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The Effects of Marine Pollution on Nigerian Coastal Resources

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Abstract. The effects of marine pollution to coastal resources are extensive, impacting on the flora, fauna and entire ecology of the coastal environment. In most cases apart from direct impact on the living resources, marine pollutants tends to adversely alter or degrade the environment to extreme conditions that are beyond the tolerant or adaptation limits of the living resources therein. The destruction of aquatic life due to acute thermal shocks. Other effects of thermal pollution include normal physiological processes, such as growth and reproduction of aquatic species which has become severely impaired. Rampant discharge of hot effluents, untreated sewage, oil spills, plastics and other forms of debris into our coastal aquatic environment is quite common off the coasts of Lagos and major industrialized cities of the Niger delta region of Nigeria such as Warri and Port Harcourt. Also flaring of associated gas especially at the flare pits are a severe source of thermal pollution in the coastal environment of Nigeria. Within the Niger Delta region, there are so many flare pits. The scorching heat from such flare sites destroy wildlife over a considerable radius of the areas around and drastically distort the natural population density of nocturnal animals through constant illumination of the forest. The following measures are recommended to the government and relevant agencies; aggressive enlightenment and advocacy, economic empowerment of residents of coastal communities, strict enforcement of relevant laws concerning the abuse of the seas, and setting up of local scientific committees which will collaborate with such international committee to solve localized problems in the affected areas and re orientation and attitudinal change amongst coastal dwellers on the best global practice in reducing pollution of the seas.

Key Words: Effects, Marine Pollution, Nigeria, Coastal Waters.

1. Introduction.

Effects of Marine Pollution on coastal environment cum resources such as degradation, damage to ecosystems, damage to the esoteric value of beaches, lethal and sub-lethal effects on marine fauna and flora etc. were elaborately discussed, using graphic and plate illustrations to elucidate understanding. The paper concluded that marine pollution has enormous impact on our coastal resources and is totally unavoidable due to Global population explosion and technological innovations by man. However, it was asserted that the problem could be minimized through careful management. Pragmatic recommendations were therefore put forward on how to minimize the impact of marine pollution on our coastal resources, with specific reference to Nigeria. The coastal environment generally refers to any piece of land next to, bothering or adjourning the sea shore. The extent of the coastal environment also varies immensely, depending on the object of the context within which it is being defined. Sometimes, it simply means the narrow linear corridor of shore line separating the continental shelf from the oceanic land mass. At other times it may be considered to extend both largely inwards, towards the continental shelf and outwards, farther away from the shore line towards the terrestrial land mass. For the purposes of evaluating marine pollution sources and its effects on the coastal environment, the latter description is considered more suitable. Consequently, the coastal environment can be said to transcend the shore line up to the exclusive economic zone seaward and across the estuarine and intertidal zones to the lower reaches of the fresh water tributaries, sandy beaches and sometimes even arid continental land masses landwards, where such bounds the world Seas and Oceans.

1.1 Effects of Marine Pollution.

The effects of marine pollution to coastal resources are extensive, impacting on the flora, fauna and entire ecology of the coastal environment. In most cases apart from direct impact on the living resources, marine pollutants tends to adversely alter or degrade the environment to

extreme conditions that are beyond the tolerant or adaptation limits of the living resources therein.

1.1.1 Degradation Effects:

Effects from ALDFG's: According to [1] report, the Abandoned, Lost or other fishing gears (ALDFG's) is a problem that is increasingly of concern. Various United Nations General Assembly resolutions now provide a mandate for and indeed require action to reduce ALDFG's and marine debris in general. ALDFG's degrades the marine environment in several ways. It constantly catches threatened and endangered species, thereby further worsening the biodiversity depletion in species of both biological and economic importance from coastal waters. Most ALDGF's physically impacts the benthic environment by obstruction of their natural locomotive pattern and trapping them in such a way that makes them easy prey to their predators. It can lead to formation of completely alien colony in ecology, thereby leading to wiping out of endemic/endangered species.

1.1.2 Effects from plastics litters: Once discarded, plastics are weathered and eroded into very small fragments known as micro-plastics. These together with plastic pellets are already found in most beaches around the world. Plastic debris cause the deaths of more than a million seabirds every year, as well as more than 100,000 marine mammals. Plastic materials and other litter can become concentrated in certain areas called gyres as a result of marine pollution gathered by oceanic currents. There are now 5 gyres in our ocean. The North Pacific Gyre, known as the Great Pacific Garbage Patch, occupies a relatively stationary area that is twice the size of Texas. Waste material from across the North Pacific Ocean, including coastal waters off North America and Japan, are drawn together. Obviously, gyres reduce marine resources in terms of natural productivity and having normal fishing access to exploit fish resources within gyres becomes seriously hampered.

1.2 Damage to ecosystem:

The effect of thermal pollution: The ambient temperature of most tropical coastal waters that enables fish and other aquatic resources to thrive is usually at an average of 24^0C. One of the

sources of damage to the coastal living resources is thermal pollution**.** Heat is an important form of energy concern that impacts on the aquatic environment. The law of thermodynamics, indicate that most of the energy generated/regenerated end up as waste heat. The waste heat often gets released into the aquatic environment, leading to what is generally referred to as thermal pollution. When waste heat is discharged into the aquatic environment, especially as point source pollutant, the tendency is to create thermal plume, especially in waters with very low turbulence and that are fairly static. Thermal plume include areas within the water body which has artificially heated water or water that is above ambient temperature. The outer limit of the plume is normally defined as the isotherm of the smallest temperature change that can be measured (usually 0.5 and 1.02 ^{o}c). This results to destruction of aquatic life due to acute thermal shocks. Other effects of thermal pollution include normal physiological processes, such as growth and reproduction of aquatic species can become severely impaired. Rampant discharge of hot effluents into our coastal aquatic environment is quite common off the coasts of Lagos and major industrialized cities of the NDR such as Warri and Port Harcourt. Also flaring of associated gas especially at the flare pits are a severe source of thermal pollution in the coastal environment of Nigeria. Within the Niger Delta region, there are so many flare pits. The scorching heat from such flare sites destroy wildlife over a considerable radius of the areas around and drastically distorts natural the population density of nocturnal animals through constant illumination of the forest.

1.2.1 Eutrophication effects: Untreated or partially treated sewage effluent, or organically rich industrial effluent such as that from fish processing plants, present a number of problems. This can cause the death of marine plants and animals particularly in calm weather and sheltered bays and may lead to changes in biodiversity. Effluent, rich in nitrogen and phosphorus, results in `eutrophication' (over fertilization), which may cause algal blooms. These blooms can discolour the water, clog fish gills, or even be toxic, e.g. red tides.

1.2.2 Depletion of dissolved oxygen in water: This is a phenomenon that often leads to the damage of marine ecosystem when in operation. The dumping of organic waste or discharge of

sewage loaded with organic effluents into the marine environment, especially in sheltered bays such as the estuaries and in some lagoons, depending on the duration of the pollution episode, amount of waste, size of the water body and the prevailing ambient temperature, leads to depletion of dissolved oxygen. Most tropical fish species require at least 4mg/L of dissolved oxygen in order to survive and thrive. Below this value most tropical fishes suffers anoxia and mortality in extreme situations and other aquatic organism important in the aquatic food chain may also be wiped away. Biochemical Oxygen Demand (BOD) is a common measure of the strength of an effluent containing biodegradable organic matter. BOD is defined as the total amount of oxygen required by microbes to decompose a given amount of waste. BOD levels are high at the source of the effluent and gradually decrease over time and downstream as the waste is stabilized. As dissolved oxygen (DO) is depleted, the macro invertebrates (those invertebrates retained in a No. 30 sieve) and fish which require high concentrations may be eliminated and replaced by pollution-tolerant forms. Algae may be eliminated at the outfall by high turbidity levels but also stimulated downstream by the release of nutrients from microbial activities. Eventually the waste is metabolized and microbial populations are reduced by organisms feeding on them. The final step in the process of recovery is the reappearance of pollution-sensitive fish and invertebrate life. Furthermore excessive nutrients from sewage outfalls and agricultural runoff have contributed to the increasing incidence of low oxygen (hypoxic) areas known as dead zones, where most marine life cannot survive, resulting in the collapse of some ecosystems. There are now close to 500 dead zones with a total global surface area of over 245,000 km², roughly equivalent to that of the United Kingdom. The excess nitrogen can also stimulate the proliferation of seaweeds and microorganisms and cause algal blooms. Such blooms can be harmful (HABs), causing massive fish kills, contaminating seafood with toxins and altering ecosystems. This is shown in the plate: 1 below;

Plate: 1 adapted from [2].

The effects of oxygen-demanding wastes on a water body are depicted in Figure: 1. The severity of the typical impact of the depletion of oxygen as a result of pollution is illustrated in terms of density, number and diversity of the biological community. It is easily seen that all three parameters (density, number and diversity) suffers severe fluctuations/depletion due to inadequate dissolved oxygen.

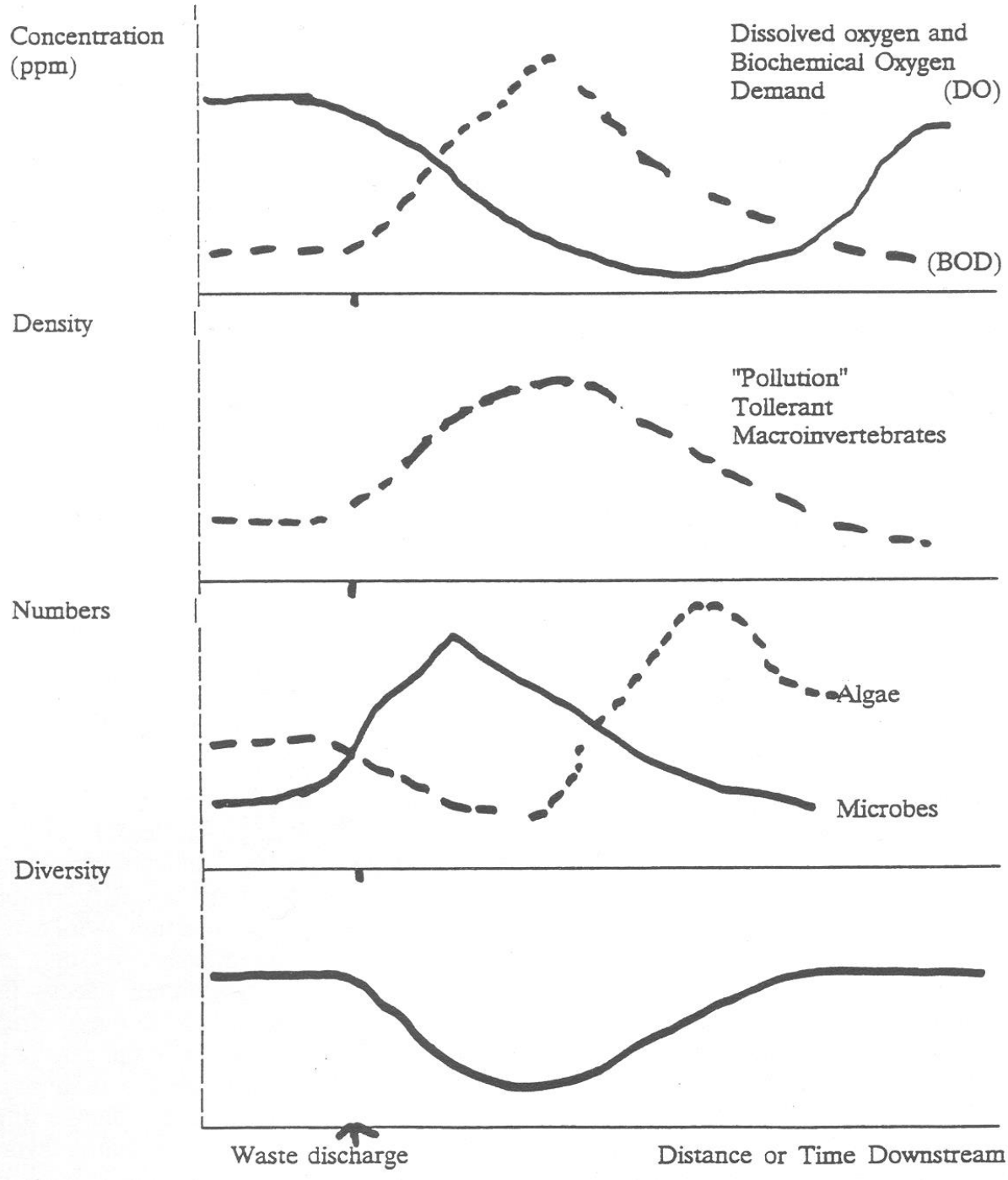

Figure:1. Effects of organic pollution (i.e., raw sewage) on a water ecosystem [3].

Sewage; with billions of people on the planet, disposing of sewage waste is a major problem. According to [4] report, about 1.1 billion people (16 percent of the world's population) don't have access to safe drinking water, while 2.6 billion (40 percent of the

world's population) don't have proper sanitation (hygienic toilet facilities); the position hasn't improved much since. Sewage disposal affects people's immediate environments and leads to water-related illnesses such as diarrhea that kills 3-4 million children each year. According to [4], water-related diseases could kill 135 million people by 2020. In developed countries, most people have flush toilets that take sewage waste quickly and hygienically away from their homes.

Yet the problem of sewage disposal does not end there. When you flush the toilet, the waste has to go somewhere and, even after it leaves the sewage treatment works, there is still waste to dispose of. Sometimes sewage waste is pumped untreated into the sea. Until the early 1990s, around 5 million tons of sewage was dumped by barge from New York City each year. The population of Britain produces around 300 million gallons of sewage every day, some of it still pumped untreated into the sea through long pipes. The New River that crosses the border from Mexico into California carries with it 20-25 million gallons (76-95 million liters) of raw sewage each day. Even in rich nations, the practice of dumping sewage into the sea continues. In early 2012, it was reported that the tiny island of Guernsey (between Britain and France) has decided to continue dumping 16,000 tons of raw sewage into the sea each day. In theory, sewage is a completely natural substance that should be broken down harmlessly in the environment; 90 percent of sewage is water. In practice, sewage contains all kinds of other chemicals, from the pharmaceutical drugs people take to the paper, plastic, and other wastes they flush down their toilets. When people are sick with viruses, the sewage they produce carries those viruses into the environment. It is possible to catch illnesses such as hepatitis, typhoid, and cholera from river and sea water.

Damage to the exoteric values of beaches

- **Effects on recreational activities on beaches**: When waters that have significantly suffered eutrophication are washed to the beach, it messes up the beach as it is often accompanied with fowl smells, awful colour and a lot of dead marine animals, particularly from fish and other macro aquatic organisms that might have died of asphyxiation due to eutrophication.

Thus, social or recreational activities such as sun bathing, gaming and picnics on beaches become hampered as a result. Some beaches are already closed to the public because the water is unsuitable for bathing and the beach is covered with litter see plate 2. Micro-plastics and plastic pellets are found on most beaches around the world. Pollution also poisons our food. The toxins and plastic ingested by fish and shellfish end up in our plates, and the consumption of shellfish and other seafood is often banned briefly to avoid food poisoning. This pollution costs the fishing and shipping industry millions of dollars:

- Discarded plastic bags get caught in boat propellers and cooling intakes, damaging the engines.
- Loss of habitat and biodiversity is increasingly impairing the ocean's capacity to provide food and other services. The extinction of fish species could lead to starvation or under-nourishment.
- Ghost fishing that occurs when discarded fishing nets entangle marine life indiscriminately, as they continue to float in the ocean, reduce fishers' revenues from lost catch. Competition over declining resources and services provided by the ocean can cause tensions and conflicts locally and internationally.

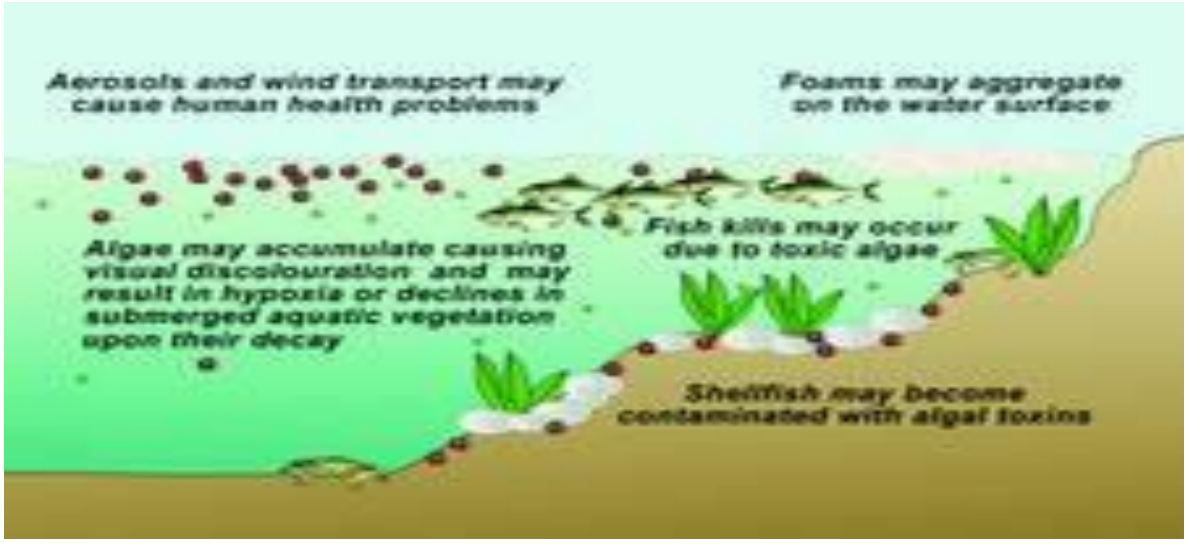

Plate: 2 adapted from [5] , showing potential impact of harmful algal blooms (HAB) in a beach.

Effects on aesthetic values of water front's/beaches: The washing ashore of numerous sea debris and litters, particularly plastics of different colours, sizes and shapes render the natural scenario beauty of beaches highly distorted. Hence, the aesthetic appeal of such beaches for nature watchers and Eco tourists of all categories is hampered. Plate 4 (a) and (b) depicts the extent of nuisance and complex marine polluting debris that can impact on the aesthetic appearance of a coastal water environment.

Plate: 3, Depicts the nuisance impact on the aesthtic value of a beach as aresult of oil and other debris pollutants.

(a)

(b)

Plate: 4a and b; Coastal water highly polluted with a complex mix of marine debris (adapted from [6].

Lethal and Sub-lethal effects of pollutants on marine fauna and flora:

Through common tests which include standardized acute and chronic toxicity tests lasting 24–96 hours (acute test) to 7 days or more (chronic tests) lethal and sub lethal level effects of toxins arising from marine pollutants are determined . These tests measure endpoints such as survival, growth, reproduction, that are measured at each concentration in a gradient, along with a control test. There are several terminologies used in toxicity tests used to determine lethal and sub lethal effects. Examples include; Median Lethal Concentration (LC50) .The chemical concentration that is expected to kill 50% of a group of organisms, Median Effective Concentration (EC50). The chemical concentration that is expected to have one or more specified effects in 50% of a group of organisms, Critical Body Residue (CBR). An approach that routinely examines whole-body chemical concentrations of an exposed organism that is

associated with an adverse biological response etc. Oil spills smother plants and animals, preventing respiration see plate:5. In seabirds and mammals it can cause a breakdown in their thermal insulation.

Plate: 5 showing an exotic bird roasted as a result of oil spill.

Chemical toxicity can cause behavioral changes, physiological damage, or impair reproduction. Oil pollution is an eyesore, and cleanup and subsequent disposal of oily wastes is difficult. Pesticides, such as DDT, and other persistent chemicals e.g. PCBs, accumulate in the fatty tissue of animals. These chemicals can cause reproductive failure in marine mammals and birds.

Other effects of marine pollution on coastal resources:

Effects on health of marine animals: Ships often paint their hulls with anti-fouling substances, e.g. tributyl-tin or TBT, to prevent growth of marine organisms. These substances leach into water and, in high traffic areas such as harbours and marinas, can affect animal life. There is a Global trend towards limiting the use of TBT containing paints. Plastics kill many marine animals. Turtles, for example, often swallow floating plastic bags, mistaking them for jelly- fish. Animals are often strangled when they become entangled with plastic debris.

Established health Effects of Marine Pollution on humans: Pathogenic microorganisms cause gastric and ear-nose- throat infections, hepatitis, and even cholera and typhoid.

Most marine food sources from polluted environment, especially those inundated with domestic and sewage effluents are mostly infected with pathogenic organisms. Filter feeding animals (e.g. mussels, clams, oysters) concentrate pathogens in their gut, so eating shellfish from polluted waters is a health risk. Health risks of carcinogenic concerns can be impacted on humans when such marine food species has bio accumulated heavy metals such as mercury, lead, cadmium, zinc etc. While marine pollution can be obvious, as with the marine debris, it is often the pollutants that cannot be seen that cause most health harm. Many potentially toxic chemicals adhere to tiny particles which are then taken up by plankton and benthos animals, most of which are either deposit or filter feeders. In this way, the toxins are concentrated upward within the ocean food chains.

Many particles combine chemically in a manner highly depletive of oxygen, causing estuaries to become anoxic. When pesticides are incorporated into the marine ecosystem, they quickly become absorbed into marine food webs. Once in the food webs, these pesticides can cause mutations, as well as diseases, which can be harmful to humans as well as the entire food web. Toxic metals can also be introduced into marine food webs. These can cause a change to tissue matter, biochemistry, behaviour, reproduction, and suppress growth in marine life. Also, many animal feeds have a high fish meal or fish hydrolysate content. In this way, marine toxins can be transferred to land animals, and appear later in meat and dairy products

Emerging health effect concerns of marine pollution:

Micro plastics from households: Washing machines: Accumulation of micro plastic debris in marine habitats is raising health and safety concerns. The bits of plastic contain harmful ingredients which when ingested transfer into the bodies of animals and could be transferred to people who consume shellfish and fish. Ingested micro plastic can transfer and persist in their cells for months." Using forensic techniques, [7] found micro plastic on shores in densely populated areas, and identified as an important source of wastewater from household washing machines. Indeed, more than 1,900 fibers can rinse off a single garment during a single wash, and these fibers look just like the micro plastic debris on shorelines." This problem is forecasted to have a likelihood of intensifying in the future, and the report suggests solutions.

Table: 1 Cause and Effects of Marine Pollution

Type	Primary Causes	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 swimming areas and seafood, spreading cholera, typhoid and other diseases.
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 (PCBs, Heavy metals, DDT etc.)	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.
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.
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.

Source: Compiled by [8]

Conclusion and Recommendation.

It is an incontrovertible fact that marine pollution tremendously impacts adversely on our coastal resources in more ways than we can readily comprehend. Whereas marine pollution is something we cannot avoid in a world with a rapidly growing population and technological concerns that generates hazardous the pollutants, its effect can be minimized if carefully managed. In other to achieve this, the following recommendations are suggested to curb the effects of marine pollution in the Nigerian coastal waters;

1) Sustained enlightenment campaign/advocacy on safer attitudes towards reducing pollution of our marine environment
2) Training of relevant stake holders including coastal communities on modern day global practices that reduces marine pollution n all its ramifications.
3) Economic empowerment of coastal communities to provide alternative sources of income in places where their existing vocations are perceived to contribute to marine pollution.
4) Active collaboration with international agencies in solving localized marine pollution problems such as abandoned lost or other fishing gears (ALDFG's) challenge for example.
5) Setting up a standing local scientific committee to develop the scope and guidelines/timeline for which all companies operating in Nigerian coastal waters can use as a working document/road map in combating the challenges of marine pollution.
6) Development of relevant legislations and its implementation and enforcement.

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