Ecotoxicological effects of chemically dispersed crude oil in the marine environment

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Motivation

In April 2010, the drilling rig Deepwater Horizon (DWH) in the Gulf of Mexico exploded and sank. Over the course of three months, 780 million L crude oil leaked from the wellhead at 1500 m depth . In an effort to limit the negative spill effects, 7 million L dispersants were injected in the well head and applied at the surface. Chemical dispersants break up the oil slick into tiny droplets which disperse into the water column (Figure 1, top), thereby reducing the risk of oil slicks landing on coasts and oiling of birds and marine mammals. Although this will result in a temporary increase in toxicity in the water column, it is assumed that the period of exposure will be short by dilution and enhanced degradation of the dissolved contaminants.

With the DWH spill, however, it was revealed that complexes of dispersed oil with sea snow, particulate matter and plankton had settled at the ocean floor (Figure 1, bottom). A thick toxic oily layer still is impairing the recovery of the benthic ecosystem years after the spill. The greatly enhanced formation of sea snow and resulting persistence was unexpected and suggested to be related to the extensive dispersant application.

Research challenge

This project focuses on the mechanisms behind the sea snow formation and the ecotoxicological consequences for the marine benthic ecosystem. Most experiments studying the fate and effects of oil with dispersants are performed in clean seawater. The hypothesis tested is that application of dispersants in the presence of phytoplankton will induce sea snow formation. This hypothesis now is proven true and the composition of the sea snow (extracellular polymeric substances, EPS) will be characterised to further elucidate the eco(toxico)logical consequences of this EPS formation. To be able to quantify the toxic potencies of different oil spill response options, in vitro bioassays are being developed for application on water and sediment samples. In vivo experiments with representative marine species will be performed to elucidate the benthic toxic effects, including repopulation and recovery.

This project is part of the US C-IMAGE research consortium funded by GoMRI (#SA 12010/GoMRI0007), and is being performed in collaboration with three other PhD projects studying biodegradation (S. Rahsepar), vertical oil fate modelling (M. Zeinstra) and developing a location specific decision support tool based on a net environmental and economic benefit analysis (NEEBA) (S. Vonk). Additional funding is obtained from the TripleP@Sea innovation program of Wageningen UR (KB-14-007).

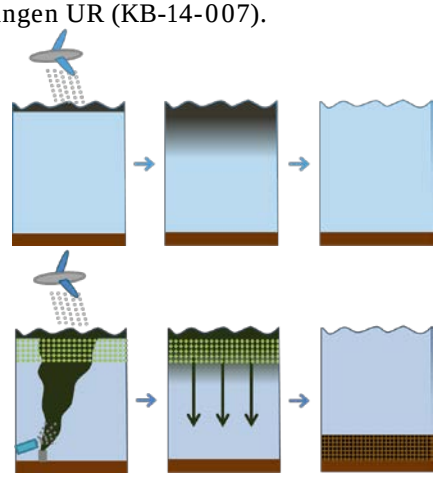

Figure 1: Theoretical effect of dispersants (top); situation during DWH oil spill (bottom)

CV
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