# OIL POLLUTION

## ITS POTENTIAL IMPACT ON THE ENVIRONMENT OF THE SOUTH PACIFIC REGION


*Chronic pollution from canneries and boats at Pago Pago (American Samoa). Photo: Dahl.*

### Oil Pollution

Everybody contributes to oil pollution. Everybody contributes directly, by washing greasy hands and throwing away the water, by dripping oil from a leaky engine sump, by spilling some fuel when refilling an outboard motor, and in many other ways. Everybody also contributes indirectly, by making use of the products of the oil industry, including petrol and diesel for motors, kerosene for lamps, electricity that has been generated using fuel, and many plastic and chemical products that we use every day, or that are used to make things that we use every day. About six million tonnes of oil find their way into the sea each year.

Chronic pollution occurs everywhere, all the time. It results from many small spills, most of them minor and insignificant if considered alone, but all contributing to a level of pollution that the environment cannot continue to contain. It has rendered many harbour and industrial areas lifeless, and puts many others under threat.

Acute oil pollution results from accidents, and sometimes makes news. It may be catastrophic, particularly in an area that is environmentally sensitive.
Most oil spills in the South Pacific region are likely to occur during transportation, and most oil handling operations are carried out in port. Most large spills result from collision or grounding, which mostly occur in ports or port approaches, and usually involve small vessels.

### What is Oil?

"Oil" includes a large range of complex and diverse products. "Crude" or unrefined oil is a natural substance, produced over millions of years by the decomposition of vegetable matter. Thus it is hardly surprising, although it is very fortunate, that many bacteria can ingest oil, and remove it from the environment, and one of the ways of cleaning up an oil spill is to enable these bacteria to work as effectively as possible. Crude oil is a "dirty" oil, since it contains tars and waxes, and it evaporates rapidly, since it also contains petrol, kerosene, and other "light fractions", and this makes it highly dangerous.

Refined oils range from petrol, aviation fuel, and kerosene, to diesel fuel, and heavy oils such as lubricating and boiler oil. These are transported from the refineries to the consumers, and regular supplies come to almost every island in the South Pacific. The light oils are highly volatile, and so present a high fire danger. They are also highly toxic. The heavy oils are much less dangerous, but they may be very dirty and persistent.

### Oil in the South Pacific

Crude oil is transported across the Pacific from South East Asia to the west coast of the United States. Refined oils are delivered into the South Pacific region, and then transported in smaller ships between island groups and islands. Oil spills may occur anywhere in this system, perhaps from accidents when loading or discharging, or from washing of tanks, or from pumping bilges. Quite apart from this tanker traffic, other ships use oils as fuel and lubricants, and some ships carry drums of oil as hold or deck cargo. These are all potential sources of spillage.

Oil is also able to seep into the environment from sources ashore. Industry requires oil as fuel, and communities require electricity, which is often generated using diesel engines. Oil spillages can occur while the oil is being transported, used, or stored. Motor vehicles drip oil, and waste oil is often sprayed to reduce dust from unsealed roads. All this oil works its way into the ground, where it contaminates well water, and the oil eventually reaches the sea.

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*Simplified profile of the island shown on the far right page, showing sources of pollution and typical environments at risk.*

## The Effects of an Oil Spill

The principal effects of an oil spill are the danger of fire, the toxic effect of the oil, and the physical coating of the environment. Their relative importance depends on the type and amount of oil, and where it is spilt.

The danger of fire is greatest with light oils, and with crude oil. The extent and amount of toxic damage depends on the season of the year, and the stage of life that the various marine organisms have reached at the time of the pollution. The lighter fractions of oil are soluble in sea water, rendering it toxic to some organisms. Whereas adult fish may be able to swim away, and avoid the toxic area, larvae, and less mobile creatures, may have no such escape. They may be killed, or may experience changes in their feeding or reproductive cycles that may materially affect the size and species composition of fish stocks. Fish, and especially filter feeders such as oysters and mussels, may become tainted, and unfit, or at least unmarketable, as food.

Physical coating of the sea surface is not as much of a problem as physical coating of the shore. This is why clean-up effort is directed at preventing oil from getting ashore if at all possible. Sea birds have a major problem if they become coated with oil. The oil infiltrates their feathers, which lose their insulating properties. Oil on birds' legs may be transferred to eggs, preventing the embryo chicks from obtaining oxygen through the shells. Seabirds may ingest oil, with toxic effects, and may pass on contaminated food to their chicks. Sea birds, diving birds especially, are major losers from oil spills.

Physical coating of the shore is the major long-term effect of an oil spill, the actual effect of a particular spill depending on the weather and type of coastline. One of the big problems in tackling an oil spill clean-up is to decide if the cleaning procedures will help, or whether the combination of oil and cleaning material will cause more environmental damage than the oil alone. For example, a sandy shore may look much better after chemical cleaning, or after mechanical removal of the oily sand, but there will be fewer worms and shellfish there than if the oil had been left alone. This is why it is so important to have a contingency plan, prepared in advance. The plan should indicate areas that have high priority for cleaning, and specify the type of cleaning to be used, as well as indicating those areas that are to be left alone if polluted.

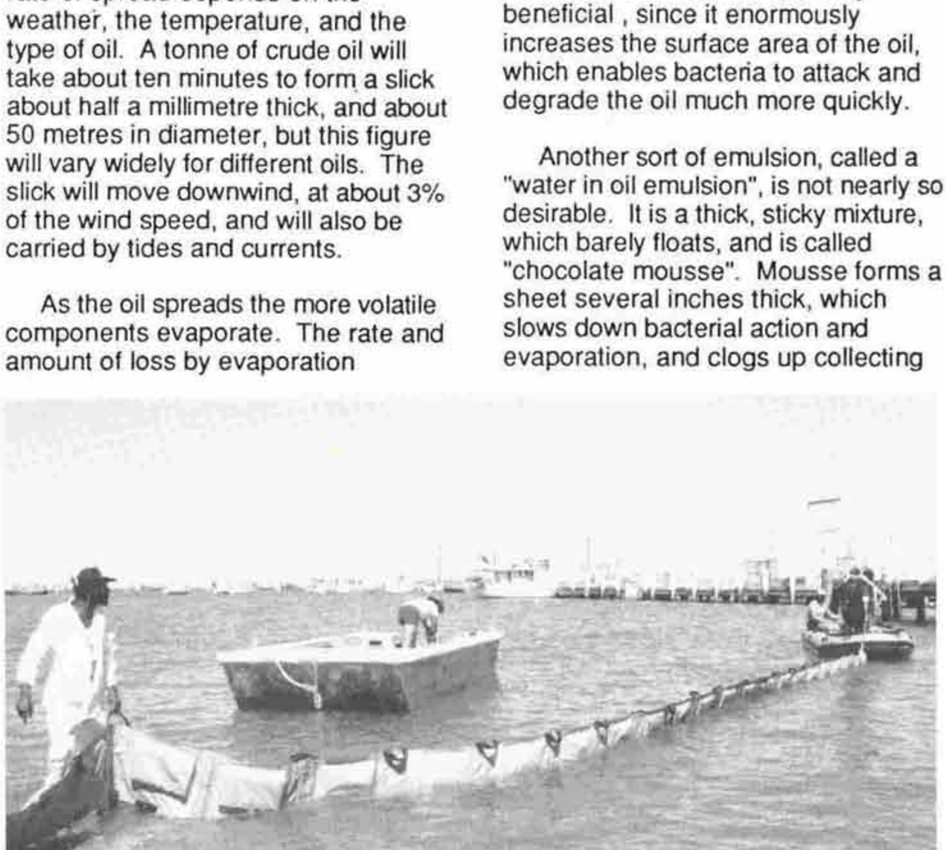
## What happens to Spilt Oil?

If nothing is done to collect or disperse it, an oil spill will spread. The rate of spread depends on the weather, the temperature, and the type of oil. A tonne of crude oil will take about ten minutes to form a slick about half a millimetre thick, and about 50 metres in diameter, but this figure will vary widely for different oils. The slick will move downwind, at about 3% of the wind speed, and will also be carried by tides and currents.

As the oil spreads the more volatile components evaporate. The rate and amount of loss by evaporation depends enormously on the type of oil. Light refined oils will virtually all evaporate. Crude oil may lose half or more of its volume by evaporation over a period of days. Heavy oils will lose very little. Evaporation is a big help to cleaning up a spill, but, particularly in a confined area, it presents a major hazard of explosion and fire. A very small proportion of oil vapour mixed with air can form an explosive mixture.

Some of the lighter elements of an oil spill will dissolve in the water. This may render the water toxic to marine life in the vicinity. If the oil is agitated and mixed with the water, for example by a rough sea, then much of the oil may be dispersed in tiny droplets through the water, perhaps down as far as 30 metres. This is known as an "oil in water emulsion". It is very beneficial , since it enormously increases the surface area of the oil, which enables bacteria to attack and degrade the oil much more quickly.

Another sort of emulsion, called a "water in oil emulsion", is not nearly so desirable. It is a thick, sticky mixture, which barely floats, and is called "chocolate mousse". Mousse forms a sheet several inches thick, which slows down bacterial action and evaporation, and clogs up collecting



*Deployment of shoreline and harbour booms.*

devices. It may come ashore, where it collects sand and debris, and forms "tar balls", which are very stable, and may last for years.

The bacteria which attack and oxidise the spilt oil are found in large numbers in polluted areas, and multiply rapidly when oil is spilt. Because of the beneficial effect of these bacteria, any dispersants or detergents used to clean up the oil should be biodegradable. Bacteria will also attack sunken or sedimented oil, and their effect is then much slower. Bacterial action means that a given environment may be able to cope with a certain level of chronic pollution, but if too much pollution is introduced, the environment may no longer manage, and plants and animals will die.

## Action to Take

One of the first, most important things to be done is to collect samples of the spilt oil, so that the source of the spill may be identified from analysis. Samples should be labelled with the time and place of collection, and must be kept in glass containers, not metal cans or plastic bottles.

No action at all to clean up the oil may be the best decision. If the oil is at sea, and not likely to come ashore, then it may be sufficient to keep a watch on it, and allow natural processes of dispersion and biodegradation to take their course. However,in many cases it will be necessary to take some action to contain, divert, or disperse the oil. The golden rules are to prevent the oil from coming ashore if at all possible, and to make every effort to physically remove it from the sea (or from the shore, if despite all efforts it gets ashore), rather than disperse it chemically.

*A boom may be towed between two boats.*

Burning the oil is not likely to be effective, at sea or ashore. The light fractions will burn, but these would have evaporated anyway, and the tarry residue will remain. At sea, the film spreads out so thinly that it is cooled very effectively by the sea, and so does not burn completely. Ashore, the heat will melt the tarry residue, and enable it to soak into the beach, which will make it very hard to remove.

In relatively calm waters, oil can be contained by the use of booms. Booms may be fixed in positions to protect sensitive areas of coastline, or they can be towed between two boats, to collect the oil for easier removal. Oil may escape both over and under a boom, and in a strong current, or in rough seas, a boom's effectiveness will deteriorate markedly. Nevertheless, in lagoons and sheltered waters, booms are an important part of the clean-up armoury, and the availability of booms in the area should be noted in the contingency plan. Some booms are absorbent, and some can absorb up to 20 times their own weight of oil. In emergency, coconut husks can be held in a fishing net and used as a boom, or vines can be laid on the water to contain and soak up the oil.

*"GT 185" skimmer and "Troilboom" boom.*

When the oil has been contained by a boom, it should be collected and removed if possible. Since oil floats, and sticks to things, it should be possible to skim it from the surface. In practice, since the oil film is often very thin, and the sea surface is often very rough, this is not so easy. Some skimmers expose a large surface to the oil, to which it sticks, and from which it is then scraped off. Others operate as centrifugal seperators, or incorporate a weir, intended to remove the oil directly from the oil/water interface.
They work well in tanks, but not so well in waves. They collect a mixture of oil and water, which then has to settle out. They tend to get clogged with mousse, tar balls, and floating debris. Nevertheless, skimmers of suitable size and type can collect a good proportion of the floating oil.

Oil may be sunk using physical agents, or dispersed using chemical agents. Sand spread on the oil will collect some of it, and sink it. Of course, it may float free and rise again later. The method is not suitable where oil on the sea bed would affect bottom-living fish, or foul fishing gear.

Chemical dispersal of oil is widely used, and has been controversial, especially in earlier days, when the dispersants used were highly toxic. Even now, a judgment has to be made, before using chemical dispersants, that the toxicity of the oil and the dispersants will not be greater than that of the oil alone. Chemical dispersants, together with agitation of the water surface, encourage the oil to form small particles, and thus promote the formation of an oil in water emulsion. The natural movement of the sea then spreads these oil particles through a huge volume of water, and as the surface area of the oil has also been increased enormously, the bacteria are able to attack it much more effectively.

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Dispersants work best on freshly spilled oil. They are not effective on highly viscous oils, and if a mousse has formed, then it is too late to use them. They should only be used on light oils if evaporation would cause too great a fire danger.

Dispersants can be sprayed from aircraft, ships or boats,or by hand.The contingency plan should indicate the location of stocks of low toxicity dispersant, and of equipment with which to spread it. Trained personnel should be available to use it. The effective use of dispersant requires quick decision making, so that a rapid response allows the oil to be dispersed at sea, before it can get ashore. If the oil gets ashore, then coral, mangroves, fish farms, and shellfish communities, are all at risk from the insensitive use of dispersants.

## Oil on the Shore

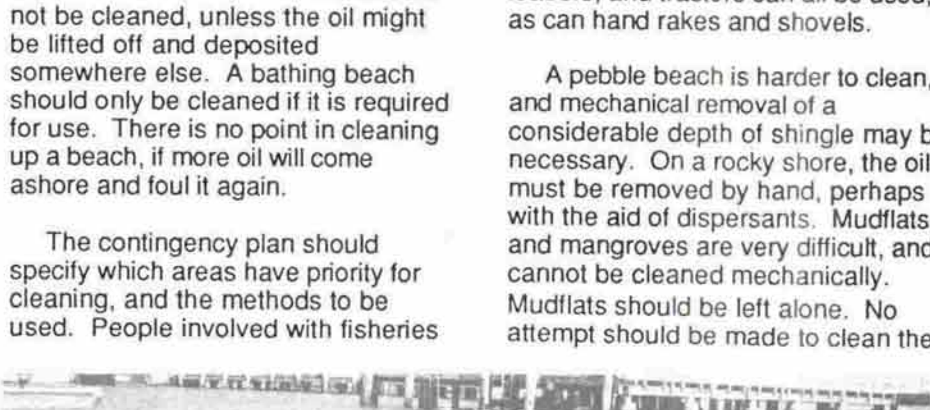
If the oil gets ashore, it is not going to be easy to clean it up. The choice of treatment will depend on the type of oil, and the type of shoreline. Careless or unskilled removal or treatment of oil may do more damage than the oil alone. Vehicular traffic can damage beaches and dunes. Washing down with fresh water will reduce the salinity of tidal pools, and may kill all the animals in them. Areas that there is no need to clean should not be cleaned, unless the oil might be lifted off and deposited somewhere else. A bathing beach should only be cleaned if it is required for use. There is no point in cleaning up a beach, if more oil will come ashore and foul it again.

The contingency plan should specify which areas have priority for cleaning, and the methods to be used. People involved with fisheries and tourism should examine the whole area concerned, to establish priorities and agree the clean-up methods to be used. Disposal of oily material must be considered, or oil may seep into the ground, and into water supplies, or back into the sea.

*A lagoon is a fragile environment, easy to pollute, but difficult to protect and clean up.*

Mechanical removal is clearly the best way to dispose of oil on the shore, provided it can be done sensitively. On a sandy beach, removal is fairly easy. Be careful that vehicles do not damage the beach, and do not spread oil to clean areas. It may be necessary to bring in clean sand to replace what has been removed. Bulldozers, front end loaders, and tractors can all be used, as can hand rakes and shovels.

A pebble beach is harder to clean, and mechanical removal of a considerable depth of shingle may be necessary. On a rocky shore, the oil must be removed by hand, perhaps with the aid of dispersants. Mudflats and mangroves are very difficult, and cannot be cleaned mechanically. Mudflats should be left alone. No attempt should be made to clean the aerial roots of mangroves. The effect of oil on mangroves will depend on the drainage of the area. In well-drained sand, the below-water roots will continue to obtain oxygen, and so the plants may survive physical coating of the aerial roots with oil. On the other hand, mangroves growing in poorly-drained mud will suffer if coated with oil. Loss of key mangrove species may have permanent and far-reaching effects on the character and ecology of an area.



*"Walosep" skimmer and "Pacific 500" boom.*

The mucus secreted by corals helps to repel oil. Most corals are below low water, and so are not directly affected by a surface oil slick. They may, however, be affected by oil dispersed in the water column, and by the lighter fractions dissolved in the water. Some shallow water corals are exposed at very low tides, and oil may be stranded on these by a falling tide. Physical removal will be difficult, and the use of dispersants will only make the situation worse. It may well be best to hope that the rising tide will lift the oil off again. The balance of species in a coral community may be badly affected by both chronic and acute pollution.

Seagrasses are very vulnerable to oil, and to chemical dispersants. Different species of seagrass respond to different chemicals in different ways. Various dispersants should be tested for their toxicity against the seagrasses in a given area, and only those found to be less toxic should be stored for use in that area. The contingency plan should specify the dispersants to be used, and those not to be used, in each area.

So the use of dispersants ashore, although effective, presents some problems. If dispersants are to be used, they must be used carefully and correctly. Even modern dispersants

*"Simplex" spray unit.*

should not be used if there are fish hatcheries, shellfish, or fish farms in the vicinity. As much oil as possible should be removed mechanically before using dispersants, then they should be used on a rising tide, so that the sea can wash the dispersed oil away. Otherwise the oil/dispersant mixture may sink into the sand until it reaches an impervious layer, where it will stay, degrading very slowly because of the lack of oxygen.

## The Contingency Plan

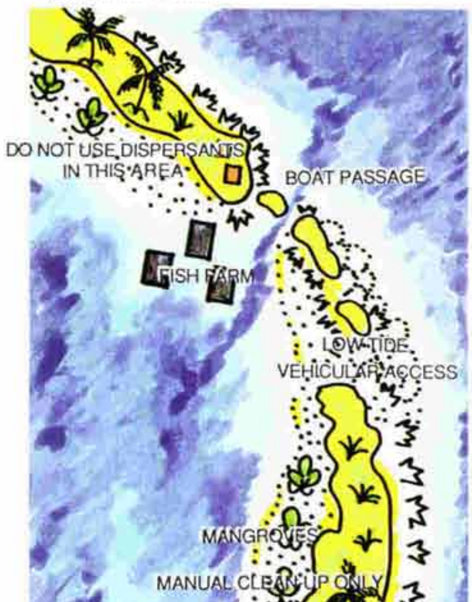
The contingency plan has been mentioned several times already. As the next oil spill may be tomorrow, or even today, it is essential that planning should be done in advance. Your Government should have an oil spill contingency plan for your country, and you should find out about it, and discuss it locally. There may be a need for a local plan to provide more detail than is found in the national plan.

The plan should aim to cope with a spill of a certain size, within a specified number of days. The size of spill that should be considered depends on the maximum probable size of spill in the area. The plan must also consider where oil is likely to be spilt, and where the wind and tide are likely to take it. It should specify the clean-up strategy for each area covered by the plan, and list the equipment and materials available, with their locations. The plan should specify who is to be in charge of operations in that area, perhaps the harbourmaster, and who are the trained personnel available, with their locations. It should include a map or chart of the area, showing the types of beaches, vegetation, access points, fishery areas, and other details that may be relevant.

The plan should specify the procedure to request outside assistance, in case local facilities are insufficient. Regular training should be carried out, for equipment operators, and for the person in charge and the management team. The plan should be exercised regularly, and should be modified to meet problems encountered in exercises. The development and implementation of a contingency plan requires the involvement and co-operation of several government departments, fire, police, marine, health and safety, fisheries, and local government, local industry, tourist operators, and environmental specialists.

## Cost Recovery

International conventions provide that member countries may take certain action on the high seas to prevent or reduce damage resulting from pollution following a marine casualty. Many countries have also passed legislation allowing their governments to take similar action in national waters.




*Part of a contingency plan.*

Other international conventions provide that the shipowner is liable for the costs of cleaning up oil pollution from his ship, and specify compulsory insurance for pollution damage compensation claims.The International Oil Pollution Compensation Fund (IOPC Fund) provides additional compensation when the amount the shipowner is liable for is inadequate, if the pollution is caused by a spill of persistent oil from a laden tanker.

There are also two voluntary industry agreements, TOVALOP, the Tanker Owners' Voluntary Agreement Concerning Liability for Oil Pollution, and CRISTAL, the Contract Regarding a Supplement to Tanker Liability for Oil Pollution. Claims should be made to the shipowner in the first instance, then to the IOPC Fund or CRISTAL if necessary. You see why it is so important to collect samples of spilt oil. You should also obtain samples of oil from the tanks and bilges of suspected offenders, in case they are needed later in court.

Claims may be made for the costs of preventive measures before the spill, and for clean-up operations afterwards. Replacement or repair costs of property and equipment damaged by oil, and economic losses as a result of the oil spill, such as loss of commercial fishing time, or loss of business by tourist operators, are all included. Spills of non-persistent oils, or spills from unladen tankers, or from ships other than tankers, are not covered by these agreements, and claims should be pursued through the normal course of national law.

## Summary- Checklist for Action

- Oil pollution is everybody's problem.
- Find out about your Government's National Contingency Plan.
- Develop a local contingency plan locally.
- Take samples of spilt oil, and from vessels suspected of spilling oil.
- Suit clean-up action to the spill, and to the environment.
- Make every effort to prevent oil from coming ashore.
- Physically remove spilt oil if possible.
- Only use dispersants after removal of as much oil as possible.
- Only use low toxicity dispersants.
- Test dispersants for toxicity on local species before stockpiling them.
- Clean up carefully, sensitively, and appropriately.
- Remember that you may damage the environment more by attempting to clean it up than by leaving the oil to weather and biodegrade.