

Borneo, and in North Sumatra, has just begun. The study, with a contract value of £400 000, was commissioned by the Asian Development Bank for the Indonesian Environmental Agency, Bapedal.

Industries centred in East Kalimantan and North Sumatra include oil refineries, liquefied natural gas (LNG), fertilizer, plywood, glue and rubber manufacturing, coal and gold mining. Waste streams from industries in North Sumatra and East Kalimantan currently comprise pulp and paper process wastewater treatment sludge, ammonia salts and nitrates, nitric and nitrous acids, sulphates, mercury, zinc and spent activated carbon. There are also sludges produced by the rubber, glue, fertilizer, LNG and oil industries. The initial task is to identify, categorize and assess the current levels of toxic and hazardous waste (THW) produced by these industries. A key element of this first step will be to establish the scope for on-site waste treatment and implementation of waste minimisation schemes. Geotechnical and hydrogeological investigations will also be carried out at planned sites to assess their suitability for centralised THW processing plants. Having projected the likely THW generation to the year 2015, three alternative scenarios for waste treatment will be developed, together with capital and running costs. Following a recommendation of the optimum treatment scheme, an institutional plan will be prepared to include private sector participation, collection of levies, strengthening of enforcement agencies and monitoring.

It is anticipated that much attention will be focused on the outcome of this study, as the Indonesian Government has recently introduced new legislation on hazardous waste and new procedures for environmental impact assessment (EIA). The contract for the work has been awarded to Entec Europe Ltd's environmental consultancy group, Cremer and Warner, who will also prepare an EIA for the proposed waste treatment facilities in accordance with the new Government guidelines. In addition, the social influences of the proposed facilities will be studied. Specific goals will include maximising the compatibility of each facility with the local character and way of life, so that community acceptance and employment opportunities are enhanced.

## Goa Coast Oil Spill

On 5 June 1994, the 64 000 t ore carrier MV *Sea Transporter* drifted to the Sinquerin-Goa coast from Mormugao harbour in a squall that hit the Goa coast, and was grounded on the rocks close to the Sinquerin beach.

The ill-fated ship carried about 1000 t of residual oil in two cargo holds. Immediately after the grounding, crew members were rescued by the Indian Coast Guard. Almost a week later, on 13 June, the Coast Guard and a Singapore-based salvage firm began an oil-flushing operation, as there was every possibility of an oil spillage which would endanger the marine environment and nearby beach.

On 2 July, due to gusty winds, a crack developed on the starboard side. This resulted in spillage of oil from the ship. By that time, salvage experts had succeeded in flushing out about 800 t of oil despite weather conditions. Initially, the amount of oil spilled was very little, but as the crack widened the spillage rate accelerated to 25–30 litres per hour. The amount of oil spilled was estimated at around 2 t and, in all, about 800 litres of chemical dispersants were used. In the meantime, flushing operations continued and efforts were made to minimise the leakage.

To examine the eventual environmental impact, a survey was carried out in the spill area of Sinquerin shortly after the oil spill. Several signs of oil patches were noticed in the nearby waters as well as on the beach. Tar concentrations on the beach ranged from 10 to 1700 g m<sup>-2</sup>. Petroleum hydrocarbon content in the waters ranged between 0.019 and 836.84 mg l<sup>-1</sup>, whereas on the sandy beach it varied from 1.25 to 6622 µg g<sup>-1</sup>. Studies on bacteria show partial degradation of oil in water and in beach sand. Zooplankton observations also showed some adverse effects of oil on marine biota.

In the meantime, a second crack developed on the port side of the ship. A flush-out operation was ended on 12 July after removal of the remaining oily residue. The ship's condition has continued to deteriorate with the cracks widening on both sides. Breaking of the ship appears imminent.

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## Research to Clear Algal Toxins

The New Zealand government is to fund a million dollar research programme that will investigate the feasibility of detoxifying shellfish affected by toxic algal blooms. The New Zealand shellfish industry was devastated by an algal bloom outbreak in 1993, which caused mussel and oyster farmers a loss of several million dollars (see *Mar. Pollut. Bull.* **26**, 233–4).

The funding has gone to the New Zealand Crown Research Institute Crop and Food, and is primarily aimed at determining if there is a way where, once a shellfish is rendered toxic by exposure to toxic algae, it can be harvested and rendered non-toxic. Shellfish are known to detoxify themselves naturally in time. However, scientists do not know how long this process takes, because normally in the growing environment the algal bloom is present, so the shellfish are continually retoxified.

Initially, it is proposed to determine rates of detoxification in purified water and then to experiment with different temperatures and food regimes, in an attempt to speed up food turnover and thus flushing time. It is also proposed to look at the use of chemical additives to speed up the detoxification process. One of the first steps will be to culture the algae causing the problem, a dinoflagellate called *Gymnodinium*. Parallel research on its culture and the toxin's chemical nature is also under way at the Cawthorn Institute in Nelson, a