Rational application of chemicals in response to oil spills may reduce environmental damage

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Background

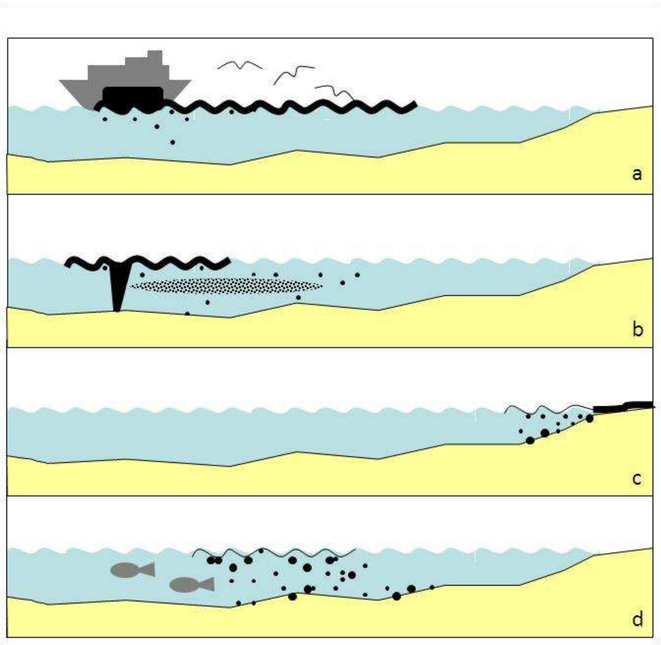
Oil spills, for example due to tanker collisions and groundings or platform accidents, can have huge adverse impacts on marine systems. The impact of an oil spill at sea depends on a number of factors, such as spill volume, type of oil spilled, weather conditions, and proximity to environmentally, economically, or socially sensitive areas. Oil spilled at sea threatens marine organisms, whole ecosystems, and economic resources such as fisheries, aquaculture, and tourism in the immediate vicinity. Adequate response to an oil spill to minimize damage is therefore of great importance. The common response is to remove all visible oil from the water surface, either mechanically or by using chemicals to disperse the oil into the water column to biodegrade. This is not always the most suitable response to an oil spill as it could result in worse effects, or no chemical response may be needed thus possibly saving costs.

Objective

Review advantages and disadvantages of using chemical treatments to reduce the impact of an oil spill in relation to the conditions of the spill and characteristics of the oil and of chemical treatment agents.
This information is needed for a rational NEEBA (Net Environmental Economic Benefit Analysis).

Results

For different spill scenario's and location of the oil (depicted in the fig.) the available chemical oil spill responses are reviewed.
A summary is presented in the tables.



- **Figure** Location and fate of oil according to different oil spill scenarios: (a) spilled from a tanker, the oil is inside a tanker and on the water surface. (b) spilled from a well at the seafloor, the oil is in the water column and on the water surface. In time, the floating oil slick could (c) reach the coastline by wind and currents, or (d) disperse into the water column, where it could end up in the sediment and/or biodegrade.

- **Tables** Options for application of chemical agents in response to the oil spill scenarios depicted in the figure. More info on limitations for use, advantages, and disadvantages are discussed in the review paper.

Inside ship (fig. 1a)				
Response option	**Category**	**Limitations of use**	**Advantages**	**Disadvantages**
Reduce outflow	Synthetic sorbents	Only effective for light to medium viscosity oil	Limits contamination of the environment	Potential increase of physical effects if not removed
	Solidifiers	Not effective for heavy, weathered oil	Limits contamination of the environment	Potential increase of physical effects if not removed
	Elasticity agents	Most products only effective on very light oils	Limits contamination of the environment	Unrecovered treated oil may be more persistent, very sticky, more likely to adhere to animals, vegetation, and shorelines

Water surface (fig. 1a & b)				
Response option	**Category**	**Limitations of use**	**Advantages**	**Disadvantages**
Enhance removal	Demulsifiers	Only suitable in case of a water-in-oil emulsion; products are oil type-specific	Increasing effective-ness, capacity and window of opportunity for mechanical recovery	Demulsifiers may enhance solubility of oil into water column thereby increasing exposure to water column resources
	Synthetic sorbents	Under specific conditions and possibility collection of oil-sorbent mixture	Limits contamination of birds and mammals until mechanical removal is possible	Risk of physical effects when oil-sorbent mixture is not removed.
	In-situ burning agents	Only suitable for thick oil slicks with low evaporation, conditions of low wind speed and low waves	Fast removal of oil slick	Creates smoke plumes and burn residues;the risks for man and environment cannot be assessed and controlled
	Elasticity agents	Mostly only effective on very light oils. Treated oil should always be recovered.	Improves recovery with mechanical equipment or sorbents; reduces natural dispersion to water column	Unrecovered treated oil may be more persistent, and very sticky to fur, feathers, vegetation, shorelines, etc.
Reduce spreading	Herders	Only effective in rare cases when wind and wave energy is very low	Increases effectiveness of mechanical recovery; prevents oil sticking to objects	Potentially toxic to aquatic organisms
	Synthetic sorbents	Under specific conditions and providing collection of oil-sorbent mixture	Limits contamination of birds and mammals until mechanical removal is possible	Risk of physical effects when oil-sorbent mixture is not removed.
	Solidifiers	Effective use of solidifiers is not possible in case of heavy, weathered oil	Limits contamination of birds and mammals until mechanical removal is possible	Solidified oil difficult to remove from water surface; inhibits natural processes; could increase physical effects
Enhance dispersion	Dispersants	Not effective for heavy-, or weathered oil; only acceptable on locations with high dilution rates	Reduces contact of oil on seabirds and sea mammals and reduces chance that oil slick will reach coastline	Increase in potential exposure likely for water column resources and, to a less extent, bottom dwelling resources

Response option	**Category**	**Limitations of use**	**Advantages**	**Disadvantages**
Water column/sediment (fig. 1b & d)				
No chemical response options available				
Specific application: Objects and Fauna				
Clean	Cleaning agents for fauna	Animals should be viable. Adequate collection of oil-water mixture after treatment required	Enhances oil removal from substrates	Chemicals are used within closed environment (i.e. washing room), so limited disadvantages
Clean	Cleaning agents for objects	Object should not be in direct contact with water column to prevent dilution of the agents	Enhances oil removal from objects (buoys, equipment , etc.)	If used in open environment, organisms in water column and sediment may be at risk

Conclusions

- There are several combinations of oil type and environmental conditions for which application of oil spill chemicals will not be effective or even adverse.
- Preparing a NEEBA including crucial location-specific and season-dependent information is important to allow fast and rational responses to reduce the adverse erffects of an oil spill in a cost-effective way.

Remarks

- In a current research project (C-IMAGE) we are studying the consequences for oil fate, biodegradation and ecotoxicity with and without the application of oil spill chemicals.
- These results will be applied for a location-specific NEEBA to be prepared for making rational response choices for maximal reduction of the damage to ecosystem services.

Reference

- Tamis JE, RH. Jongbloed, CC. Karman, W Koops, AJ Murk (2012). Rational Application of Chemicals in Response to Oil Spills Reduces Environmental Damage. IEAM 8, 2: 231–241

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