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ENVIRONMENTAL LAW AND POLICY

Lecture 9.1. SOURCES OF MARINE POLLUTION

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MARE

Related definitions

- "Area" means the seabed and ocean floor and subsoil thereof, beyond the limits of national jurisdiction;
- "Activities in the Area" means all activities of exploration for, and exploitation of, the resources of the Area;
- "Pollution of the marine environment" means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities;

Source of marine pollution

- **Based on Article 201 – 207, United Nations Convention on the Law of the Sea, there are 6 sources of marine pollution as follows:**
  - Pollution from land-based source;
  - Pollution from seabed activities subject to national jurisdiction;
  - Pollution from activities in the Area;
  - Pollution by dumping;
  - Pollution from vessels;
  - Pollution from and through the atmosphere.

1 - Pollution from land-based source

Urban runoff

Sewage

1- Pollution from land-based source

Agriculture

Industry

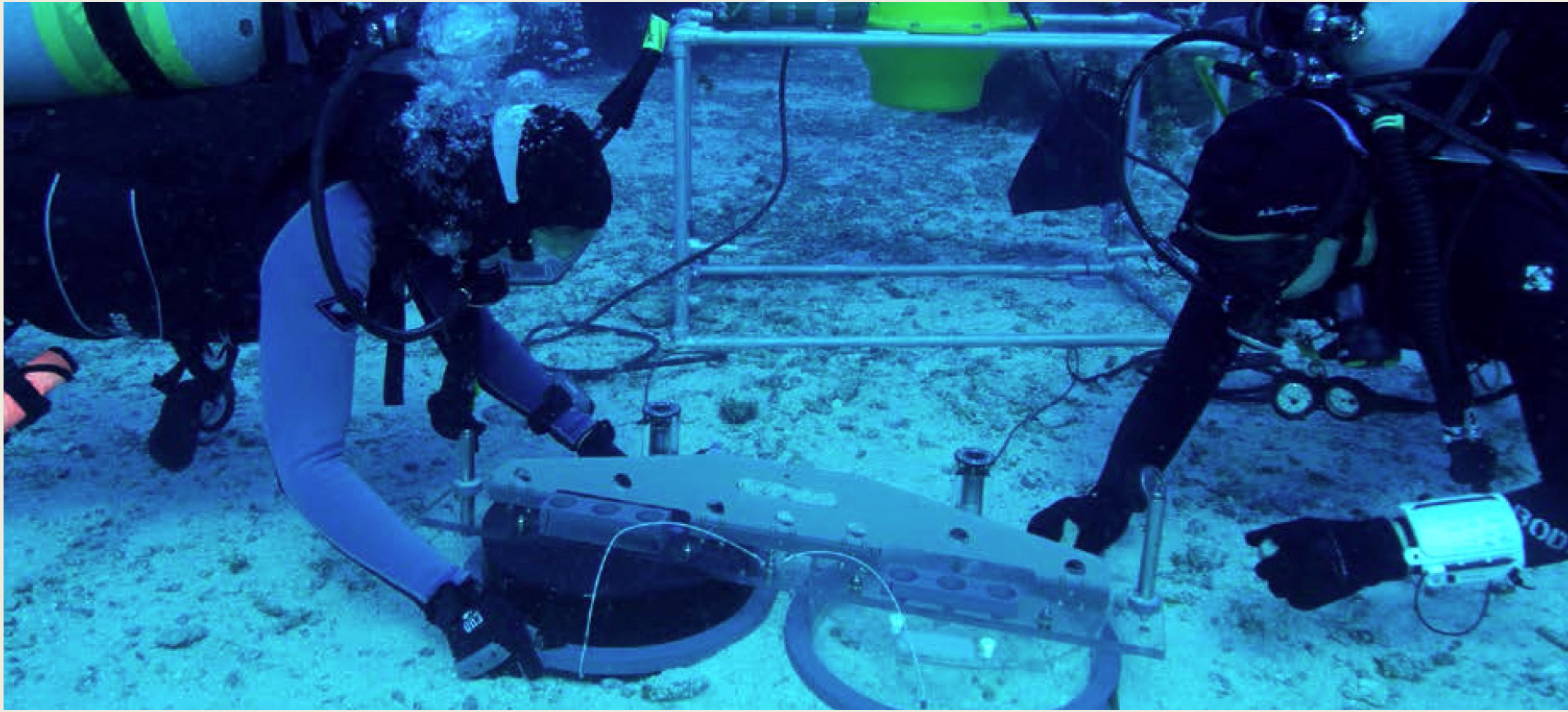
1- Pollution from land-based source

Spill

Others

2-Pollution from seabed activities of national jurisdiction

3 - Pollution from activities in the Area



4 - Pollution by dumping

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What was dumped into the ocean before 1972 ?

- In 1968, the National Academy of Sciences (USA) estimated annual volumes of ocean dumping by vessel or pipes:
  - 100 million tons of petroleum products;
  - two to four million tons of acid chemical wastes from pulp mills;
  - more than one million tons of heavy metals in industrial wastes; and
  - more than 100,000 tons of organic chemical wastes.

What was dumped into the ocean before 1972 ?

- A 1970 Report to the President from the Council on Environmental Quality on ocean dumping described that in 1968 the following were dumped in the ocean in the United States:
  - 38 million tons of dredged material (34 percent of which was polluted),
  - 4.5 million tons of industrial wastes,
  - 4.5 million tons of sewage sludge (significantly contaminated with heavy metals), and
  - 0.5 million tons of construction and demolition debris.

What was dumped into the ocean before 1972 ?

EPA records indicate that more than 55,000 containers of **radioactive wastes** were dumped at three ocean sites in the Pacific Ocean between 1946 and 1970. Almost 34,000 containers of radioactive wastes were dumped at three ocean sites off the East Coast of the United States from 1951 to 1962.

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What materials are dumped into the ocean today ?

- Mostly uncontaminated sediment (dredged material) from waterways to support a network of coastal ports and harbors for commercial, transportation, national defense and recreational purposes.
- Human remains for burial at sea, vessels, man-made ice piers in Antarctica, and fish wastes.

How about incinerating wastes at sea?

- Incineration at sea is considered to be ocean dumping because the emissions from the stack will deposit into the surrounding ocean waters.

5 - Pollution from vessels

- Crew wastes
- Sewage and sludge
- Oily water
- Emissions

6 - Pollution from and through the atmosphere

Types and impacts of marine pollution

Type	Primary Source/Cause	Effect
Nutrients	Runoff approximately 50% sewage, 50% from forestry, farming, and other land use. Also airborne nitrogen oxides from power plants, cars etc.	Feed algal blooms in coastal waters. Decomposing algae depletes water of oxygen, killing other marine life. Can spur algal blooms (red tides), releasing toxins that can kill fish and poison people.
Sediments	Erosion from mining, forestry, farming, and other land-use; coastal dredging and mining	Cloud water; impede photosynthesis below surface waters. Clog gills of fish. Smother and bury coastal ecosystems. Carry toxins and excess nutrients.
Pathogens	Sewage, livestock.	Contaminate coastal swiming areas and seafood, spreading cholera, typhoid and other diseases.

Types and impacts of marine pollution

Type	Primary Source/Cause	Effect
Alien Species	Several thousand per day transported in ballast water; also spread through canals linking bodies of water and fishery enhancement projects.	Outcompete native species and reduce biological diversity. Introduce new marine diseases. Associated with increased incidence of red tides and other algal blooms. Problem in major ports.
Persistent Toxins	Industrial discharge; wastewater discharge from cities; pesticides from farms, forests, home use etc.; seepage from landfills.	poison or cause disease in coastal marine life, especially near major cities or industry. Contaminate seafood. Fat-soluble toxins that bio-accumulate in predators can cause disease and reproductive failure.

Types and impacts of marine pollution

Type	Primary Source/Cause	Effect
Oil	46% from cars, heavy machinery, industry, other land-based sources; 32% from oil tanker operations and other shipping; 13% from accidents at sea; also offshore oil drilling and natural seepage.	Low level contamination can kill larvae and cause disease in marine life. Oil slicks kill marine life, especially in coastal habitats. Tar balls from coagulated oil litter beaches and coastal habitat. Oil pollution is down 60% from 1981.
Plastics	Fishing nets; cargo and cruise ships; beach litter; wastes from plastics industry and landfills.	Discard fishing gear continues to catch fish. Other plastic debris entangles marine life or is mistaken for food. Plastics litter beaches and coasts and may persist for 200 to 400 years.

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Types and impacts of marine pollution

Type	Primary Source/Cause	Effect
Radioactive substances	Discarded nuclear submarine and military waste; atmospheric fallout; also industrial wastes.	Hot spots of radio activity. Can enter food chain and cause disease in marine life. Concentrate in top predators and shellfish, which are eaten by people.
Thermal	Cooling water from power plants and industrial sites	Kill off corals and other temperature sensitive sedentary species. Displace other marine life.
Noise	Supertankers, other large vessels and machinery	Can be heard thousands of kilometers away under water. May stress and disrupt marine life.

Plastics

- In the north-western Mediterranean, plastics constituted most of the debris, at an average of about 77% (Goldberg, 1995).
- Wace (1995) reported that as many as 600,000 plastic containers worldwide were being dumped daily at sea by **shipping.**
- In a survey on the stranded and buried litter on beach in Japan and Russia along Japan Sea, Kusui and Noda (2003) reported that plastics contributed 72.9% by number and 53.8% by weight of the total litter deposits in the beaches of Japan and 55.1% by number 23.4% by weight in the beaches in Russia.
- Similar significant contributions of plastics were reported by many experts from Northern New South Wales beaches, from South Georgia, from Fog Bay, Northern Australia, and from South Caribbean.
- The bulk of plastic materials are even bigger in developing countries with poor waste disposal regulations.

Plastics

- The eventual fate of the plastic materials generally involves burial in adjacent sediments. The plastics are virtually indestructible and accumulate organic coatings which adsorb shells, sand and other debris and sink to the bottom where they create and act as partition inhibiting the transfer of nutrients and gases between water and sediments.
- Anoxia and hypoxia are the most common form of phenomena occurring at the sediment–water interface due to plastic partition.
- Such effects may seriously interfere in the normal functioning of the ecosystem and may alter the topographical and biological make-up of the sea floor.
- Information on the effects of plastic materials on aquatic organisms is scarce except some reports suggesting the occurrence of plastics.

HOW LONG UNTIL IT'S GONE?
Estimated decomposition rates of common marine debris items
Waxed Carton
3 months
Apple Core
2 months
Foamed Buoy
50 years
Plastic Grocery Bag
10 – 20 years
Plywood
1 – 3 years
Disposable Diaper
450 years
Cigarette Butt
1 – 5 years
Wool Socks
1 – 5 years
Plastic Bottle
450 years
Photo-degradable Beverage Holder
6 months
Aluminium Can
200 years
Fishing Line
600 years
Glass Bottle
undetermined
Styrofoam Cup
50 years
Tin Can
50 years
Plastic Beverage Holder
400 years
Cotton Shirt
2 – 5 months

How to collect plastics from the Ocean?

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Sediments

- Global estimates of erosion and sediment transport in major rivers of the world vary widely, reflecting the difficulty in obtaining reliable values for sediment concentration and discharge in many countries.
- Milliman and Syvitski (1992) estimated global sediment load to oceans in the mid-20th century to be 20,000 million tons per year, of which about 30% comes from rivers of southern Asia.
- High levels of turbidity limit penetration of sunlight into the water column, thereby limiting or prohibiting growth of algae and rooted aquatic plants.
- In spawning rivers, gravel beds are blanketed with fine sediment which inhibits or prevents spawning of fish.
- The hypertrophic status of many shallow lakes, especially in developing countries, would give rise to immense growth of algae and rooted plants.

Sediments

- The role of sediment in chemical pollution is tied both to the particle size of sediment, and to the amount of particulate organic carbon associated with the sediment.
  - For phosphorus and metals, particle size is of primary importance due to the large surface area of very small particles. Phosphorus and metals tend to be highly attracted to ionic exchange sites that are associated with clay particles and with the iron and manganese coatings that commonly occur on these small particles.
  - Many of the persistent, bioaccumulating and toxic organic contaminants are strongly associated with sediment and especially with the organic carbon that is transported as part of the sediment load in rivers.
  - Chlorinated compounds such as DDT and other chlorinated pesticides are very hydrophobic and are not, therefore, easily analyzed in water samples due to the very low solubility.

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Sediments

- Unlike phosphorus and metals, the transport and fate of sediment-associated organic chemicals is complicated by microbial degradation that occurs during sediment transport in rivers and in deposited sediment.
- Organic chemicals associated with sediment enter into the food chain in a variety of ways. Toxic compounds bioaccumulate in fish and other top predators both directly though sediment ingestion and indirectly through the food web (associated with the particulate C fraction of the sediment).
- Deltas, mangrove forests, beaches and other coastal habitats are sustained by the supply of sediment, while other habitats, such as coral reefs and seagrass beds, may be smothered or deprived of light.
- Sedimentation is one of the major global threats to reefs, particularly in the Caribbean, Indian Ocean, and South and Southeast Asia.

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Radioactive wastes

- Nuclear power is the **only** large-scale energy-producing technology which takes **full responsibility for all its wastes and fully costs this into the product**.
- The **amount** of radioactive wastes is very **small** relative to wastes produced by fossil fuel electricity generation.
- Used nuclear fuel may be treated as a resource or simply as a waste.
- Nuclear wastes are neither particularly hazardous nor hard to manage relative to other toxic industrial wastes.
- Safe methods for the final disposal of high-level radioactive waste are technically proven; the international consensus is that this should be geological disposal.

Radioactive wastes

- All parts of the nuclear fuel cycle produce some radioactive waste (radwaste) and the relatively modest cost of managing and disposing of this is part of the electricity cost, *i.e.* it is internalised and paid for by the electricity consumers.
- Unlike other industrial wastes, the level of hazard of all nuclear waste – its radioactivity – diminishes with time. Each radionuclide contained in the waste has **a half-life** – the time taken for half of its atoms to decay and thus for it to lose half of its radioactivity.
- Radionuclides with **long half-lives** tend to be **alpha and beta** emitters – making their handling easier – while those with **short half-lives** tend to emit the **more penetrating gamma rays**. Eventually all radioactive wastes decay into non-radioactive elements. The more radioactive an isotope is, the faster it decays.

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Types of Radioactive wastes

- Exempt waste & very low level waste: contains radioactive materials at a level which is not considered harmful to people or the surrounding environment.
- Low-level waste (LLW): is generated from hospitals and industry, as well as the nuclear fuel cycle. It comprises paper, rags, tools, clothing, filters *etc*, which contain small amounts of mostly short-lived radioactivity.
- Intermediate-level waste**:** contains higher amounts of radioactivity and some requires shielding. It typically comprises resins, chemical sludges and metal fuel cladding, as well as contaminated materials from reactor decommissioning.
- High-level waste (HLW): arises from the 'burning' of uranium fuel in a nuclear reactor. HLW contains the fission products and transuranic elements generated in the reactor core.

How much radioactive waste is produced?

- Each year, nuclear power generation facilities worldwide produce about 200,000 m^3 of low- and intermediate-level radioactive waste, and about 10,000 m^3/12,000 tonnes of high-level waste including used fuel designated as waste.
- Today, volume reduction techniques and abatement technologies as well as continuing good practice within the work force all contribute to continuing minimisation of waste produced, a key principle of waste management policy in the nuclear industry.
- Whilst the volumes of nuclear wastes produced are very small, the most important issue for the nuclear industry is managing their toxic nature in a way that is environmentally sound and presents no hazard to both workers and the general public.

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How radioactive waste is treated?

- There are 2 major options for countries towards radioactice wastes:
  - Reprocessing: China, Japan. India, Russia, UK, etc.
  - Direct disposal: Canada, Finland, South Korea, Sweden, USA, etc.

Generally speaking, …

1. Effect of Toxic Wastes on Marine Animals

Oil spill is dangerous to marine life in several ways. The oil spilled in the ocean could get on to the gills and feathers of marine animals, which makes it difficult for them to move or fly properly or feed their children. The long term effect on marine life can include cancer, failure in the reproductive system, behavioral changes, and even death.

2. Disruption to the Cycle of Coral Reefs

Oil spill floats on the surface of water and prevents sunlight from reaching to marine plants and affects in the process of photosynthesis. Skin irritation, eye irritation, lung and liver problems can impact marine life over long period of time.

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Generally speaking, ...

3: Depletes Oxygen Content in Water

Most of the debris in the ocean does not decompose and remain in the ocean for years. It uses oxygen as it degrades. As a result of this, oxygen levels go down. When oxygen levels go down, the chances of survival of marine animals like whales, turtles, sharks, dolphins, penguins for long time also goes down.

4: Failure in the Reproductive System of Sea Animals

Industrial and agricultural wastes include various poisonous chemicals that are considered hazardous for marine life. Chemicals from pesticides can accumulate in the fatty tissue of animals, leading to failure in their reproductive system.

Generally speaking, …

5: Effect on Food Chain

Chemicals used in industries and agriculture get washed into the rivers and from there are carried into the oceans. These chemicals do not get dissolved and sink at the bottom of the ocean. Small animals ingest these chemicals and are later eaten by large animals, which then affects the whole food chain.

6. Affects Human Health

Animals from impacted food chain are then eaten by humans which affects their health as toxins from these contaminated animals gets deposited in the tissues of people and can lead to cancer, birth defects or long term health problems.