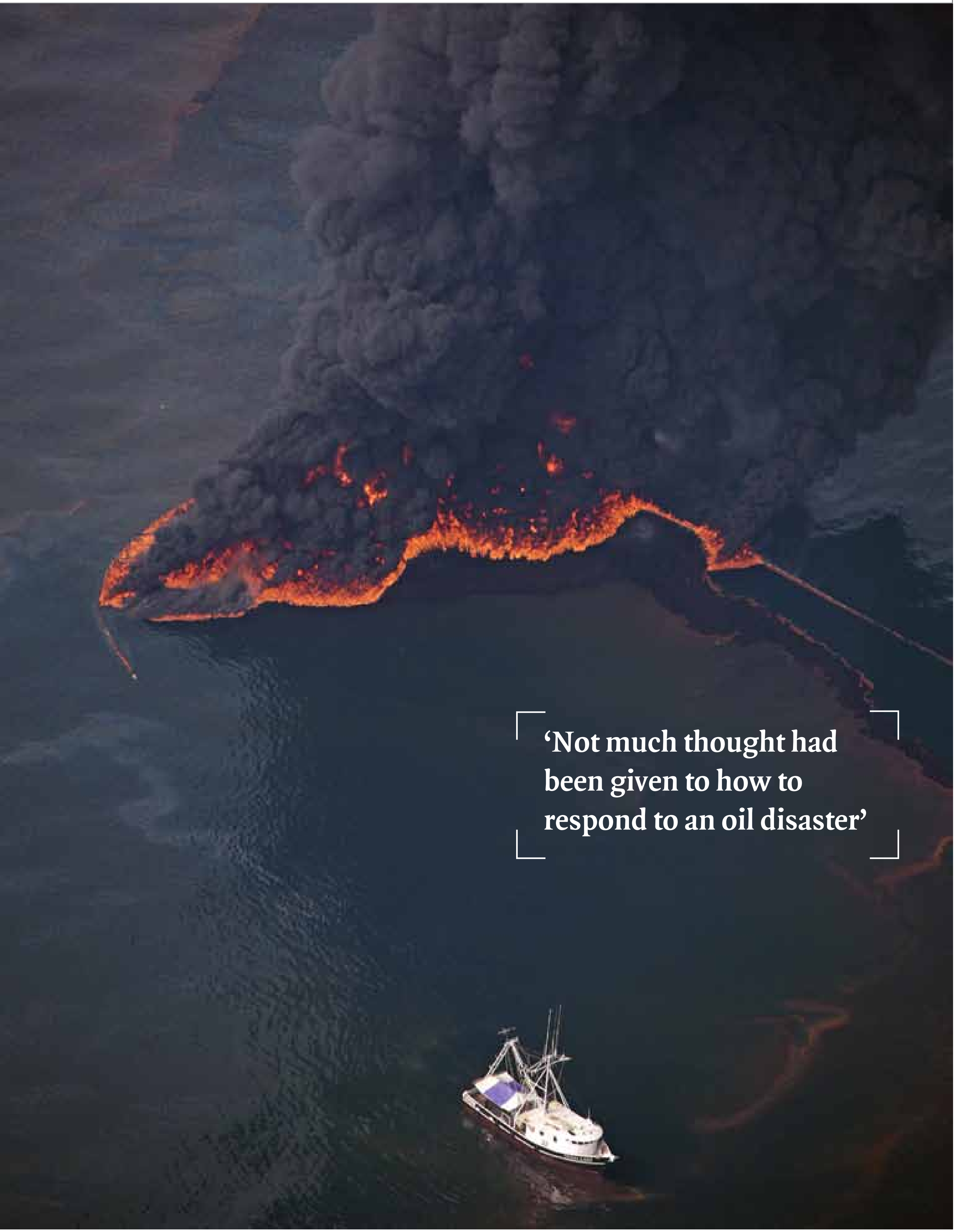
As soon as the explosion happened, there were fears for an ecological disaster of unprecedented proportions. Transocean, the owner hiring the platform to oil company British Petroleum (BP), decided to keep the oil below the surface using three million litres of dispersing agent. 'Beforehand, not much thought had been given to how to respond to an oil disaster,' says Tinka Murk, professor of Environmental Toxicology at Wageningen University, part of Wageningen UR. Almost three years down the line, her analysis is: 'The owner wanted to use this soapy substance to keep the oil not just off the beaches but literally out of sight. Just as washing up liquid dissolves the fat on the pans, dispersant mixes oil with water and creates a cloudy suspension.'

ASPHALTED SEABED

Sometimes this approach works and the dispersant prevents the oil from reaching the coast and harming birds and mammals. 'However, in this disaster the oil had already been dispersed mechanically because of the force with which it was spewed into the sea,' recalls Murk. 'There is still a debate about whether using the dispersant had any effect, with less oil coming ashore as a result. Supporters of the method say yes. But opponents say the dispersant released more toxic agents into the water and that great damage was done to the seabed.'

Whatever the case, after a few weeks oil started surfacing and reaching the coasts of Florida and Louisiana. Tourist beaches were evacuated, fisheries brought to a standstill, and a number of pelicans got covered in oil. Photos of these birds and the polluted beaches soon went all around the world. The biggest tragedy remains hidden from view, however, says Murk. 'Many square kilometres of seabed – we don't know exactly how much yet – are covered in a tarry layer full of polycyclic aromatic hydrocarbons (PAHs) , some of which are carcinogenic. Normally, in three months less than one millimetre of natural sludge is deposited on the seabed, but now it has been asphalted with a layer of gunk many centimetres thick. The disaster response team from BP and Transocean expected the dispersant to thin the oil sufficiently, but because of the interaction with floating material in the seawater, it just created a thick gunk,' explains Murk. 'At a blow, the seabed became a mass grave for its fauna.'

Three years on it appears there are some signs of recovery among the seabed fauna, particularly the foraminifera (single cell organisms with shells) as well as fish such as the blueline tilefish and a few species of snake eels. 'Under normal conditions this seabed life contributes a lot to the natural breakdown of organic substances such as >



> ‘Not much thought had been given to how to respond to an oil disaster’

OIL ON THE SEABED

After the Deepwater Horizon oil disaster in 2010, millions of litres of dispersant were used to dissolve the oil. With the result that many square kilometres of seabed are now covered in a centimetres-thick tarry layer full of polycyclic aromatic hydrocarbons (PAHs).

Number of days the leak continued
87

Litres of crude oil spilled per day
8,400,000

Litres of oil spilled
780,000,000

Litres of dispersant applied
7,600,000

Vacuuming up the oil is effective but only works in calm seas

Burning the oil

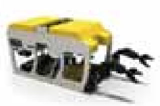
Platform Deep water Horizon

Much of the oil still surfaces, reaching hundreds of kilometres of Florida and Louisiana coast and coating birds and turtles

Dispensing dispersant above and under water

Oil mixed with dispersant forms a cloudy suspension that continues to float

Tests at Wageningen UR show that when exposed to dispersant certain algae form a stringy network in which living material gets attached to oil particles and it all sinks to the seabed



Unmanned aircraft chart the underwater pollution

Two days after the explosion, the Deepwater Horizon platform sinks

Unmanned aircraft try to plug the leak at a depth of 1500 metres

On the seabed a centimetres-thick tarry layer forms, estimated at dozens of square kilometres in area, which kills seabed life

Source: NOAA, EPA, Wikipedia

‘At a blow, the seabed became a mass grave for its fauna’

oil, through its movement and rootling,’ says Murk. If the layer is too thick and too toxic, bacteria and fungi are unable to carry out their job as the garbage workers of the sea, and the organic breakdown of the pollution caused by the Deepwater Horizon explosion cannot get going. These micro-organisms in the Gulf of Mexico are by nature ‘programmed’ to break down oil, small quantities of which have leaked from the seabed since time immemorial.
A human intervention to tackle the sludge on the seabed is not an option. ‘It is impossible to do anything about it at a depth of 800 metres, ‘says Murk. ‘That mess will just have to be broken down by natural processes. It is a matter of time.’

ALGAE NETWORK

Since the beginning of 2012, Murk has been project leader of the Dutch branch of a large-scale international study of the consequences of the Deepwater Horizon oil disaster. The study, called C-IMAGE, is funded by BP as a gesture to society. The contracts are in the hands of independent American organization Ocean Leadership. Nineteen institutes – most of them American – are doing the research. The Dutch project is being implemented by the Toxicology and Environmental Technology chair groups at the university together with IMARES Wageningen UR and NHL University of Applied Sciences in Leeuwarden.
Murk: ‘Three Wageningen PhD students are studying the effects of the dispersing agent, the breakdown of the oil and the ecotoxicological effects. We are focusing not only on the column of water but above all on the seabed.’ This research started in April last year and has already delivered one spectacular result. ‘Tests on seawater showed that under the influence of the dispersant certain algae form a stringy network in which all kinds of living material such as zooplankton gets stuck to oil particles, after which the whole lot sink to the seabed together. This is a mysterious phenomenon that depends on local conditions, and which we would like to know more about.’
Another PhD scholar is working at NHL University on the impact of oil with and without dispersant, and is studying the effect of mixing the two. ‘We want to know more about how sticky the dispersed oil particles are in reality. How long do they go on floating, do they stick to clay particles, do they sink or melt, and do they end up surfacing after all?’ A third PhD student is looking at the breakdown of the oil and the toxic substances in it.

CAREFUL THOUGHT

Eventually all this research should lead to a well-founded decision support tool. The instrument is a model loaded with location-specific details about ecosystems, economic functions, currents and meteorology. If an oil spill occurs at sea, you fill in the data and the model calculates whether a vulnerable turtle beach will be reached, whether the nearby coral reef that is a tourist attraction will be affected, whether the seabed will be polluted or the coast endangered. ‘The model not only has to calculate the impact of the oil slick horizontally, but also what is happening in the vertical water column at six, sixty and six hundred metres down. There is no complete model like this yet,’ says Murk. The model will also make it possible to calculate the impact of interventions such as applying dispersants, pumping out the oil or burning it. All on the basis of data about levels of vulnerability at the time of year when the accident takes place. ‘Take for example the growth of fish larvae or the presence of migrating birds. You can use this aid to give careful thought in advance to disaster scenarios. An added advantage is that it makes it possible to train people before there is an actual problem. When a disaster actually happens, managers are paralysed by stress of course,’ says Murk. ‘The model provides you with a basis for the decision whether to use a dispersant, for example. In the case of the Deepwater Horizon disaster, that could have saved money and prevented environmental damage.’ ■

www.wageningenUR.nl/en/show/learning-lessons-from-bp-oil-spill.htm

TRIPLEP@SEA

‘The busy North Sea, with its many oil rigs and wind turbine parks, could be hit by an oil disaster too,’ says Tinka Murk. ‘Now that the Barents Sea is now longer free of ice and oil- and gas-drilling activities are increasing there, more oil tankers will be passing the Norwegian and Dutch coasts on their way to Rotterdam. Collisions and oil spills cannot be ruled out.’
So Murk has embarked on the development of a decision support model for responding to a disaster. The case being used is the relatively straightforward situation around Saint Eustatuis island in the Caribbean. The Dutch water board Rijkswaterstaat has already expressed interest in Murk’s approach. The study comes under a large Wageningen UR programme: TripleP@Sea, which is researching how to make responsible and sustainable use of marine ecosystems. Murk is leading this programme. Another branch of TripleP@Sea focuses on the potential for oil drilling in the Barents Sea in the Arctic Circle, for transporting the oil and for calculating in advance the impact on the marine environment.
www.triplepatsea.wur.nl/UK