# Pollution of Coastal Seas

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**Pollution of various environments is a consequence of population growth and industrialisation. Coastal seas form part of marine environment and are very rich in minerals, crude oil, fishes etc. They are also being used for disposal of wastes from cities. Various types of wastes, if not properly treated, would cause serious pollution of these shallow seas endangering marine life and spoiling recreational facilities. Different polluting agents like sewage, chemicals, industrial coolants etc. and their effects in the coastal seas are discussed with a historical background.**

## Introduction

The world's coastal lands are, perhaps, the best places for both habitation and industries. Many of the big metropolises are situated at river mouths e.g. Calcutta, Shanghai, Cairo and Rome. The large rivers with their tributaries provide abundant fresh water supply, cheap transport, fertile land and good sea foods. These are the things ideally required for locating industries also. The mega-cities with their large populations and industries generate millions of tons of domestic and other wastes every year, safe disposal of which is a big problem. During the sixties and seventies many coastal seas were so polluted that some of them became lifeless. Fishes caught from some were poisonous and gases emanating from some others made the surrounding air impure. Now, the situations have improved considerably all over the world. Many dead waters are brought back to life; many beaches are bleached of their stink. But a relapse or failure of the cleaning and monitoring processes might happen, if the administering agencies are not always aware of the seriousness of the problem (see the section on Thames). Almost all marine pollution problems are present in the coastal seas and brackish waters except those caused by deep sea mining and deep sea

dumping of wastes. Some aspects of coastal pollution are described in the following sections.

## What is Pollution?

The Inter-Governmental Oceanographic Commission, an international agency (within UNESCO) for ocean research and related matters, defines: 'marine pollution is the introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries), resulting in such deleterious effects as: harm to living resources; hazards to human health; hindrance to marine activities including fishing; impairing the quality for use of sea water and reduction of amenities'. Almost all human activities in coastal waters can cause changes or damage, minor or major, short term or long term to the environment, if not properly planned and monitored. Even seemingly harmless (?) activities like constructions, shipping, fishing and boating can dirty or damage the water bodies, especially the shallow waters. (Here it is important to state that while many activities have potentials for serious pollution, pollution can be prevented or mitigated with proper planning, treatment of wastes and monitoring).

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Now, it seems that the word 'deleterious' in the above old definition if resolved further can lead to a better definition of pollution. If the damage to the water or environment is of minor nature or easily and naturally recoupable, then this can be considered as unavoidable and insignificant. But, if the destruction is of a serious nature, whose recouping might take many years of effort involving research and technology, then this is the situation where the word 'deleterious' rightly fits in. Many sewage discharging problems are results of carelessness and lack of civic values and can be solved by community based efforts.

## Coastal Areas and Pollution Sources

India has over 6000 kms of coastline. Its territorial seas alone come to about 0.13 million square kms (with 12 nautical miles as limit). The exclusive economic zone (EEZ) covers an area of

*Figure 1 (left). Photograph of a marshy area.*
*Figure 2 (right). Photograph of a wide beach used for recreation.*

about 2.3 million square kms including those around the islands. As far as coastal development and pollution are concerned only the territorial seas and brackish waters are of relevance. This long stretch of coastline consists of various types of lands like marshes (*Figure 1*), mangrove swamps, hilly or raised areas, rocky coasts, sandy coasts, cities and ports. These varied coastal environments are used for ports and shipping, industries, waste dumping, fishing, salt pans, aquaculture, and recreation (*Figure 2*) and water sports. The Central Pollution Control Board (Government of India) has classified the entire coastal areas into five types based on evaluations of 'best-use-of-coastal-segment' from traditional and organised uses and activities. They are: (1) SW1 – salt pans, mariculture, contact water sports and ecologically sensitive areas, (2) SW2 – fishing and noncontact recreation, (3) SW3 – industrial cooling and aesthetics, (4) SW4 – harbours and (5) SW5 – navigation and coastal waste disposal. According to this classification the central west coast of India including northern Karnataka, Goa and southern Maharashtra is grouped under SW1. The main sources of pollution of the Indian coasts are urban sewage, drilling and shipping of crude oil, industrial effluents like chemicals, heat etc., and radioactive wastes.

## Sewage and Coastal Dumping

Many of the world's big cities were letting out their domestic waste directly into nearby rivers or seas during the 19th and early 20th centuries. This polluted coastal seas and rivers causing dangerous contagious diseases and eutrophication[1]. City administrators were later required to install treatment plants for

[1] The enrichment of natural waters with inorganic materials, especially nitrogen and phosphorous compounds, that support excessive growth of water plants, choking out other forms of life.

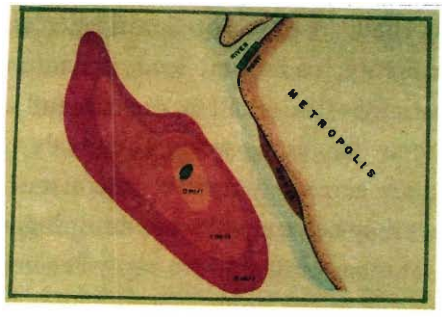


*Figure 3. Schematic diagram of oxygen depletion patterns around a sewage sludge dumping site (hatched area) in coastal water.*

making the domestic wastes harmless for dispersal in the seas. The sludge coming out of the treatment plants was dumped in safe (well circulated) marine areas. *Figure 3* (Even this sludge is a potential source of pollution if not well dispersed and unmonitored). This improved the sewerage systems and city environments.

**Box 1.**

The ambitious marine outfall projects at Worli and Bandra are on their way to becoming the first of its kind in India to discharge sewage 3kms away from the coastline, (through a tunnel below sea bottom at about 50m. *The Times of India*, May 17, 1997).

But for the financial constraints of the poor nations, sewage disposal with or without treatment, is not a big technological problem today. Sometimes, it would be better to let out the untreated sewage many kilometres away into the open seas where sufficient oxygen supply and mixing exist for degradation and dispersal of the wastes (*Figure 4*). Calculations show that expenses for a large treatment plant are comparable to that of a long pipeline of about 10 kms length for dumping untreated waste in well circulated deep areas of coastal seas.

## Chemical Wastes

A large variety of chemical wastes are formed by various industrial

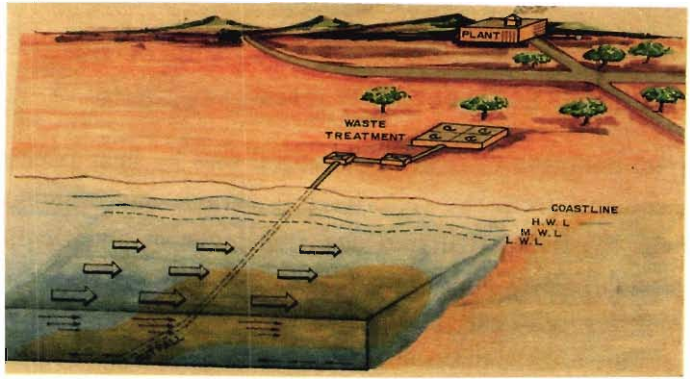


*Figure 4. Schematic diagram of dispersal of treated factory waste in deep waters of a coastal sea.*

activities. Many of them are of minor significance as polluting materials. But mercury, cadmium, lead, vanadium, nickel, chromium and pesticides like telodrin, diedrin and endrin are some of the common dangerous waste chemicals. Mercury, cadmium and lead are extremely toxic to organisms. Many of the chemical wastes may be treated before dumping, to remove the poisonous contents and to degrade to easily decomposable or absorbable materials in sea or land. Sewage sludge is found to have higher concentrations (10–200 times) of heavy metals than that of normal Earth's crust material. These concentrations can further increase if industrial effluents form part of sewage.

Many of the dispersed chemicals can accumulate in marine organisms depending on ambient concentrations, tissue peculiarities etc. and their concentrations would go on increasing in other organisms who feed on them. Humans and other organisms when fed on food items contaminated with pollutants are affected with various types of physiological problems or diseases. The Minimata disaster in Japan is a glaring example in which dozens died and hundreds became sick due to mercury poisoning. DDT poisoning was found to kill thousands of pairs of breeder birds (terns) off the coasts of the Netherlands in 1965. A drastic reduction in number of healthy pelicans was noted in California where DDT pollution existed. Studies revealed heavy contamination of pelican eggs by DDT. Efforts to reduce the DDT in the environment resulted in lowering the concentration levels of DDT in pelican eggs from 907 to 97 (mg/kg of fat) during 1969–1974. Effects of chemicals on life are of a very different type compared to eutrophication effects.

**Box 2.**

Showa Denko, the company blamed for the mercury poisoning in Niigata prefecture, known as Minimata disease, has 'sincerely apologised' to the victims of the illness and agreed to pay those not already compensated by the government. This came 30 years after the disease was first officially recognised. (news, *Marine Pollution Bulletin*. March 1996).

**Box 3.**

A Russian Milke class nuclear powered submarine sank in the Norwegian Sea on 7 April after an explosion. Norwegian and Russian scientists have been on the site since the accident, analysing air, surface and deep water samples for radioactive contamination. (News, *Mar. Poll. Bull.*, June, 1989).

## Thermal and Radioactive Wastes

Thermal pollution of rivers and coastal seas by heat released from coolants from the factories is a serious environmental problem causing destruction and imbalance of aquatic life. Many aquatic lives are very temperature sensitive. The warm waste water released into coastal seas raises the ambient temperature causing physiological and other problems to aquatic

organisms. Standard guidelines exist for levels of permitted *warmings* to avoid harm to aquatic life. In Europe (temperate regions) 2° C is the upper limit of differential warming with a maximum of 26°C. In tropical regions 2°C rise can be harmful. In all thermal pollution problems some basic points are to be properly weighed before taking remedial measures. These are (1) warming can favour some life forms at the disadvantage of others; (2) indirect effects of favoured growth can be bad to aquatic ecology and human food items and (3) if the whole range of aquatic life (other than favoured) is found not affected over long monitoring periods warming consequences can be considered nondeleterious and dealt with calmly.

Radioactive waste water released from nuclear plants is of a very different nature due to their long half life periods and damaging effects on cells compared to waste heat. In the oceans the amounts of natural and induced radioactivities are low. The main sources of induced radioactivity are (1) nuclear weapons testing, (2) nuclear reactors and processing plants, and (3) nuclear powered ships and submarines. One important point to be noted is that the half life periods of almost all radiation products (induced) are very low (< 30 years) compared to periods of natural radioactivity (of the order of 1000 yrs). Radioactive wastes affect surface planktonic organisms and fishes living near the bottom to various degrees. Even during the sixties and seventies, the radioactive wastes in the seas were at tolerant levels. Now, after instituting better 'test bans', decommissioning bad reactors and with international inspection mechanisms, radiation pollution is of no alarming nature. This is not a plea for complacency. Presently, deep waters of international seas and national territories of safe geological formations are used to deposit nuclear wastes safely for decades.

## Petroleum Products and Shipping

Large cities flush out lakhs of tons of waste hydrocarbons into their sewage. Drilling, pumping and marine transport of crude oil are major sources of oil spills in the seas (about 2 million

**Box 4.**

Another lawsuit has added to the roster of those seeking compensation from Exxon Corporation .... the suit seeks restitution for the thousands of birds, otters and seals killed, a claim that could cost the company billions of dollars .... . The suit is just one of almost 200 pending against the company. (*Mar. Poll. Bull.*, 1989, 20 (10): 485.)

tons). Polluted rivers and port operations and clean-ups in harbours add thousands of tons of oil wastes into coastal seas. Oil pollution caused by marine transport (largest from the Arabian oil fields) can reach the coasts of Africa, Asia and the Americas.

Effects of crude oil and its remnants in the sea are of many types. Oil on sea surface is subject to evaporation, dissolution, emulsification and biodegradation. After these processes, the residue would have solid shapes like peas and are called tar clumps. They spread on the water column and may sink as sediments. Sometimes they drift to the beaches. Large scale oil spills from accident sites of ships and harbours had caused widespread damage to marine organisms like planktons, fishes and birds. The cases of Torrey Canyon (1967), Amoco Cadiz (1978), Exxon Valdez (1989) and the biggest Gulf War oil slick (1991) are well-known examples.

The effects of landing of oil on different types of coastlines are different. Wave activity is found to have considerable effect on the dissipation of oil on coasts. On rocky coasts with high wave activity, oil clean-up is not generally necessary. But salt marshes, mangrove areas and sheltered (from waves) tidal flats would have serious long-term after-effects. As regards to oil pollution on coasts, the following conclusion of the Warren Spring Laboratory of UK is noteworthy: "*from the point of view of pollution of the environment the best thing to do with oil pollution of the beach is to do nothing. With the climatic conditions and the types of sea around the British Islands, oil left alone will fairly rapidly become innocuous or disappear altogether.*" Even though this is specific to British coasts, the conclusion is applicable for other coasts also depending on their nature and wave activity.

**Box 5.**

'*Saving Oiled Seabirds*' a booklet prepared by the International Bird Reserve Research Centre, Berkeley California and distributed by the American Petroleum Institute, summarises the best established techniques for rehabilitating oiled birds (News, *Mar. Poll. Bull.*, May, 1978).

## Story of Thames

The brackish waters of river Thames provide a glaring, long story of pollution, cleaning and restoration, during two centuries (see for details the book *The Restoration of the Tidal Thames* by

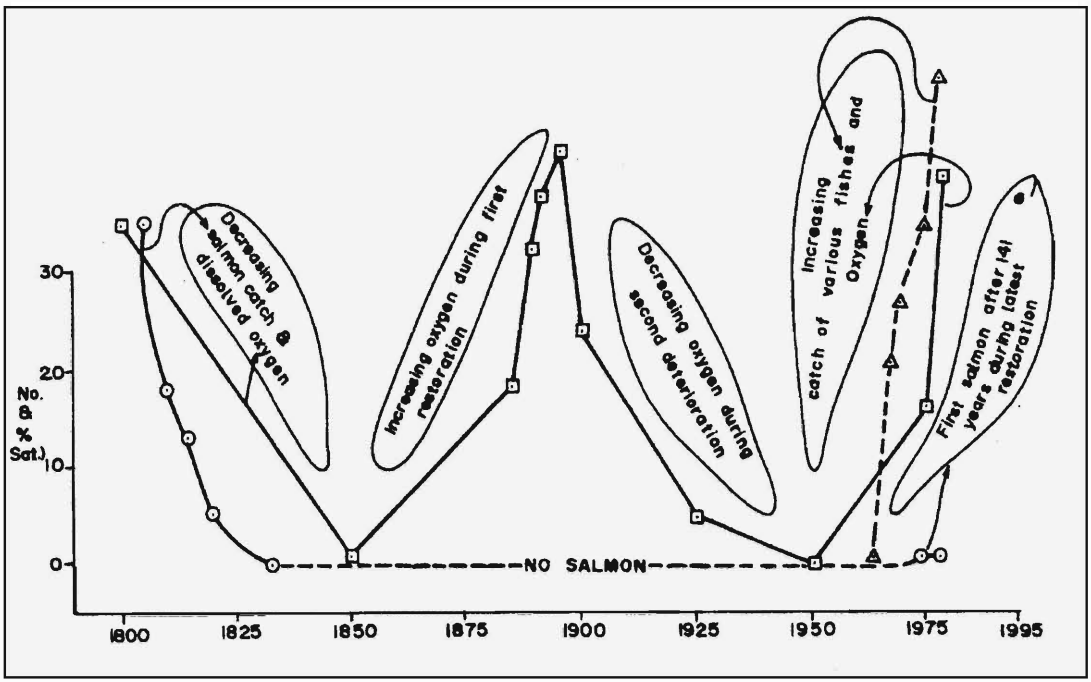


*Figure 5. A composite of oxygen saturation levels and fish catch in tidal Thames for about two centuries.*

L B Wood 1982). This book gives data and information on many pollutants, treatment methods, oxygen depletion, fish catch etc. during different periods at different locations along the tidal Thames from 1800 to 1980. The adjoining figure on oxygen (percentage of saturation) and fish catch is composited from these data (*Figure 5*). The tidal Thames passed through two cycles of 'pollution-restoration' during 180 years each with a period of about 90 years. It would be very interesting to search out the reasons for the second phase of deterioration during 1895–1950, even though the city experienced one cycle of 'deterioration-restoration' earlier. Was it due to lack of civic values or callousness of ordinary citizens or administrators? Is it likely that such cycles can happen in other large cities also? What were the exact socio-economic reasons? The answers would be definitely useful for other cities and city administrators.

## A Message

Many case histories of pollutions of various types in various


*Figure 6. A visualisation of global human endeavours and sustainable development.*

places make it clear that pollution is a result of ignorance or lack of values in ordinary people, local administrators and factory managers. Problems of ozone holes and greenhouse gases were, perhaps, beyond anybody's forethinking and are of global nature. These required long term international programmes for remedies and are being carried out. As far as the future of our Earth is concerned 'sustainable development' of all seems to be the only solution (*Figure 6*).

The search (explore and exploit) for new resources and techniques have to continue. But in the case of planned, new industrial processes, projects and sewage systems the following points (for conservation) are of high importance:

(1) When a factory is planned with new manufacturing processes or for new products the pathways of degradation and end-products of wastes and products are also to be studied and necessary treatment methods are to be implemented.

(2) Efficient and harmless (over long periods) waste disposal systems are to be installed.

(3) Continuous monitoring of the environment for any accumulated after-effects caused by various uses of products and waste disposal (in sea or land) are to be carried out. This can prevent unpredictable consequences (e.g. ozone hole).

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## Suggested Reading

[1] S A Gerlach. *Marine Pollution*. Springer-Verlag. Berlin, 1981.
[2] L B Wood. *The Restoration of the Tidal Thames*. Adam Hilger Ltd. Bristol. United Kingdom, 1982.