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Review Article

Oceanic pollution; A threat to life

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Abstract

Water covers about 71% of the Earth's surface and is a basic need for all the oceanic fauna and flora. According to the Ocean Pollutants Guide, 2018, marine life is constantly being harmed and there is an abundance of plastic pollution still found on the shorelines. Along with that, oceanic dead zones have expanded four times since the 20th century. If harm to the oceans continues, then there is a chance that every species of animals existing in the marine environment will be endangered. All of this is due to anthropogenic activities such as sewage entry into the oceans, oil spills and plastic pollution which form the top three oceanic pollutants, destroying the marine ecosystems. These pollutants negatively affect fish, bivalves' crustaceans, birds and mammals which are directly associated with water. This leads to reduced life expectancy, genotoxicity and cancer formation in said organisms. Unless stopped, these pollutants will be the cause of death of marine fauna. It is recommended to examine the oceanic water quality, prevent ocean pollution and clean the polluted water bodies, by all necessary means.

Keywords: Metal deposition; ocean pollution; sustainable strategies; toxic chemicals

Introduction

The term "Global Ocean" denotes the 71% of land surface that is made up of water. It holds a total of 97% of the water that is present on Earth. The remaining 3% water is present as rivers, lakes, glaciers, ice caps and the water vapor in our environment. Oceans act as a home to more than a million species of both fauna and flora, out of which the majority are yet to be named **[1]**. Oceans are the source of half of the oxygen production by the action of sea life. Since humans, depend on it for performing different activities, we can never escape from its impacts as well, whether good or bad **[2]**.

Ocean Pollution

Water is considered polluted when the water quality has been inhibited by the action of anthropogenic activities making it unfit for its desired use **[3]**. People used to believe that all the waste they threw in the oceans would never resurface. But today that notion is proved wrong, when we witness the destruction of ocean life. Oceans have started to vomit back all the wastes that we used to throw in it. Today, the world witnesses contaminated sea food, disheveled marine life and plastic pollution that litters the shorelines. Not only that, there is a non-stop expansion of oceanic dead zones which have increased four times since the 20thcentury **[2]**.

Persistent organic pollutants (POPs) and heavy metals are the first and foremost cause of oceanic pollution. Being highly toxic in nature they cause instant injury when dumped in to the oceans **[4]**.

Agricultural runoff and industrial discharge have also played a big role in making oceans as they are today. Sewage, fossil fuel combustion, oil spills and land runoff directly contaminates the rivers, which fall into the oceans and indirectly cause the death of marine life [5].

Other than that, the never ending manufacture of plastic and then its release into the oceans has bore its brunt. The amount of plastic entering the world's oceans is estimated to be 6.4 million tons annually, making it the principal component of marine debris [6]. Plastics dumped into the oceans undergo degradation in just a few days to form smaller pieces of plastics. These small pieces, also known as "microplastics", aid in the absorption of other pollutants from seawater [7]. Microplastics are also eaten by turtles' everyday leading to their impeding deaths [8].

According to an estimate 80% of chemical pollution of the oceans originates on land [9]. Global land surfaces are in direct connection to the marine by the presence of rivers, so chemical pollution that enters the rivers cause chemical pollution in the oceans. Industries approximately use 100,000 different chemicals on daily basis. A lot of these chemicals penetrate the marine environment by atmospheric transport, runoff into waterways, or direct disposal into the oceans [10]. Every year, manufacturing industries, waste incinerators, coal fired power stations and fossil fuel generation introduces hundreds of tons of toxic emissions into the air [11]. Fuel combustion in transportation vehicles, factories and smelters release hydrocarbons and heavy metals into the surroundings. Pulp and paper mills, untreated sewage and mining adds to the dilemma of contaminants that directly run off into the aquatic environment. In any case these chemicals are adding to the woes of oceanic pollution [12].

Sewage

Like so many other things, humans are also behind one of the biggest challenges that the world is facing today i.e. enrichment of freshwater resources with nutrients. This problem roots back to the heavily populated areas of the world, where people dump their waste products into the waterborne sewage system on daily basis, thereby contaminating it [13].

According to various sources it has been seen that sewage water consists of domestic wastes, pharmaceutical chemicals, agricultural run-off and other heavy metals. When this contaminated water is dumped into the oceans, it causes a wide range of problems for the ocean life [14].

Studies also show that sewage water contains high concentrations of nutrients mainly ammonia, nitrates and phosphates [15]. When these nutrients enter water bodies, the end result is in the form of eutrophication and the formation of algal blooms. This causes decline in oxygen and the overall reduction in the quality of water, fish, coral, and other marine populations [16].

Oil pollution

The most obvious forms of marine pollution is oil pollution. Oil pollution is mostly caused due to the oil tanker disasters in the ocean. It can also occur as a result of port activities, leakage from boating traffic and urban-based oil runoff. Oil enters the marine environment via water drainage from agricultural farms, untreated factory waste and industrial facilities, and unregulated boating used for recreational purposes [17]. Oil discharged from boats makes up 24% of the total amount of oil present in the ocean, with 8% of overall oil ocean pollution a result of spills during transportation or production [18]. Water acts as the medium of transfer for oil, organic compounds and oil based fertilizers.

Being volatile in nature, hydrocarbons cause irritation in the respiratory tract of marine mammals and birds upon inhalation [19].

Birds depend upon their feathers for buoyancy and warmth. However, when oil adheres to the feathers of birds, it often leads to hypothermia or drowning in these birds [20].

Plastic pollution

Today, plastics comprise 45 to 95% of the marine litter [21]. Since the year 1950, plastic production has increased from 1.7 million tons to 245 million tons produced in the year 2006 [22]. Maximum plastic waste that enters the ocean, comes from the coastlines of Asia and the United States of America [6]. It has been studied that three industries responsible for the most plastic waste production have been packaging, textile and the consumer-institutional product sectors [23]. According to a UNEP survey, plastic production is still escalating by 8.7% every year [24].

Different researches establish that marine fauna is highly impacted by plastic pollution via ingestion and entanglement [7]. The ingestion of plastics can cause a number of harmful effects: internal abrasion, reduction of stomach capacity, a false sense of satiation, blockage of the digestive tract, bioaccumulation and translocation [25]. The chemicals present on plastic signify some more risks to aquatic life, as the biofilm communities residing on the plastic, may comprise toxic, pathogenic, and /or invasive species [26]. Plastic debris is found to be present in all aquatic environments, ranging from coastlines to the open oceans, from the sea-beds to the sea surface, deep sea sediments and even Arctic sea ice [27]. There are concerns that biodegradation rates in the deep sea will be slow because of darkness and cold [28, 29].

Effects on Ocean Life

Water pollution is known to have negative effects on the environment as well as the life that exists in the ocean. Oceanic pollutants have been reported to kill sea weeds, crustaceans, mollusks, fishes, marine birds and various other organisms that play their part as a source of nutrition for humans and animals alike. Insecticides, despite being banned, such as DDT are still growing in concentration in the food chain [30]. River Pollution causes acute water-borne diseases leading to health problems that are a huge burden on economies around the globe [31]. In addition to these crisis, ocean acidification, rise in the average temperature of oceans, oxygen depletion, distorted salinity levels and eutrophication have badly affected the aquatic species' nutritional levels and their overall adaptability to ecosystems [32]. Increased concentration of heavy metals mainly mercury and cadmium can also accumulate in the flesh of big, predatory fishes, marine birds and mammalian fish such as dolphin and whales due to the impacts of bio-accumulation and bio- magnification [33].

Fish

[34] carried out a study to determine the presence of microplastics in the digestive tract of ten fish species taken from the English Channel. They found out that microfibers made up 35.6% and rayon made up 57.8% of the plastic content in the fish. Along with that microplastics have been known to get deposited in skin, muscle, gills and liver [35]. Small particles of microplastics ranging < 600 μm/ 0.6mm in size, travel from the digestive tract directly in the liver and deposit there before reaching any other organ [36]. Microplastic deposition eventually results in inflammation, oxidative stress and disrupted energy metabolism in fish [37].

Mercury contamination of the environment, lakes, rivers and oceans has led to extensive contamination of the oceans. Mercury in the form of Methyl mercury is directly deposited in the muscular tissues of fish. Once this fish is consumed, the underlying Methyl Mercury acts as a potent neurotoxin for humans and other fish-eating wildlife [38]. Other heavy metals such as Fe, Cu, Zn and Pb have an inhibitory effect on the development of phytoplankton and zooplanktons [39]. Furthermore, these metallic compounds cause histological changes such as the necrosis of gills and the degeneration of fatty tissue of the liver of fish and crustaceans [40]. According to a prediction, mercury concentrations will increase by two times in the North Pacific Ocean by 2050 [41].

Bivalves and Crustaceans

Industrial chemicals released into the oceans are known to bring about adverse effects in bivalves and crustaceans that include alterations of immunological responses, neurotoxic effects and the subsequent arrival of genotoxicity. Bivalves and crustaceans are often used by scientists, as bio-monitors in the oceans due to their ability to show immediate responses to the smallest changes [42]. Mussels' survival also decreases incredibly with the growing PVC abundance in oceanic ecosystems, perhaps due to delayed periods of valve closure as a response to presence of particles [43].

Birds

Seabirds have been the best models to study the harmful effects of oceanic pollution to life. They are the group of animals that ingest microplastics at a massive level [34]. According to a study done in the year 2011 in the North Sea, it was seen that as much as 95% of the Northern fulmar had plastic deposition in their stomachs, with an average piece weighing about 0.31 grams [44]. Birds have been studied to give the most drastic responses to the oceanic pollution. They exhibit high levels of ingested plastic which leads to a reduction in the overall body weight and a high contaminant load. Industrial chemical leaching in to the marine environment ultimately comes in contact with the eggs laid in the ocean waters. These eggs have weakened shells and when the birds sit on them, they break easily [45].

Mammals

One of the biggest concerns for environmentalists and zoologists around the world is the microplastic ingestion by the marine mammals. These microplastics end up in the stomachs of major marine mammalian fauna such as harbor seals, beaked whales and baleen whales. This leads to the deposition of phthalates in the fins of the whales [46].

Unlike most other animals, Californian sea lions live close to human communities due to their ability to habituate easily. According to a study an estimated 20% of sexually active sea lions had a high occurrence of urogenital cancer. This cancer is directly linked to herpes virus which occurs when the sea lions are exposed to Persistent Organic Pollutants contaminants such as Polychlorinated Biphenyls and Dichlorodiphenyltrichloroethane. These chemicals pollute the feeding grounds of sea lions and when they feed from them they form these diseases [47].

Solutions

Prevention is always better than cure. The same theory applies here when we say that preventing pollution is better than managing it. Pollution control is a terminology that refers to the control of harmful emissions in the external environment such as air, water and land. Pollution prevention and waste reduction are far more popular strategies than pollution control. Regulating and monitoring pollution is another valuable way for managing pollution. Pollution can be minimized by adopting certain practices such as reducing, reusing, recycling, waste minimization and composting [3].

Manufacturing industries are another main reason of pollution as they release toxic chemicals into the water bodies on a regular basis. Sustainable technologies that appeal to the environment and all the fauna related to it should be made accessible to the conventional manufacturers namely, the textile dying industry. Synthetic dyes released as textile effluents have sulphur, napthol, vat dyes, nitrates, acetic acid, enzymes, soaps and heavy metals in high quantities. These products are bad for the oceans as they give it a foul smell and prevents penetration of sunlight in the water. As a result photosynthesis is blocked, disturbing the oxygen transfer mechanism thereby, having lethal effects for the marine fauna. Efforts are needed to raise peoples' consciousness about the broad implications of their choices from buying clothes to the different necessities of life [48].

It is necessary to make strict laws for the effective waste management and have those laws be implemented to prevent future clutter [28].

Preventative scientific methods, such as debris-retention booms that catch plastic remains before dilution in the oceans, can considerably decrease harm to wildlife **[49]**.

Apart from all that a number of strategies have already been taken up in different countries for managing pollution. They work by removing toxic pollutants from drinking water and the wastewater. Coagulation is one of the purifying methods which removes dissolved toxic substances by destabilizing their charges. Adsorption uses active carbon as a tertiary purification to remove organic micro-pollutants and metals in organic complexes. Membrane process, foam flotation, dialysis, osmosis, photo catalytic degradation are some other methods used to clean up the oceans **[50]**.

Conclusion and Recommendations

Water is the basic necessity for all life on this planet. Clean water is an extreme necessity for all the fauna and flora that lives in the oceans of the world. However, due to anthropogenic activities, oceans are getting polluted with every day that goes by. This pollution is not only destroying the oceanic ecosystems but also the feeding habitats for the millions of marine animals and birds. Oceanic pollutants such as untreated sewage, oil spills and plastic pollution are reducing life expectancy of the fish and other animals by getting deposited under their skin. It gets in the food chain and ultimately harms humans when they consume such contaminated fish, causing cancers and other such diseases. It is recommended to develop such sustainable strategies that not only prevent pollution in our oceans but also helps us clean them in an effective way. Laws should be made that make every person responsible for causing harm to the ocean life in any way. Proper waste disposal must be done before releasing any harmful products into the ocean. Spread of awareness to even a single person can make a difference, to save our oceans.

Authors' contributions

Conceived and designed the idea: F Saeed, Performed the experiment: F Saeed, Analyzed the review paper: F Saeed & F Malik, Wrote the paper: F Saeed.

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