Ecological aspects of oil pollution.

Principles for advice on treatment and methods for quantitative follow-up studies.

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INTRODUCTION

By request from FAO and UNDP forwarded to the IRC for environmental planning and services a group of ecologists from the Swedish Water and Air Pollution Research Laboratory (IVL) was sent to Kiltan Island, Laccadives, India, in connection with an oil spill from the tanker Trans Huron in the area in November 1974.

In addition to an evaluation of the effects caused by the oil spill, the consultant group was assigned to advise on basis of observations made in the field on: a. the feasibility of using chemical dispersants and oil herders in the present situation, and b. to design methods for quantitative biological sampling and methods for chemical analysis of oil to be used in a follow-up study.

The following abstracts from the original report presented by the consultant group (1) pertain especially to these two issues which because of their more general character can be applicable to other cases of oil spill hazards.
A. ARGUMENTS ON THE USE OF CHEMICAL DISPERGENTS AND OIL HERDERS BROUGHT FORWARD BY THE SWEDISH TEAM DURING DISCUSSION IN BOMBAY AND COCHIN

The question of whether or not to use chemicals in connection with oil spills naturally has to be seen in the light of the local conditions such as type of oil spilled, amounts, water temperature and turbulence and the object one wants to protect.

There are four main objects for protection 1) fishing potentials and aquatic resources 2) recreational beaches 3) aquatic bird populations and 4) ground water.

The physical effects of chemical dispergents resulting in formation of droplets of oil in water instead of a layer of oil on the water result in less oil on beaches and less hazard for bird population. If protection of any of these is the prime concern chemical dispersion may be effective.

Dispersions and oil in combination however increase the acute toxicity compared to oil only. Therefore, if acute damage to aquatic organisms is the prime concern it should be avoided. The to date relatively unaffected coral reef at the northern side of the island might be destroyed if dispergents are applied. If so, the natural protection of the island should be reduced with unknown consequences. (Long term effects and rate of recovery has so far not been subject to any proper comparative study with or without dispersion. Arguments can be found why recovery ought to go faster after dispersion in certain situations).

When considering application of oil herders the risk that oil, if already present on beaches, may be pressed into the ground water as a rekyle-effect of the forces pushing it away from land.
Based on these general arguments and the observations made of the oil and of the local situation at Kiltan Island, the Swedish team concludes that there is no case for application of chemical dispersents and that the small benefit that could be obtained from the use of oil herders is outweighed by the hazard of oil contamination of the island ground water. Therefore it is strongly recommended not to use any chemicals in the present situation.

B. PROPOSAL OF QUANTITATIVE METHODS THAT COULD BE USED IN A FOLLOW-UP STUDY

Intertidal study

Transect study

Transect studies could be made both in the rocky intertidal and in the sandy intertidal area. The tide amplitude is 1.5 m. Sampling should be performed at low tide. Permanent transects could preferably be layed out, i.e. marked out so that about the same area could be sampled repeatedly over a long time. The transects could be marked by a long line in the intertidal zone. Sampling could be made at 3 or preferably 5 points along each transect, with the end stations at the low and high tide marks. A 0.1 m$^2$ frame could be used as a quantitative measurement. The number of samples at each point of the transect should be 3 - 5. When rock is present the organisms could be scraped off within the frame and when sand is present digging to a certain depth could be made. The sand should be sieved through 0.5 - 1 mm meshes and the organisms picked out.
Rock-pool study

Rock pools are found on the northern and south-eastern part of the island. The rock-pool ecosystem is a hardy ecosystem and its reactions to oil pollution should be of much interest. The rock-pools should be sampled at low-tide. Some pools of different size and of different location in the tidal zone could be selected at both parts of the island, i.e. one group that is heavily affected and one group that is slightly affected by the oil spill. The rock-pool ecosystem can be examined by two methods. (a) A preservative can be added to the pool and all organisms picked or siphoned out. (b) the organisms can be identified and counted and the percentage alga cover estimated by looking into the pool. Measurements of temperature, salinity, oxygen, and oil content could preferably be made.

Benthic fauna

The benthic fauna could be studied at 3 stations in the vicinity of the wreck and at a few localities on other stations around the island. A 0.1 m² van Veen grab and a sieving aperture of 0.5 – 1 mm can be used. Five samples should be taken at each station. In the lagoon area, where previously mortality of the benthos has been reported, either of two sampling procedures could be used. (a) Random sampling at about 30 points with one sample at each site. Areas with corals should not be included when the sites are choosen. (b) Systematic sampling at about 10 points with 5 samples at each point. If not the van Veen grab can be used here a lighter grab might be used. The sampling under (a) is to prefer as this makes a quantification of the whole lagoon possible.

Quantitative corals and algae ecosystems analysis

The epifauna and flora and also to some extent the pelagic fauna could be sampled by means of the "plastic bag method". This is made by a diver who carefully puts a plastic bag over the coral or the algae and closes it at
the lower end. The coral or alga is then cut off and the content in the plastic bag and the epifauna examined. Quantitative figures could be given in relation to the weight or surface area of the coral or alga.

Photographic examination

The corals and the rocky bottom communities could be quantitatively studied by photos. This might also be suitable for some of the intertidal areas. The areas chosen for photographic reproduction should be permanently marked so the diver can return to exactly the same spot repeatedly. This might be a good method to study the repopulation of affected areas.

Lobster stock examination

As the lobsters have been affected by the oil and the local population catch the lobsters it should be of interest to estimate the lobster stock. About 30 - 50 lobsters pots with bait could be set out at random in the lagoon and left over night. The lobsters caught are counted and marked individually and released. If capture-recapture statistics are applied to the results a good estimate of the lobster population will be obtained.

Fish stock estimates

The coral fish population can be estimated by a skin-diver covering a defined area of the corals repeatedly and reporting what he sees e.g. on a tape recorder. The diving should be made at about the same time of the day and at about the same tide water level when repeated. The stock of other pelagic fish could be obtained by using observation nets, where different sections of meshes are put together.
A quantitative measure of microbial activity

Microbial degradation of oil is one important aspect of oil pollution, since this is a route by which petroleum hydrocarbons can be excluded from the system. Therefore, a quantitative measure of microbial activity due to oil pollution would be of great interest. Since it can be concluded that microorganisms degrading oil always are present in the sea in a sufficient number to initiate growth on spilled oil, there is little need to specifically look at the formal composition in order to determine whether or not these bacteria are present. Instead an ecologically valuable information can be given by determining the least amount of sea water that is needed to inoculate and degrade a standardized amount of oil. This can be done by using a liquid medium and estimating the most probable number.

Water-samples taken from the investigation area are immediately diluted in consecutive dilutions of ten. From each dilution five tubes containing about five mil. of sterile salts medium equibrilated with oil are inoculated. The tubes are kept in sea water temperature for seven days after which a small amount of oil from the spilling is added. This oil has been exposed to allow volatile compounds to evaporate. The tubes are then further inoculated for ten days in sea water temperature. In tubes where growth has occurred, the oil layer is disrupted and/or the media becomes opaque when shaken. The number of tubes with growth from each dilution is noted and the most probable number of degrading bacteria in the original sample can be obtained from table-works. (2)
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Effects of oil spill from the tanker "Trans Huron" on
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