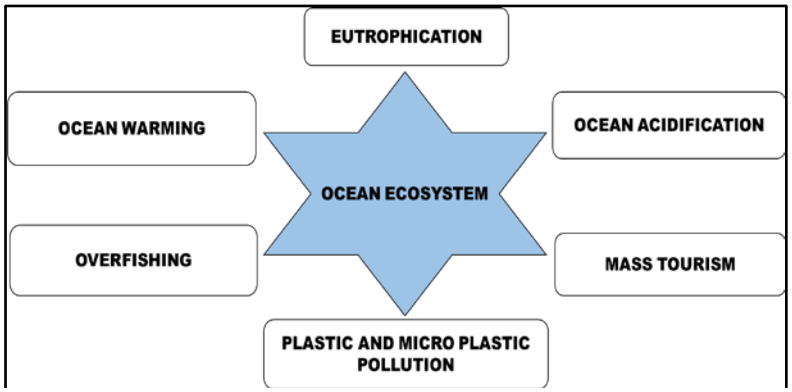
ANTHROPOLOGIC EFFECTS ON OCEAN ECOSYSTEM: CASE STUDY

[1]Bhavna D Deshpande, [2]Deepika S Brijpuriya
Assistant Professor, PG Department of Chemistry, Santaji Mahavidyalaya, Nagpur

Abstract:
The conservation and sustainable use of the ocean and marine resources is the main focus of Sustainable Development Goal (SDG) 14. SDG 14 seeks to maintain the health of the oceans in order to support a robust and harmonious global ecosystem. It demands action to stop marine pollution, save biodiversity, and advance sustainable fishing. Various anthropological activities including ocean eutrophication, ocean acidification, ocean warming, mass tourism, plastic and micro plastic pollution and overfishing have led to serious problems effecting the entire food chain and food web. This has further led an imbalance with respect to energy due to increase in heat trap by gases in Earth's atmosphere. This review focuses on the impacts faced by ocean ecosystem and case study of some aquatic organisms which are adversely affected by anthropological activities.

Key words: Ocean Eutrophication, Ocean Acidification, Ocean Warming, Plastic and Micro-plastic Pollution and Over-Fishing.



Introduction:

The ocean is under unprecedented pressure due to the rapidly expanding ocean economy, which is being driven by human needs for food, energy, transportation, and recreation. Pollution, biodiversity loss, and climate changes are factors, increasing this pressures. Social prosperity and well-being of coastal communities and those working in related areas are dependent on ocean ecosystem and their produce. Human interference has gradually led to change in Earth's terrestrial and aquatic ecosystem to a greater extent. This interference has brought modification in the climate pattern, global warming, and emission of greenhouse gasses, which has effect aerial, terrestrial and aquatic ecosystem in numerous ways. Global systems that keep Earth liveable for humans are propelled by the ocean. The sea offers and controls a great deal of our food, rainwater, drinking water, weather, climate, coastlines, and the oxygen we breathe, which has apparently built pressure on oceans.

A sustainable future be determined by the careful management of all vital global

resource. Unfortunately, pollution is causing coastal waters to constantly deteriorate, and lowering of pH has negatively affected biodiversity and ecosystem functioning. Regulations must be implemented to lessen

overfishing, marine pollution, and ocean acidification, as well as to ensure that marine protected areas are adequately resourced and managed. Though, many government organising, NGOs, and environmentalists have provided the framework, yet there is need to spread awareness of the marine eco-system by providing bachelor's degrees in environmental, earth, geology and marine sciences by the university grants. Further, stringent law enforcement, proper coordination amongst ministries and agencies, experts, is imperative.

Integrated ocean management (IOM) is a holistic approach to ensure sustainability in ocean ecosystem which includes deep knowledge, developing public-private sector partnerships, enhancing stakeholder engagement and stewardship, enhancing capacity building, applying regulatory frameworks, climate and environmental changes [1]. Managing renewable resources means its sustainable use. Which means "satisfying the current needs without jeopardizing future generations' capacity to meet their own needs". However, achieving sustainability of resources may be challenging due to natural unpredictability, scientific ambiguity, and contradictory goals (or values) [2]. In present review effect of various anthropological activities including ocean eutrophication, ocean acidification, ocean warming, mass tourism, plastic and micro plastic pollution and overfishing which has led to serious problems relating the entire marine ecosystem and how it has affected our environment and coastal life immensely has been featured.

Coastal Eutrophication:

From an ecological perspective, the coastal zone is a complex system from which numerous ecosystems are adapted for the nutrient flow. Coastal marine ecosystems are subject to constant fluctuations in terms of production rates, species diversity, and community organization. These alterations show the both local and regional influences as well as global effects like climatic shifts [3]. The nutrients flow is observed from terrestrial point source or non-point sources. Point sources includes effluent discharge from industries or sewage, and non-point includes agricultural run-off (Fig.1)[4][5].

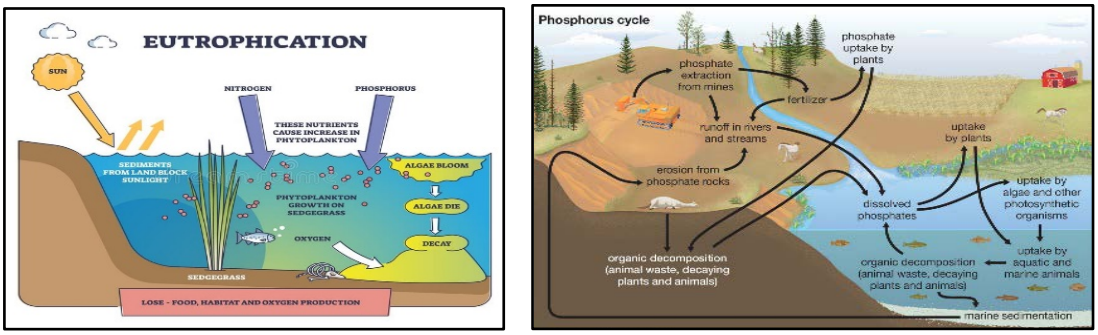


Figure 1: Eutrophication and Phosphorus cycle responsible for Eutrophication (Encyclopaedia Britannica, Inc)

Coastal ecosystems are significant global assets. Human activities are certainly effecting their integrity. Phytoplankton’s dwells on organic and inorganic nutrients. The coastal ecosystem though benefited from phytoplankton growth, deposition of excess of organic matter could have negative ecological effects and even be dangerous for humans. This increase in the rate of organic matter supply to water bodies, as required by both scientific and legal standards is "eutrophication". It is a natural and gradual process. But human activities has fastened the rate of eutrophication, coined as cultural eutrophication. Fertilizers, pesticides, chemicals, detergents and soaps add additional nutrients (nitrogen and phosphorus) which are responsible for eutrophication in water bodies as a result, the natural self-purification process lowers leading to death of aquatic life. Nitrogen and phosphorus nutrients mostly used in fertilizers are primarily responsible for eutrophication [6]. To keep the pasture green loads of fertilizers are used in Golf Courses, garden and government offices, heavy rains and storms drains, the runoff into rivers and to the estuary respectively. Sewage runoff also adds N

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

and P to the water bodies. The primary producers use the N and P to produce oxygen. High concentration of these nutrient causes imbalance in the ecosystem whereas low concentration keeps the phytoplankton activity in equilibrium with its consumption. High concentration of oxygen leads to more detritus that sinks to the lower layers in the ocean further, more oxygen is required to metabolise the sunk detritus which creates zones of low oxygen [7]. Sudden bloom of phytoplankton have negative effect on the ecosystem. Some species when bloom in large quantity release toxic and hazardous chemicals which may be lethal to many organisms, more over dense vegetation limits light to the phytoplankton below them which limits oxygen production as well.

Reasons and Effects of Eutrophication:

Ancient civilization flourished near water sources, since then aquatic organisms were used as food, decoration, jewellery making and for trade mostly by the population residing near the costal ecosystem. The means and needs were limited and controlled. However, exploitation of costal ecosystem began gradually when mechanical harvesting and ship transportation were developed, harvesting picked up speed. It was observed that Oysters population depleted in early 1700s by human consumption and in 1920s disease eliminated them in Ireland. Similarly, decline in oyster population due to over harvest and disease outburst was observed in Chesapeake Bay in the United States. Ocean ecosystem gets affected by overharvest and diseases profoundly, which are overlooked. Oysters feed on phytoplankton and sediments that helps to balance nutrient levels and plankton ratio in waters. Uneaten phytoplankton may then increase zooplankton populations, which may then benefit zooplankton predators like jellyfish. Records show that predatory fish gets depleted prior to the forage fish that are small zooplanktivorous fish [8].

Studies show link between increase in jelly fish and reducing fishing. The food chain shows that piscivorous fish would feed on zooplanktivorous fish, but these tiny forage fish are heavily fished for human consumption, oil and meal for aquaculture feeds, hence, fishing reduces forage fish which results in bloom of zooplanktivorous jellies, (Chiaverano et al., 2018) which may be due to less competition of food as observed in black sea [9]. However, it is observed that jelly fish has bloomed over the years to greater extent. It has been observed that human activities have effect the coastal ecosystem but has favoured jelly fish numbers, as jelly fish feed on eggs and larva it becomes difficult for other fishes to produce. Irregular bloom has effected tourism, coastal services, marine fisheries, human life safety, and zooplanktons [10][11]. The study shows that New Jersey coastline is highly enriched with anthropogenic nitrogen due to which the population of jelly fish has grown extensively in recent years. Large population of jelly fishes affects humans directly and indirectly [7].

Low level of oxygen creates dead zones due to eutrophication which do not support water organisms. Many secondary consumers die because of high level competition, scarcity of food and human intervention, however, jelly enjoys this condition, firstly, as the population size of jelly fish is large and increases rapidly, secondly as sea turtles and sunfish die they do not inhabit the area which they occupied once hence, no more treat to jellyfish prey. The preditors-prey relationship is not observed as the production rate of jelly fish is more. In addition jelly fishes can feed on variety of food available in sea, they do not look for a particular type of prey which helps to withstand hard conditions. Jellyfish polyps can go dormancy at the bottom of sea till favourable conditions arrive. Overgrazing, reduced diversity, and inefficient energy transfer are caused by the abundance of jellyfish in the marine environment [12][13].

The ideal condition for jelly fish is warm and tropical water but human activities, rise in temperature, and competition for food may affect them greatly. Although organic fertilizers had been used in agriculture for millennia, the global availability of chemically synthesized inorganic fertilizers lead to the “Green Revolution” and coastal eutrophication.

The cultural eutrophication can trigger various changes including phytoplankton shift, its composition, formation and development of dead zones due to hypoxic. Many densely populated countries like North America and Europe are facing problem of eutrophication. It can be commonly noticed when the water turns

greens due to algal blooms, it restricts sunlight entry in water. Limited penetration of solar energy limits photosynthesis hence, lack of oxygen causing death of aquatic plants and fishes, which additionally contaminate the water and harms the environment. The reduced oxygen level and light can affect the bottom dwellers to a large extent, forming low oxygen areas, hypoxic creating the dead zones. Some species such as *Noctiluca scintillans* have been found to be hypoxic tolerant [14].

In New Jersey water over bloom of jelly fish was observed due to high nutritional levels caused by anthropological means. These blooms were a problem in Barnegat Bay which had very rich ecosystem, resulting in dead zones, due to no competition, jelly fish population took over the entire area. However, this might lead into the disappearance of significant coastal ecosystem, hence anthropological means need to tackle to balance the ocean ecosystem. Similar dead zone was observed in Gulf of Mexico near Louisiana [7]..

Gulf of Mexico and Baltic Sea are examples of dead zone caused due to the agriculture run off and algal bloom due to human activities. In Lake Erie some algal blooms releases toxins which has caused death of thousands of geese and ducks in United State. In several studies cyanobacteria, has been reported to poison wildlife and living organisms. Cyanobacteria changes the odour, colour and taste of water making the treatment process costly and time consuming. Studies show eutrophication has led to jelly fish outbreak which can degrade water habitats in shallow water and adds to ocean acidification [8][15].

In another study, Denmark water bodies had high concentration of nitrogen and phosphorus discharged. National Action Plan on the Aquatic Environment, 1987 enacted to reduce the nutrient concentration to save aquatic lives. The aim was to remove N and P by 50% and 80% respectively. Further, Danish estuaries and coastal area were prone to hypoxia due to over-enrichment, deleted oxygen and loss of macrophytes [16]. Moreover, Colony of eelgrass and microalgae were affected by the water transparency and chlorophyll a, which depends on nitrogen load of waste water [17].

Studies show, Coral reef provides livelihoods to the coastal communities and is a means of economic growth world-wide. Climatic changes, pollution, overfishing, construction under waters and many other factors responsible for declining of reefs. Hence, cultural, social and economic benefits associated with reef are in treat [18]. Nitrogen from the agriculture run off or sewage threatens coral reefs causing coral diseases.

Sea level rise and increase in nutrient loading, at the same time may cause synergistic marsh loss that is larger than the effects of either stressor alone. When silt and mud are deposited along a protected portion of the coastline, salt marsh are formed. Small plants followed by large plants take root and trap sediments, with the accumulation of saltmarsh forming a wet land. Protecting salt marshes benefits people to a large extent. Marshes helps to stop erosion, maintain shorelines, guard against storm surges, and sustain species that are essential to hunting, birdwatching, fishing for pleasure and profit, among other activities [19]. The movement of reactive nitrogen from land to coastal marine ecosystem has significantly increased due to an accelerated global nitrogen cycle, resulting in detrimental algal blooms, hypoxia, and loss in fisheries [20][21][7]. In addition to providing vital ecological and commercial services salt marshes occupy a crucial interface between the land and the sea.

Aurelia has been reported in large numbers between May to August [22], offshore in temperate region like Yellow sea and Bohai sea causing troubles around nuclear power plant, estuaries, ports, and bridge [23].

Ways to reduce or prevent eutrophication:

- Lowering phosphorus in detergents.
- Implementing sustainable agricultural practices.
- Limited use of chemicals.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

- Removal of N and P from the wastewater before it is dumped in water bodies.
- Daphnia, crustacean feed on algae preventing its excessive growth.

Several tactics can be used to reverse eutrophica tion in a lake or pond, such as:

- *Reducing nutrient inputs:* This entails lo wering the quantity of fertilizer and othe r nutrient-containing materials that get into the water. This can be accomplished by enacting stronger laws governing the treatment of sewage and the disposal of industrial waste, as well as by implementing sustainable agricultural practices.
- *Mechanical removal of excess nutrients:* This tactic entails taking the extra nutrients out of the water physically. Numerous techniques, such as dredging, aeration, and the application of nutrient-absorbing materials, can be used to accomplish this.
- *Biological control:* This tactic entails bringing in organisms that eat surplus nutrients, like specific fish species or bacteria that feed on algae.
- *Altering land use practices:* This entails altering the way that land is utilized in the vicinity of the lake or pond, including the creation of buffer zones, the removal of impermeable surfaces, and the addition of more vegetation.

Therefore, reverse eutrophication needs a combine approach and strategies which has to be tailored for the given set of unique conditions knowing to the water body. Eutrophication can be prevented or reduces by the cooperation of state-holders and government, which includes scientists, experts, environmentalists, politicians, farmers and even the public.

Ocean Acidification:

The burning of fossil fuels is the main source of rising atmospheric carbon dioxide (CO_2), the ocean absorbs around one-third of the carbon dioxide released by burning fossil fuels, which lowers ocean pH and causes chemical imbalance. Lowering of pH level results due to carbon dioxide absorption and conversion into carbonic acid. The reduction of calcium carbonate saturation due to ocean acidification affects marine organisms to a large extend. The changes in the carbonate chemistry of ocean shall increase the rate of acidification and gets accelerated over the course of time unless CO_2 emissions are considerably reduced. In high CO_2 environment, many calcifying species show decreased rates of calcification and low growth rate was observed in laboratory. Certain photosynthetic organisms (including calcifying and non-calcifying) experience an increase in carbon fixation rate as a result of ocean acidification [24]. Many aquatic organisms are in danger due to pH drop, including corals, which offer one of the richest habitats on the planet. It is assumed that in coming century, the Southern Ocean's surface will erode the shells of small snails, which are an essential component of the marine food chain (Fig. 2).

Seawater carbonate chemistry is governed by a series of chemical reactions:

$$CO_2\ (atmos) \rightleftharpoons CO_2\ (aq) + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons 2H^+ + CO_3^{2-}$$

The measure cause of climatic change and ocean acidification is increase in atmospheric CO_2 to a large extent, which may be imperative to industrialization, urbanization and population explosion. Fossil fuel combustion and agricultural runoff produces strong mineral acids and bases inputs to coastal areas. Such inputs are prevalent in northern hemisphere

.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

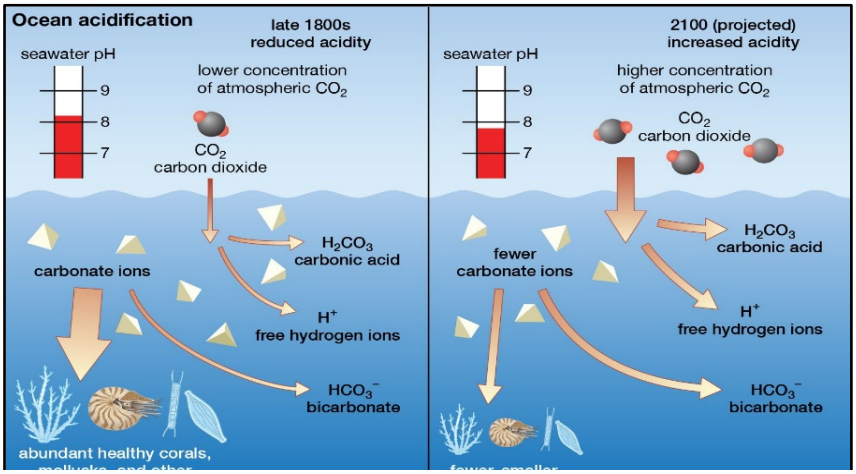


Figure 2: Ocean Acidification: effect of aquatic life (Google Picture)

Since, the calcite would always remain supersaturated in the ocean, scientists largely dismissed any foreseeably impact of CO_2 on ocean biota. Despite the researchers being aware that the concentration of CO_2 in the surface ocean was more or less in balance with the over-lying atmospheric CO_2.

Reasons and Effects of Acidification:

Investigators suggested some issues that can endanger marine biota due to increased ocean acidification [24]:

- The degree of supersaturation affects the calcification rates of many shell-forming organisms.
- In the early 21st century, the surface ocean may become under saturated in aragonite, a more soluble $CaCO_3$ mineral that is equally important in calcifying organisms.
- Declining ocean pH has biological effects that goes well beyond restricting calcification.

In a study carried by Fine & Tchernov (2007) corals when grown in acidified water, lost their skeleton completely, which regrew when corals were shifted to ocean habitat at normal pH. The study reveals that pH and aragonite saturation are responsible for the rate of coral calcification, due to loss of protective skeleton the organism might be unfit but coral polyps remained alive to regrow at normal pH [25][26]. From the Great Barrier Reef a colony was analysed which showed 21% decline in the rate of calcification between 1988 and 2003. It was suggested that further decline may be due to climatic changes [27]. Acidification effects marine organisms, from planktonic coccolithophores and pteropods and molluscs, to echinoderms, corals, and coralline algae. The calcification and growth rate reduce due to high CO_2 concentration. The adaptation to the increase in CO_2 concentration by the aquatic organisms needs further study. Ocean acidification causes chemical imbalance of trace metals and elements, dissolved organic matters, organic C, N, P and calcium carbonate concentration. This impact may affect livelihood of large communities which are directly or indirectly dependent on numerous resources derived from oceans. An effort to slow global warming without lowering atmospheric CO_2 concentration is the use of stratospheric aerosol injection, however, it cannot stop acidification of the ocean [28].

Researchers found that acidification of ocean increase the concentration of carbonic acid in the body fluid of larger animals such as squid and fishes which is known as acidosis, may lead to respiratory as well as growth and reproduction related problems. Furthermore, a great deal of marine scientists believe that the significant reduction in oyster beds along the US West Coast since 2005 was a result of the increased ocean acidification due to which oyster larvae were under stress [29].

It is observed that a small shift in pH can be alarming, as the carbon dioxide absorbed gets dissociated to form carbonate ion, the hydrogen ion present in ocean combines to form

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

bicarbonate ions, hence, the concentration of carbonate ion reduces. Lowering the concentration of these ions shall hamper the production of calcium carbonate which will effect growth of some aquatic organisms. Numerous tiny creatures (amoeba, snail) are the part of small food chains and webs, these are food sources for big sharks and mammals (whales) [30].

The existence of corals is at stake, corals are the colonies of tiny animals which look as plants, they feed on Plankton from water and secretes skeletons made of calcium carbonate, which builds up to form coral reefs in years together. The coral reefs form diverse, productive, vibrant, and eye-catching biological entity amongst the ocean ecosystem. Similar to corals, coralline algae secrete $CaCO_3$ and helps in calcification of reefs. The world's largest biological structure, the Great Barrier Reef off the coast of Australia, is nothing more than the accumulation of coral and coralline algae from generation together is a living example. Lesser-known examples can be found further down the ocean floor, where seamounts and continental margins are dotted with cold-water coral communities that serve as crucial fish habitats. It has been seen that some organism add magnesium with calcite which is more soluble than calcite alone [31]. They are too harmed due to ocean acidification. With the increase in pH the shell portion becomes thinner, hence, the ocean gradually be hospitable for calcifying organism. It is observed that ocean acidification affects high latitude and deep water ecosystem prior, as they are under saturated than warm or surface waters. It is predicted that before the end of this century polar surface water shall turn under saturated. In a study carried out by Victoria J. Fabry of California State University, suggests that polar pteropods have disappeared or have migrated to warmer latitudes. These small snails are a part of big food chain in Southern Ocean, large population of sea birds, whales and fishes feed on them. Similarly, decline in calcite may affect high latitude calcareous phyto and zoo planktons. Western North Atlantic ocean too contains high carbon content that lead to coral suffering [32].

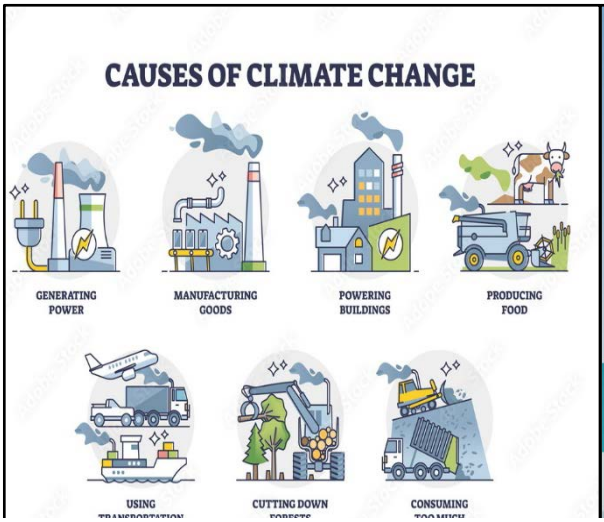
The symbiotic algae that reside inside the coral cells are partially responsible for the stunning colours of shallow-water corals. These algae occasionally separate from their hosts due to different environmental stresses, exposing the white skeleton ($CaCO_3$) beneath. Events like "bleaching" can be caused, by extremely high temperatures. Additionally, some scientists believe that such changes are frequently triggered by the ocean's acidification, or more accurately, by a decrease in the ocean's slightly alkaline state [33].

Ocean Warming:

As 70% of the earth surface is covered with oceans, take about 93% of heat entering Earth’s climate which causes global warming, 3% melts ice, 3% warm the land, and 1% warm and moist the atmosphere [34]. This huge volume of ocean water absorbs large amount of CO_2 emitted by the anthropogenic means into the atmosphere. The study shows that more than 440 Gt CO_2 has been absorbed with last two hundred years. CO_2 produced and emitted by humans get absorbed into the surface layer which travel to deep waters by ocean currents. Ocean biology plays an important role in CO_2 uptake that is comparable to that of the terrestrial biosphere. Nevertheless, as atmospheric CO_2 concentrations rise, seawater's capacity to act as a buffer diminishes, reducing the ocean's capacity to absorb CO_2 [35].

The effects of CO_2 accumulation on ecosystems and its relation with warming, eutrophication, and hypoxia are drawing attention around the world. It has been observed as the atmospheric CO_2 increases, the biological processes like respiration and photosynthesis modify distribution kinetics and equilibria according to Henry’s Law depending on CO_2 dissolved in water. Due to the similar solubility of CO_2 inwater and air, concentration of CO_2 in physical equilibrium remains same. Changes in the acid-base status of ocean water is linked to increase in aquatic CO_2 levels mostly observed in the upper layers.

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52



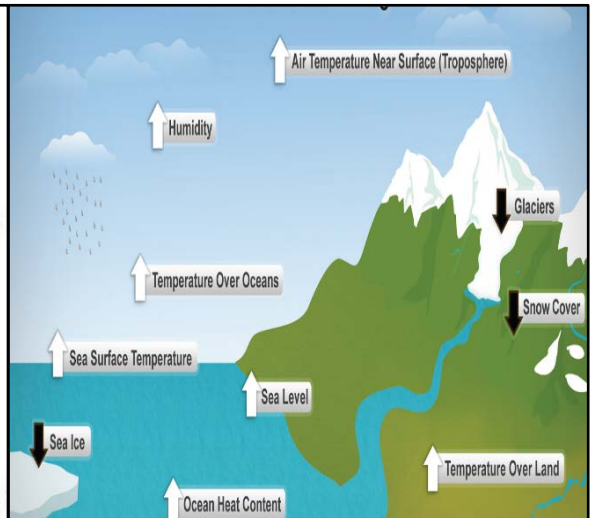


Figure 3: Causes of climate change (Google Site) Figure 4: Ten Indicators of Warming

The total CO_2 in ocean comprises of 1% CO_2 and H_2CO_3, 91% HCO_3^- and 8% CO_3^{2-}. The model calculation shows that since pre-industrial era (1996) there was accumulation of CO_2 beyond 0.1 units which was equivalent to 30% increase in H^+ ion activity in Surface Ocean. With the continuous use of fossil fuels the atmospheric CO_2 concentration is increasing exponentially leading to pH reduction hence, acidification of surface water. Increase in CO_2 in atmosphere has brought changes in regional temperature, its variability and climatic factors (Fig. 3 & 4). The geographic distribution of aquatic and terrestrial animals are at the verge extinction due to global warming, coral reefs been one of such species [36][37]. Global warming and acidification of the oceans have changed the composition and function of marine ecosystems which is due to temperature change. However, effects of acidification and hypercapnia in the ocean caused by CO_2 may be so small and little evidence are reported [38].

Reasons and Effects of ocean warming:

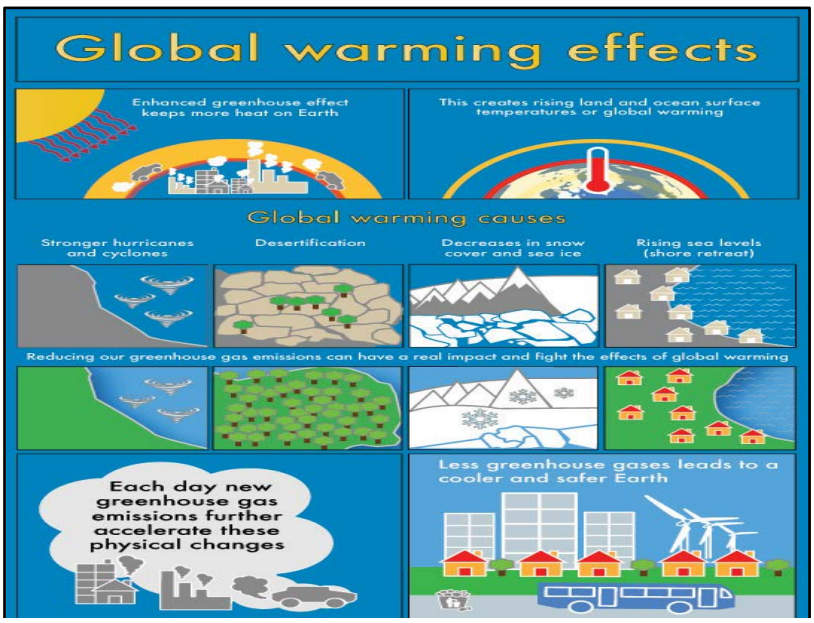


Figure 5: Effects of Global Warming [39]

The large-scale geographic distribution of marine animals is largely shaped by temperature, within parameters determined by geomorphology, ocean currents, water depth and stratification, or salinity. The organism can reach a geographical ranges depending on its mobility and tolerance for physical factors and its mode of life, food chain, competitors for food [40]. These factors also determine their reproductive cycle, adult phase and interaction with ecosystem (Fig. 5)[41].

A positive Earth Energy Imbalance (EEI) caused by rising anthropogenic greenhouse gas (GHG) concentrations results in an excess of heat in the environment resulting in rising ocean temperature known as ocean heat content (OHC). Ocean warming has been increasing since 1950s and has reached high values presently. The ocean warming spreads from surface to the lower layers of ocean [42].

Due to ocean warming, intensity of the rainfall has increased, the sea level has risen, the melting of ice sheets, glaciers and ice caps in the Polar Regions has increased, depletion of coral reefs; and the reduction of ocean oxygen levels is observed [43]. Ocean warming as observed to lower chlorophyll and productivity of ocean gyres. The tendency of chlorophyll is to decrease with rising temperatures or to increase with falling temperatures. If the amount of chlorophyll is equivalent to phytoplankton biomass, then Warmer Ocean suggests lower phytoplankton productivity and stocks. Chlorophyll signal depends on penetration of light and nutrient condition which change physiological adjustments in cellular pigmentation[44][45]**.**

Various models have been built to study the effect of rise in temperature on upper ocean surface, the models have shown consistency in basin scale temperature change corresponding to anthropogenic means and inconsistency with model based observations of natural variability. Instrument based bathythermograph datashows systematic and improved ocean temperature trends and variability. Using the improved techniques, observations and the external stimulations, causes of ocean warming were examined [46].

Plastic and Micro-plastic Pollution:

Plastics have become an inevitable part of humans because of convenience, attractive colours, light weight, durability, in short cost effective. With such properties plastic demand raised exponentially and eventually ended creating huge waste causing massive damage to ecosystem and bring climatic changes. An increasing threat to both terrestrial and aquatic ecosystems is plastic and microplastic (MP) pollution. It is complex, plentiful, and environmentally persistent. Research on alternatives and mitigation strategies has received a great deal of attention due to environmental, economic, and social concerns about the impact of MP pollution in ecosystems and possible solutions for the same. MPs are ubiquitous in all areas of human interaction—soil, water, and atmosphere—and dangerous to ecosystems' biota, which could eventually contaminate food systems and have an adverse effect on public health. The main sources of MP pollution are plastic leaks and products containing plastic, plastic mulch (fertilizers, and pesticides), wastewater, polyamide fabrics, and cosmetics [47].

Plastic Pollution is a global tragedy for oceans and aquatic life. Their accumulation on beaches and ocean has causes global crises. It is expected about 40% of the world's ocean surfaces are home to billions of pounds of plastic debris. By 2050, plastic is predicted to surpass all fish in the ocean at current rates [48]. Plastic pollution in ocean by plastics can vary from bottles, bags and wrappers of plastics to microplastics formed from the fragmentation of these materials. Nano or micro plastics are the resultants of photo-degradation of plastics in water bodies. The photodegrade plastics are smaller in size and these floating particles are broken further down to zooplankton sizes which are then consumed by jelly fishes. Plastics have deadly effects on aquatic flora and fauna along with the terrestrial plants and wildlife.

Reasons and Effects of Plastic Pollution:

Thousands have aquatic animals have found floating on ocean surface due to ingestion and getting entangled in plastics [49]. The sea turtles and sea birds take plastics for garbage which choke them (suffocation) or starve to death as the stomach is full with plastics. Some

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

plastic products like cigarette butts, bags, cans, wrappers and six pack rings are dangerous to aquatic life. It is estimated that by 2050, 99 % of sea birds would have eaten plastics which is estimated 60% presently. Steller sea lion and whales have found dead with plastic full bellies. Research shows that nearly 700 species of Hawaiian monk seal and Pacific loggerhead sea turtles have consumed and were caught in plastics, are endangered species. Studies show in North Pacific Ocean the fishes ingest 12,000 to 24,000 tons plastics resulting in intestinal injuries leading to death (Center for biological diversity). The plastic gets transferred to higher food chain from fish – sea mammals – humans (Fig. 6-7). A study found presence of microfibers in the gut of fishes from California [50]. Studies in Switzerland shows approximately 3,000 tons of nanoplastics in heavy snow.

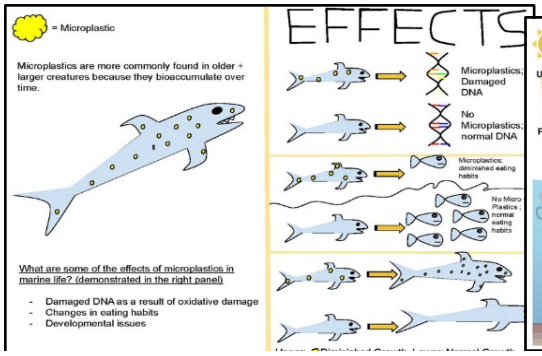


Figure 6: Microplastic Pollution in aquatic life

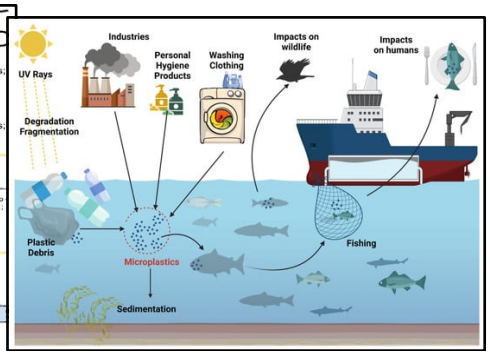


Figure 7: Entry of plastics in ocean [51]

Data shows 300 million tonnes of global plastic consumption per year as of 2022, out of which around 8 million tonnes finds its way to oceans. The plastics are primarily created by land activities which leaks into the aquatic ecosystem slowly yearly (Fig. 8). As plastics are low degrading and are widely spread in oceans they are extremely hazardous. At times fishing nets are lost in oceans, which turn to ghost nets when dolphins, dugongs, sea turtles, crabs, crocodiles get stuck leading to moment restriction, starvation, infection, and suffocation resulting in death (Fig. 9-13) Bottle caps in stomach have led to obstruction of digestive and respiratory track of turtles and sea birds [52].

Over time, leaking or improperly handled plastics break down into smaller pieces or particles within ecosystems. Microplastics (MPs) are plastic particles that are 5 mm to 1 mm in size; [53][54] further degradation of MPs results in finer particles that are called nanoparticles (NPs). MPs are present in soil, water, and the air [55]. They are dangerous to ecosystems because they can contaminate food systems and cause health issues for the marine biota that consumes the soil.

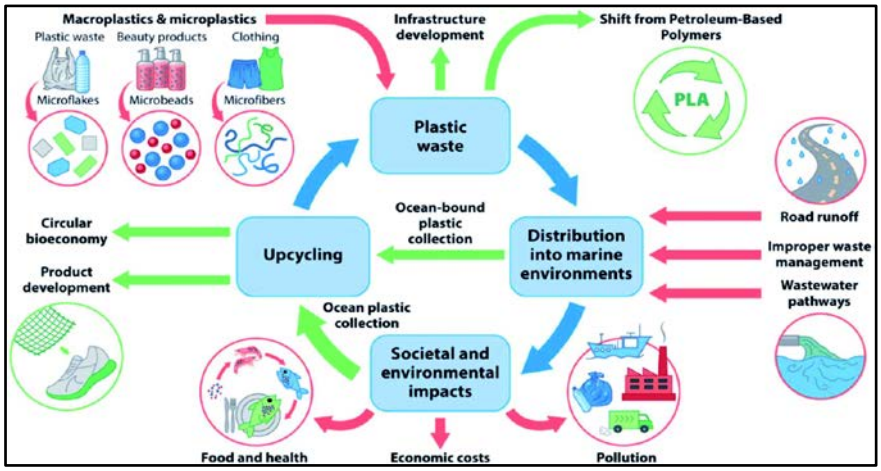


Figure 8: Interactions between marine microorganisms and microplastics [47]

Figure: 9. Sea Turtle entangled in fishing net

Figure: 10. A great blue heron with a fish caught in plastic bag

Figure 11: Variety of plastics in dead albatross

Figure 12: Great Pacific Garbage Patch in Hawaii

Figure 13: Singapore Beach with Plastic Waste

Figure14: Clean Up exercise

The creation of materials and substitutes for traditional plastics that can lessen or mitigate the issues related to plastics and microplastics (MPs), as well as the enhancement of waste management systems to prevent the seepage of plastic waste into ecosystems

Clean-up drives are essential for getting rid of plastics (Fig.14). Because micro-plastics breaks down more quickly and is more susceptible to microorganisms than conventional plastic, biodegradable plastic is acknowledged as an alternative to conventional plastic. A possible solution to the issues caused by MPs contaminating ecosystems is the combination of biodegradable plastics and bioremediation, which is the removal of MPs using MPs' microorganisms. Studies have found that microorganisms such as bacteria, fungi, actinomycetes have the potential to degrade manmade and natural plastics, the degradation depends on type, characteristics, molecular weight, hardness, form, and crystallinity of the plastics. Surface degradation of Polylactic acid seems 20 times faster than polyethylene on land and water. The rate of degradation depends on its fragmentation, residing time, and mobility of

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

MPs due to human intervention. The plastics and MPs can sink, float, settle on snow, settle near sea beds, and submerge in different depths depending upon their mass and size, reaching to all possible flora and fauna in aquatic ecosystem and affecting them in all possible ways [56][57].

Thus, the production of biodegradable plastics from biomass that is not edible, like algae, may offer a way to end MP pollution and promote sustainable ecosystems. Consequently, thorough research is necessary to evaluate the effects on the environment, the economy, and society of biodegradable plastics and MP bioremediation in ecosystems to prevent any possible harm to the environment and public health [58].

The studies show that plastics seeps from one ecosystem to another affecting every sector of humans. Microplastics are contaminating every bit of food chain and food web affecting lives. Despite the fact that MPs are present in numerous segments of ecosystems its remediation and quantification is not yet standardised. Numerous awareness programs, clean-up drives, manufacturing of biodegradable plastics, its design and development are on going to reduce plastic pollution. Elimination or reducing use of plastics shall require intervention of local people, NGO, environmentalists, local governing body and government. All together can bring changes and same the terrestrial as well as aquatic ecosystem.

Over Fishing:

Since ages the civilization have flourished near water bodies particularly in the area of high fish catch. Human settlements have relied on fisheries resources for food, employment and cultural significance. Over 3.2 billion people get nearly 20% of their daily intake of animal protein from fishing [59][60]. FAO (2022) states that worldwide fisheries would increase by 6% from 2020 to 2030, approximately 96 million tonnes in 2023[61]. According to UNEP, 47% of the world's fish stocks are fully exploited, and 18% are overexploited, hence, there is no room for refilling [62]. The world's expanding population may also put pressure on the remaining supply. According to some authors inland fishing has excessed already resulting in the over exploitation of rivers, lakes and oceans [63]. Scientists and environmentalists worry that if overfishing is not addressed now, there may not be enough seafood in the world by 2048 [64].

Overfishing results in reducing the number of catches, declines the average size and age of catches, a drop in the average weight of catches, and a reduction in the population of reproducing individuals. Overfishing has become a factor that disrupts the replenishment of stocks and resources, making aquatic environments more vulnerable and less productive, and contributing to the depletion of locally available produce [65][66]. Overfishing has led to unequal distribution of ocean resources. Moreover, the population of developing countries who depend on sea food as their occupation and protein are suffering, however, the effluent countries demand high value fisheries which has increased the competition in global commercial markets. Therefore, food scarcity and unemployment in the coastal communities and developing countries has greatly affected. Overfishing, if continued surely will result in collapse of economy and marine ecosystem globally (Fig. 15) [67].

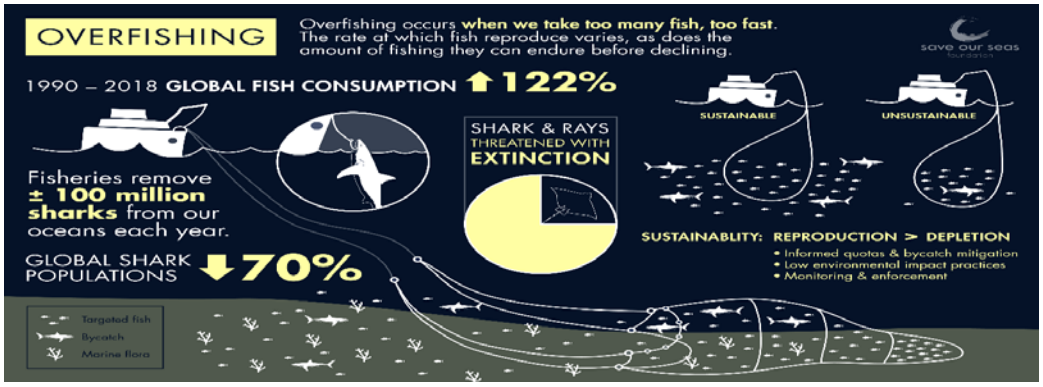


Figure 15: Overfishing causing energy imbalance (Artwork by Nicola Poulos)

As reported by the World Wildlife Fund (WWF, 2006) in "The State" (10), "Once thought to be endless, our oceans are now in a state of global crisis as more and more people compete for fewer and fewer fish."[68] Despite the fact that experts differ on the extent 53 percent of the world's marine fisheries resources are thought to have either reached their maximum sustainable level of fishing or have completely run out, while 32 percent are either overfished, depleted, or recovering from depletion ("Fisheries and Aquaculture") [69]. More than 170 billion pounds of wild fish and shellfish are harvested from the oceans each year, which is almost three times the combined weight of all American men, women, and children (Greenberg). Future strain on seafood will rise as a result of the current rate of exploitation, according to the Food and Agriculture Organization and the World Bank ("The State" 8).

Fishing regulations are lax in developing nations all over the world, including those along the West African coast. Because of this, both domestic and international fishing fleets are destroying fish stocks and widening the socioeconomic gap between fishermen and the populations of Senegal, Ghana, Guinea, and Angola (Montaigne).

Analogously, in Asia, uncontrolled fishing practices have led to the demise of almost all fisheries in the Java Sea and the Gulf of Thailand (Montaigne). Impoverished individuals in developing Countries have few alternatives, which encourages them to keep using fish stocks in an unsustainably destructive manner for meagre compensation. When people fall into a "poverty trap," as illustrated by Cinner et al. (2009), their immediate survival needs take precedence over any potential long-term benefits from conservation or sustainable management. Fishermen in the Mediterranean, who also depend mostly on fishing for their subsistence, experience comparable struggles. "The price is cheap because more and more tuna are being caught," stated an Italian tuna fisherman. The Mediterranean's fishermen also endure similar struggles. Who also make their primary means of subsistence fishing? It's a vicious circle due to the extremely low cost [70].

Large apex predator fish like bluefin tuna remain popular in wealthy countries like the US and Japan. Of these fish population that are rapidly declining are the sushi industry, Huge Chilean tuna and Sea bass, which are the most demanding and regarded as a luxury food item being served in more and more upscale restaurants worldwide. Japan is at the top of the unsustainable seafood demand pyramid and has developed a very lucrative market for these highly sought-after fish. A single Bluefin tuna caught off the northeastern coast of Japan was auctioned off in Tokyo in January 2013 for US $1.76 million. Fishermen are further encouraged to continue taking advantage of this valuable species by such enormous profits [71]. To meet the seafood requirements farming of marine species has rapidly growing world-wide. Since the 1980s the shrimp aquaculture industry in Thailand has rapidly increased from 31,000 tons in 1976 to 2.6 million tons in 2006. Of all farmed shrimp, about 90 percent of it is produced in Asia and South Asian countries, most notably in Thailand, China, Vietnam, Indonesia, and India [72].

Reasons and Effects of Overfishing:

As the number and scale of these aquaculture operations increases so do the risks of rapid environmental degradation. The continuous improvement in aquatic production technologies, and economic incentives created by international trade have created a global production system based on high chemical inputs to satiate the global demand for seafood. The conversion of mangrove swamps to profitable fishing ponds has led to the cultivation of shrimp and other fish species at a level that has reduced the capacity of the mangroves. This threatens the health of entire vital mangrove ecosystems, coastal habitats, and contributes to the growing socioeconomic disparity of Thai coastal village people. For age’s mangrove ecosystems are the source of food, fuel, medicine, textiles, shelter, and grazing areas, which helps to prevent soil erosion, acts as buffer from pollution and toxic run off and save from the effects of storms, due to exploitation for fish stocks efficiency of mangrove habitats has declined to a large extent. Improper management of mango groves has accelerated urban migration,

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

unemployment, food availability for the local communities.

Studies using modelling and empirical data have demonstrated that the depletion of lower-trophic level species, such as sardines, anchovies, herring, and krill, can cause population declines in dependent predators, such as seabirds [73], larger fishes, and marine mammals. Significant decreases in predators have affected the fishes that are commercially exploited [74]. Loss of predator's leads to increase in carbon dioxide in ocean hence, change in marine ecosystem.

In 19^{th} century overfishing was documented, when marine lives (whale) were not only consumed but were killed for lamp oil, this gradually led to the extinction of whale, herring, sardines and cod. Overfishing was a prey to market liberalization which eventually led to privatization as the government would not regulate laws. Privatisation could not solve the problem but area of overfishing increased.

The Cape Cod extends from the southeastern corner of the Massachusetts continent in the northeastern United States to the Atlantic Ocean. Cape Cod is the staple food for United States and many European and American Countries. Studies show due to overfishing swamp's coastal flora die fast. Further, overfishing of top fishes increases Sesarma, which results in the damage of shoreline [75].

The maximum sustainable yield (MSY), a technique for monitoring fish stocks globally, was created in response to increasingly cases of overfishing. Although many regard the MSY as a target rather than a cap, it is the absolute maximum harvest of fish that should be taken each year from a particular population of fish, in order for the species to regenerate to the same amount or higher for the following year. The United States passed the Magnuson Stevens Fishery Conservation and Management Act (MSFCM) in 1976 to establish an annual catch limit for fisheries because this approach failed to stop overfishing. Before this law overfishing contributed by foreign ships were 10 times than US fishermen. However, setting a strict MSY by itself won't be sufficient to restore the amount of fish in our supply because overfishing isn't the only issue causing yields to decline [75].

Fishing Tools Caused Overcapacity: The researchers have ascribed overfishing to two primary causes: advancement of fishing implements and the dietary demands of growing populace. Overcapacity of large ships, tools, and technologies used to reach the ocean's depths are a feature of fisheries industries around the world responsible for overfishing. Technology can process the fish while at sea for weeks or months before coming ashore. Unsustainable means of fishing is the second factor for over fishing. The use of technologically effective equipment has led to catch large amount of fishes that they go extinct. In the process, bycatch which includes sea urchins, starfish, crabs, turtles, corals and invertebrates like crabs, sea urchins and starfish are caught. These captures have a negative impact on reproduction.

*Economic Growth and Globalization:*The world's population increased exponentially as result, both food and economic needs are growing. The fishery's harvest quantity is determined by consumer demand and the state of the market. Due to the increase in human population, there has also been an increase in the demand for food and fish. In conjunction with the
Fisheries are forced to catch more fish than the ocean can replenish due to their economic aspirations. There is overfishing, as stocks drop and fishing gets more expensive, people have to decide whether to fish less or find other ways to occupy their time. People are currently opting for the latter. Rather than putting an end to overfishing, they keep eating different kinds of fish, though obviously not indefinitely.It's also important to note that the overfishing debate frequently brings up the topic of globalization. Despite the benefits and drawbacks of globalization, it is certain that this process will continue to evolve and be put into practice. Current FAO research demonstrates that globalization has benefited and still benefits many countries' fisheries sectors [76]. On the other hand, there is also a certain influence on the local fishery market due to the low cost and abundant supply of marine products exported to European and American nations.

Policy based explanation of overfishing:

*The Policy Addresses Overfishing In the United States:*Several bills to address the issue of overfishing were put issued in the United States in an effort to effectively eradicate something like Cape Cod. These bills include the Magnuson-Stevens Act, the Endangered Species Act, the National Environmental Policy Act and the Marine Mammal Protection Act (manatees and walruses). Preventing overfishing, replenishing overfished stocks, boosting long-term economic and social benefits, and guaranteeing a secure and sustainable seafood supply were the goals of the first act.In order to effectively improve the ecological environment, national environmental policy was based on the principles of encouraging better decision-making, considering all environmental impacts of actions, and involving the public in the decision-making process.

*The Role of Liberalism in Policy Making:*Trade liberalization according policymakers, is required to decrease debt loads, boost export output, and improve the competitiveness of imports and domestic production. Prior to the reforms, Mexico's tax rate on international trade was approximately 30%; it was now 8.6%, Chile's 12.5%, and Peru's 14.8%. Significantly, because there are no export taxes, production for foreign markets was dependent on domestic consumers and was an economic burden. Privatization in fishing industry led to concentration of industries and benefits were shared by rich groups. Nevertheless, overfishing due to greed and excessive industrialization resulted in escalating environmental issues and further resulted in a severe decrease in the number of fish in the area, even shorten menstrual cycles, and caused eutrophication of seawater [77].

In 1995 Global Environment Facility (GEF), an institution that helped developing countries to restore and improve environmental degradation by providing monitory help and further authorized the use of large marine ecosystems (LMEs) for the management of International Waters (IW) of coastal oceans [78].

Mass Tourism:

The interconnected system of tourism consists of travellers and the services (attractions, accommodations, transportation, and facilities) that are offered and used to support their travels 14. For any tourism to flourish the primary requirement remains desirability, amenities, easy approachability, ambience and inspirational.Coastal tourism is fastest growing sector in the world, but whether tourism protects or destroys the coastal area shall depend on what practices we follow. The growth of tourism in coastal environments has altered the natural beauty which once attracted people. This indicates that even though coastal tourism is based on ecological principles, it is not environmentally sound. A comprehensive analysis of environmental research on tourism reveals that countries prioritize economic development over environmental sustainability and environmental protection. In reality, the environment is being harmed by the activities of the three societal sectors—the public, private, and social. According to Higham, the tourism industry is making sincere efforts for sustainable development, inspite of the responsibility to maintain the requirement of sustainable development [79].

In the 1960s and 1970s, research on the ecological effects of tourism began. According to Fennell, the mid-1970s saw a significant increase in the field of tourism studies' concern for environmental issues, thanks to the work of Budowski [2], Cohen [6], and Krippendorf [25] in their studies on environmental issues and tourism. Budowski considered “conflict, coexistence, and symbiosis” being the bases of interaction between tourism and environmental preservation. According to him, the relationship that was once coexisting was heading toward conflicts.

Krippendorf, discussed the value of planning and the dispersion of visitors and tourism-related developments which can lessen the impact on environments [80]. Cohen talked about the development for aesthetically pleasing environment and ambience and the obscene, unwanted, and irreversible harm caused by contemporary tourism to the surroundings. The 1980s saw a continuation of studies on the ecological effect of tourism, growing concern about how tourism is affecting the environment. A lot of researchers focused on assessing how

tourism affects the environment. Pearce provided a framework for the investigation of tourism and environmental stress. He included the primary environmental response, the secondary human response, pressure resulting from the activity, and stressor activities in his framework [81].

The swift and unregulated growth of tourism in coastal regions has put ecosystems at high risk of environmental deterioration. Natural environment is an intricate relationships between plants, animals, and physical and chemical factors which forms an ecosystems [82](p. 195). Negative effects of excessive tourism development in coastal areas have been identified, including overcrowding, poor sewage disposal, boat-generated waste, beach erosion, overfishing, and destruction of wildlife habitats. The fascinating region may be impacted by these harmful activities. Additionally, they would jeopardize the environmental quality and damage the delicate ecosystem for the foreseeable future generations. Through excessive energy use, transportation, water consumption, and the creation of solid and liquid waste, among other things, tourism has also contributed to global warming. The phenomena of cloud cover, wind patterns and velocity, rainfall, and snow cover are all related to temperature and have an impact on both terrestrial and marine environments [83](p. 353). The geological changes may affect the serenity of the tourist place hence, may lessen the number of tourist. Hence, tourism development must be in a sustainable way and stakeholders (tourists) must know the positive and negative impacts on the environment and the ecosystem of the destination.

There are four broad categories into which the effects of tourism can be divided: political, social and cultural, economic, and environmental. There are both positive and negative effects in every category. To make the transition to sustainability, leaders in the community and tourism industry must work to maximize the benefits of tourism while minimizing its negative effects on the host community. The effects of tourism that are most frequently mentioned in the literature are listed below [79].

Considering economical aspect, tourism creates jobs, helps to raise living standards, money rotation, investment in public work, helps to raise local economy, and promote local artisans. However, some negative effects include: the inflationary effects of tourism-related expenses; rising prices for goods and services, real estate, and housing; rising costs of living; rising costs for health care, law enforcement, and fire protection; rising potential for the influx of foreign labor, and rising costs for new infrastructure.

The growth of tourism can have positive political effects, such as lowering political discontent brought by unemployment, boosting community security, and fostering international understanding and respect. However, tourism can has a negative political effect, such as kidnapping visitors, and raising the risk of political unrest among government opponents.

Meeting new people, sharing ideas, and advancing cultural values and beliefs are all made possible by tourism. This could enhance tolerance for cultural diversity and encourage national recognition of one another. Through interactions with other travellers, tourism can boost the availability of recreational facilities, improve welfare and the quality of life for locals, and encourage a higher level of psychological satisfaction [84]. In addition, there could be negative effects from tourism, such as alterations in language and culture, unwelcome lifestyle changes, changes in behaviour patterns brought in by visitors, health issues (such as AIDS and Hepatitis), an increase in crime, traffic jams, and crowded conditions that lead to tension, annoyance, conflict, and rage. Additionally, it might force locals to relocate in order to make room for more tourism amenities. Tourism development may neglect other activities and build pressure on infrastructure of home ground.

The money generated by tourism development helps for the preserving and protecting the natural scenic beauty, such as water bodies, gardens, public utility space, proper waste management, upkeep of existing monuments, raising environmental awareness, and managing new sites and local community as a whole. However, the following are a few

detrimental effects of tourism on the environment: excessive use of water and energy, increase in pollution and solid waste, deforestation, due to deforestation change in wildlife behave\or, feeding, and breeding patterns, overcrowding leading to traffic jams, the aesthetic appeal of the nature being affected; as a result entire ecosystem being disturbed.

Some cascading effect of mass tourism on the resources have been studied, which has increased environmental stress. Tourism authorities along with all the stake holders should shoulder the responsibility to guard the coastal area with hands together for future generations or else many species shall be endangered.

The northern Iranian Caspian Sea region has a competitive edge in terms of its natural tourism attractions thanks to its long coastline, exceptional natural and cultural riches, friendliness, and generosity of locals are involved, but it is observed that neither the public nor the private sectors of society give sustainability the attention it needs, hence, eco-systems are at risk of coastal degradation. The environment is seriously threatened by an insufficient sewage disposal system, liquid and solid waste, pollution of all types, and overcrowding. The disposal of sewage, solid and liquid waste in water bodies has led to eutrophication and ocean warming, hence, causing ecological disturbance in aquatic ecosystem.

In a similar study, the Gulf of Manner, which lies on Sri Lanka's west coast, has distinctive ecosystem with variety of biodiversity, consisting of 21 islands having coral-and coral-rubble. As a consequences of pollution, the marine ecosystem which once continued to be a refuge for numerous rare and endemic species and the vast variety of biodiversity, are in threat from industries, coral mining, silting due to unplanned construction, and unsustainable fisheries management. Moreover, over cropping of commercially valuable seaweed species, and sea cucumber species is alarm and immediate action is imperative [84].

The environmental quality of Caribbean has decreased due to beach erosion, destruction of reefs, overfishing, sewage disposal, solid waste produced by tourists, overcrowding [85]

Goa, in India is famous for beaches, the consumption of electricity of one tourist of a five star hotel is 28 time more than a local Goan consumes moreover, the water consumption by one such hotel was found as much as five surrounding village. Therefore, there is a local discontentment over the excessive use of available resources to some (tourists) and scarcity to some (localite). Excessive consumption of resources are responsible for global disruptions [86].

Some urban beaches are closed done for swimming in summers in New Jersey and New York due to faecal contamination and deposits of medical wastes on the sea shores. This lead to eutrophication and ocean acidification. Medical waste can affect the life cycle of marine flora and fauna [82].

The negative impacts of mass tourism can be reduced by considering following points for the coastal sustainability.

- Awareness of complex systems
- Responsiveness and involvement of local people
- Collaboration of public, private and government organizations
- Eco Tourism
- Shift in tourism researches

Change to Sustainable Lifestyle a better Options:

Protection of oceans is a necessity, as they contribute to our life style, climate and most importantly economy. It is important to value the coasts, ocean and the produce we get from them. The biogeochemical cycles (water, carbon, nitrogen, phosphorus, and sulphur cycles) essential for living organisms are ocean governed, hence, the oceans are responsible for weather and climate changes. The ocean provides ecosystem service to mankind providing food, oxygen and water); helps in regulating (climate/temperature regulation, coastal stabilization); supports (transportation of goods, pollution filtration, waste processing,);

ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-11, ISSUE-9, 2024
DOI: 10.21276/ijcesr.2024.11.9.52

and extends cultural services (aesthetics, tourisms: recreation, fun and inspiration) [87]. Hence, change to a sustainable lifestyle is a better option to save environment.

• **Dietary decisions:** Cutting back on sea food intake and consuming more plant-based foods can greatly reduce greenhouse gas emissions related to livestock agriculture. Finding new options which can complement coastal food.
• **Sustainable Agricultural Practices:** Crops can be grown in organic ways, limited use of fertilizers and pesticides. Use of hybrid seeds which are insect resistant and require less time to grow.
• **Use of Cloth bags rather than plastics:** The plastic bags should be banned in coastal areas to reduce death of marine animals due to choking. The cloth bag are reusable and sustainable.
•**Environmental Consciousness:** Sustainability is promoted by making deliberate decisions about what to buy, taking into account how products will affect the environment, and rooting for environmentally conscious companies, hence, mindful consumption of products is imperative.
• **Education:** Keeping up with the most recent advancements in conservation, renewable energy, and climate science enables people to make wise decisions.
• **Promotion:** Advocating activism, green policy voting, and voice for the support of environmental and climate actions collectively.

Conclusion:

Deforestation, the influx of large animals, agricultural runoff, and modifications to natural drainage patterns, and anthropological means has led to increase in nutrient level in coastal waters. Water bodies were dumping grounds since ages. Hence, eutrophication, ocean acidification, ocean warming, plastic pollution, overfishing and tourism has affected coastal region and aquatic life greatly over the years.

Human activities that release greenhouse gases into the atmosphere are the main causes of climate change. Climate change has serious repercussions on both human societies and the environment in addition, Extreme Weather, Sea Level Rise, Food Insecurity, Biodiversity Loss, Health Impacts are also observed in last few decades. However, the effects of climate change can be lessened by adopting strategies like switching to renewable energy, increasing energy efficiency, forest conservation and supporting sustainable agricultural methods. To achieve a sustainable future, governments, corporations, and individuals must work together to implement these solutions. To combat climate change, education and awareness-raising can be extremely important in addition to these remedies. Real change can be achieved by enlightening people about the causes and consequences of climate change and arming them with the knowledge and resources necessary to take appropriate action. Additionally, people can lower their daily energy and meat consumption, use public transportation, and make other small lifestyle changes that will help lower greenhouse gas emissions.

References:

[1] M. Dai *et al.*, “Achieving a Sustainable Ocean Economy,” no. December, 2019.
[2] A. A. Rosenberg, M. J. Fogarty, M. P. Sissenwine, J. R. Beddington, and J. G. Shepherd, “Achieving Sustainable Use of Renewable Resources,” no. 12, pp. 828–829.
[3] L. L. Tyson P, Steffen W, Mitra A, Fu C, “The earth system: regional–global linkages.,” *Reg Env. Chang.*, vol. 2, no. 3, pp. 128–40., 2001.
[4] L. T. M. Crossland CJ, Kremer HH, Lindeboom HJ, Crossland JIM, “Coastal fluxes in the Anthropocene.,” *Berlin: Springer*, 2005.
[5] D. Kitsiou and M. Karydis, “Coastal marine eutrophication assessment : A review on data analysis,” *Environ. Int.*, vol. 37, no. 4, pp. 778–801, 2011, doi: 10.1016/j.envint.2011.02.004.
[6] D. A. Lemley, J. B. Adams, P. Elizabeth, and S. Africa, “Eutrophication,” pp. 1–5, 2018, doi: 10.1016/B978-0-12-409548-9.10957-1.
[7] R. J. Diaz and R. Rosenberg, “Spreading dead zones and consequences for marine ecosystems.,” *Sci. AAAS*, vol. 321, no. 5891, pp. 926–929, 2008, [Online]. Available: https://www.jstor.org/stable/20144596
[8] J. E. Purcell, “Jellyfish and Ctenophore

Blooms Coincide with Human Proliferations and Environmental Perturbations," 2012, doi: 10.1146/annurev-marine-120709-142751.

[9] B. Chiaverino, L. M., Robinson, K. L., Tam, J., Ruzicka, J. J., Quiñones, J., Aleksa, K., Hernandez Jr., F. and W. M. R. D., Leaf, R. T., Uye, S., Decker, M. B., Acha, M., Mianzan, H., Graham, "Evaluating the Role of Large Jellyfish and Forage Fishes as Energy Fishes Pathways, and Their Interplay With Fisheries, in the Northern Humboldt Current Systems," *Oceanography*, vol. 164, pp. 28–36, 2018.

[10] M. C. 2001., "Jellyfish blooms: Are populations increasing globally in response to changing ocean conditions?," *Hydrobiologia*, vol. 451, pp. 55–68.

[11] L. W. Purcell JE, Uye SI, "Anthropogenic causes of jellyfish blooms and direct consequences for humans: a review," *Mar. Ecol. Prog. Ser*, vol. 350, pp. 153–74, 2007.

[12] "'Overall Level of Expression of Eutrophication Condition.' ASSETS - Assessment of Estuarine Trophic Status.," National Oceanic and Atmospheric Administration.

[13] and D. K. Whitaker, David, Rachel King, "SCDNR - Jellyfish." Sea Science," *South Carolina Dep. Nat. Resour.*, 2010.

[14] P. M. Glibert, M. A. Burford, G. C. Pitcher, and M. M. Caldwell, *Global Ecology and Oceanography of Harmful Algal Blooms Series editors*.

[15] "Taking Steps toward Marine and Coastal Ecosystem-Based Management – An Introductory Guide.","* *UNEP*, 2011.

[16] J. Carstensen and D. J. Conley, "Coastal eutrophication and trend reversal : A Danish case study," vol. 51, pp. 398–408, 2006.

[17] S. Ren, L. A. N. Ielsen, K. S. Aj, J. E. N. S. B. Orum, and O. L. E. G. E. Ansen, "Depth Colonization of Eelgrass (Zostera marina) and Macroalgae as Determined by Water Transparency in Danish Coastal Waters," vol. 25, no. 5, pp. 1025–1032, 2002.

[18] J. N. Kittinger, L. T. Teneva, H. Koike, and K. A. Stamoulis, "From Reef to Table : Social and Ecological Factors Affecting Coral Reef Fisheries , Artisanal Seafood Supply Chains , and Seafood Security," pp. 1–24, 2015, doi: 10.1371/journal.pone.0123856.

[19] L. A. Deegan *et al.*, "Coastal eutrophication as a driver of salt marsh loss," *Nature*, vol. 490, no. 7420, pp. 388–392, 2012, doi: 10.1038/nature11533.

[20] R. T. Watson *et al.*, "Ecosystem and Human Well- Being".

[21] D. E. Canfield, "Nitrogen Cycle," vol. 192, 2010, doi: 10.1126/science.1186120.

[22] S. Uye, "Human forcing of the copepod–fish–jellyfish triangular trophic relationship," *Hydrobiologia*, vol. 666, pp. 71–83, 2011, doi: https://doi.org/10.1007/s10750-010-0208-9.

[23] J. X. Haiyaue Zhang, Guangyue Zhang, Yifan Lan, "A Modeling Study on Population Dynamics of Jellyfish Aurelia aurita in the Bohai and Yellow Seas," *Sec. Mar. Ecosyst. Ecol.*, vol. 9, 2022, doi: https://doi.org/10.3389/fmars.2022.842394.

[24] S. C. Doney, V. J. Fabry, R. A. Feely, J. A. Kleypas, W. A. S. H. J. E. N. L, and P. Y. Ol, "Ocean Acidification : The Other CO 2 Problem ?," vol. 6, no. 2, 2016, doi: 10.1146/annurev.marine.010908.163834.

[25] T. D. Fine M, "Scleractinian coral species survive and recover from decalcification.," *Science (80-.).*, vol. 315, no. 1811, 2007.

[26] H. L. Stanley SM, "Secular variation in Phanerozoic marine biocalcification and the original mineralogy and mode of calcification of receptaculitids: a reply.," *Palaeogeogr. Palaeoclim. Palaeoecol.*, vol. 168, pp. 363–64, 2001.

[27] L. J. Cooper TF, De 'Ath G, Fabricius KE, "Declining coral calcification in massive Porites in two nearshore regions of the northern Great Barrier Reef.," *Glob. Chang. Biol*, vol. 14, pp. 529–38, 2008.

[28] C. PJ., "Albedo enhancement by

stratospheric sulfur injections: a contribution to resolve a policy dilemma?," *Clim. Chang.*, vol. 77, pp. 211–20, 2006.

[29] John P Rafferty, "ocean acidification biochemistry," *Sci. Tech*, no. Encyclopedia Britannica.

[30] S. American, N. America, and S. American, "The Dangers of Ocean Ac," vol. 294, no. 3, pp. 58–65, 2006.

[31] K. C. and M. E., "Anthropogenic Carbon and Ocean pH.," *Wickett in Nature*, vol. 425, p. 365, 2003.

[32] J. C. O. et Al., "Anthropogenic Ocean Acidification over the Twenty-First Century and Its Impact on Calcifying Organisms.," *Nat.*, vol. 437, pp. 681–686, 2005.

[33] "Ocean Acidification Due to Increasing Atmospheric Carbon Dioxide.," Royal Society,. [Online]. Available: www.royalsoc.ac.uk/displaypagedoc.asp?id=13314

[34] G. C. Johnson1 and and J. M. Lyman, "Warming Trends Increasingly Dominate Global Ocean," *Nat. Clim. Chang.*, no. May, pp. 1–28, 2020.

[35] M. Nanoparticles *et al.*, "Secondary Metabolites in the Green Synthesis of," no. Figure 1, pp. 1–25, doi: 10.3390/ma11060940.

[36] Y. G. Parmesan C, "A globally coherent fingerprint of climate change impacts across natural systems.," *Nature*, vol. 421, pp. 37–42, 2003.

[37] B. M. and others Thomas CD, Cameron A, Green RE, "Extinction risk from climate change.," *Nature*, vol. 427, pp. 145–148, 2004.

[38] H. Pörtner, "Ecosystem effects of ocean acidification in times of ocean warming : a physiologist ' s view," vol. 373, pp. 203–217, 2008, doi: 10.3354/meps07768.

[39] Olivia, "Unmasking the Human Impact: Unveiling the Causes of Global Warming," *Environ. Issues*, 2023.

[40] R. J. Perry AL, Low PJ, Ellis JR, "Climate change and distribution shifts in marine fishes.," *Science (80-.).*, vol. 308, pp. 1912–1915, 2005.

[41] S. R. and Hoegh-Guldberg O, Mumby PJ, Hooten AJ and Others, "Coral Reefs under rapid climate change and ocean acidification," *Science (80-.).*, vol. 318, pp. 1737–1742, 2007.

[42] G. C. et al. Johnson, "Ocean heat content. State of the Climate in 2020," *Glob. Ocean. Bull. Am. Meteorol. Soc.*, vol. 102, pp. S156–S159, 2021.

[43] L. et al. Cheng, "Another record: ocean warming continues through 2021 despite La Niña conditions.," *Adv. Atmos. Sci.*, vol. 39, pp. 373–385, 2022.

[44] J. M. Johnson, G. C. & Lyman, "Warming trends increasingly dominate global ocean.," *Nat. Clim. Chang.*, vol. 10, pp. 757–761, 2020.

[45] M. J. Behrenfeld *et al.*, "global phytoplankton," vol. 6, no. March, 2016, doi: 10.1038/NCLIMATE2838.

[46] P. J. Gleckler *et al.*, "Human-induced global ocean warming on multidecadal timescales," *Nat. Clim. Chang.*, vol. 2, no. 7, pp. 524–529, 2012, doi: 10.1038/nclimate1553.

[47] P. Roy, A. K. Mohanty, and M. Misra, "mitigation pathways †," pp. 9–29, 2022, doi: 10.1039/d1va00012h.

[48] A. Weisman, *The World Without Us*. 2007.

[49] S. Y. Jang, Y. C.; Lee, J.; Hong, S.; Choi, H. W.; Shim, W. J.; Hong, "'Estimating the global inflow and stock of plastic marine debris using material flow analysis: a preliminary approach,'" *J. Korean Soc. Mar. Environ. Energy.*, vol. 18, no. 4, pp. 263–273., 2015, doi: doi:10.7846/JKOSMEE.2015.18.4.263.

[50] E. Yuan, Zhihao; Nag, Rajat; Cummins, "Human health concerns regarding microplastics in the aquatic environment – From marine to food systems"," *Sci. Total Environ.*, doi: doi:10.1016/j.scitotenv.2022.153730.

[51] D. D. and O.-T. P. Khaled Ziani, Corina-Bianca Ioniță-Mîndrican, Magdalena Mititelu, Sorinel Marius Neacșu, Carolina Negrei, Elena Moroșan, "Microplastics: A Real Global Threat for Environment and Food Safety: A State of the Art Review," *Nutrients*, vol. 15, no. 3, p. 617, 2023, doi: https://doi.org/10.3390/nu15030617.

[52] P. M. García Rellán, Adriana; Vázquez Ares, Diego; Vázquez Brea, Constantino; Francisco López, Ahinara; Bello Bugallo,

""Sources, sinks and transformations of plastics in our oceans: Review, management strategies and modelling.," *Sci. Total Environ.*, vol. 854, doi: doi:10.1016/j.scitotenv.2022.158745.

[53] H. W. B. Xu, F. Liu, Z. Cryder, D. Huang, Z. Lu, Y. He and P. C. B. and C. T. Z. Lu, "Microplastics in the soil environment: occurrence, risks, interactions and fate–a review," *Crit. Rev. Environ. Sci.Technol*, vol. 50, no. 21, pp. 2175–2222, 2020, doi: Microplastics in the soil environment: occurrence, risks, interactions and fate–a review.

[54] M. A. A. E. Watt, M. Picard, B. Maldonado and M. M. and A. K. M. D. F. Mielewski, L. T. Drzal, "Ocean plastics: environmental implications and potential routes for mitigation – a perspective," *RSC Adv.*, vol. 11, pp. 21447–21462, 2021, doi: 10.1039/D1RA00353D.

[55] F. G. P. Alexy, E. Anklam, T. Emans, A. Furfari, H. S. and B. S. G. Hanke, A. Koelmans, R. Pant, and Kluettgen, "Managing the analytical challenges related to micro- and nanoplastics in the environment and food: filling the knowledge gaps," *Food Addit. Contam. Part A*, vol. 37, no. 1, 2020, doi: https://doi.org/10.1080/19440049.2019.1673905.

[56] H. L. J.-J. Guo, X.-P. Huang, L. Xiang, Y.-Z. Wang, Y.-W. Li and C.-H. M. and M.-H. W. Q.-Y. Cai, "Source, migration and toxicology of microplastics in soil," *Environ. Int.*, vol. 137, p. 105263, doi: https://doi.org/10.1016/j.envint.2019.105263.

[57] R. L. and G. N. W. Wang, H. Gao, S. Jin, "The ecotoxicological effects of microplastics on aquatic food web, from primary producer to human: A review," *Ecotoxicol. Environ. Saf.*, vol. 173, pp. 110–117., 2019, doi: https://doi.org/10.1016/j.ecoenv.2019.01.113.

[58] H. H. and P. M. M. Pirsaheb, "Review of microplastic occurrence and toxicological effects in marine environment: Experimental evidence of inflammation," *Process Saf. Environ. Prot.*, vol. 142, pp. 1–4., 2020, doi: https://doi.org/10.1016/j.psep.2020.05.050.

[59] "Introduction to tropical fish stock assessment."

[60] N. H. Welcomme R, "An international symposium on fisheries and society Budapest, Hungary 01-03 June, 2000.," *Fish. Mnag. Ecol*, vol. 85, pp. 283–462, 2000.

[61] H. Idossou, A. Clovis, and A. Montcho, "Understanding Overfishing : A Literature Review," vol. 26, no. 1, pp. 61–71, 2024, doi: 10.9734/AJFAR/2024/v26i1727.

[62] C. I. Arlinghaus R, Mehner T, "Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europ," *Fish Fish.*, vol. 3., pp. 261–316, 2002.

[63] L. D. Smith DR, Villela RF, "Application of adaptive cluster sampling to low-density populations of freshwater mussels.," *Environ. Ecol. Stat.*, vol. 10, pp. 7–15, 2003.

[64] J. Eilperin, "'World's Fish Supply Running Out, Researchers Warn.,'" The Washington Post.

[65] V. C. and S. Agboton, "Fishing activities in the South of lake Toho in Benin West Africa," *Int. J. Fish. Aquat. Stud.*, vol. 7, no. 4, pp. 239–245, 2019.

[66] E. G., "The Governance of Marine and Coastal Biodiversity in the Gulf of Guinea. Thesis and dissertation, University of NiceSophia Antipolis.," p. 175, 2009.

[67] E. Jones, "The Environmental and Socioeconomic Effects of Overfishing Due to the Globalization of the Seafood Industry".

[68] "WWF Annual Review 2006. Rep. World Wildlife Fund," 2013.

[69] "'Fisheries and Aquaculture.,'" *FAO FAO Home. Web.*.

[70] S. Cinner, Joshua E., Timothy R. McClanahan, Tim M. Daw, Nicholas A.J. Graham, Joseph Maina and and T. P. H. K. Wilson, "Linking Social and Ecological Systems to Sustain Coral Reef Fisheries."," *Curr. Biol.*, vol. 19, no. 3, pp. 206–12. Web., 2009.

[71] M. Foster, "'Bluefin Tuna Sells for Incredible Record $1.76 Million at Tokyo Fish Auction.,'" *Huffingt. Post*.

[72] and L. L. Giap, Dao Huy, Po Garden, "'Enabling sustainable shrimp aquaculture: Narrowing the gaps between science and policy in Thailand.,'" *Sustain. Prod. Consum. Syst. Springer Netherlands*, pp. 123–144, 2010.

[73] T. : Philippe M. Cury, Ian L. Boyd, Sylvain Bonhommeau, "Global Seabird Response to Forage Fish Depletion—One-Third for the Birds," *Science (80-.).*, vol. 334, pp. 1703–1706, 2011, [Online]. Available: https://www.jstor.org/stable/41352310%0D

[74] et al. E. K. Pikitch, C. Santora, 1 E. A. Babcock, A. Bakun, R. Bonfil, "Ecosystem-Based Fishery Management," *Science (80-.).*, vol. 305, pp. 345–347, 2012.

[75] Y. Du, J. Sun, and G. Zhang, "The Impact of Overfishing on Environmental Resources and the Evaluation of Current Policies and Future Guideline," vol. 586, no. Icprss, pp. 1120–1124, 2021.

[76] S. Warfield, "The Issue of Overfishing in the United States. The Issue of Overfishing in the United States | Department of English.," 2020, [Online]. Available: https://english.umd.edu/researchinnovation/journals/interpolations/fall-2020/issueoverfishing-united-states.

[77] B. Mansfield, "Neoliberalism in the oceans: 'Rationalization,' property rights, and the commons question. Geoforum," *Geoforum*, vol. 35, no. 3, pp. 313–326., 2004, doi: https://doi.org/10.1016/j.geoforum.2003.05.002.

[78] A. M. Duda, "Strengthening Global Governance of Large Marine Ecosystems by Incorporating Coastal Management and Marine Protected Areas," *Environ. Dev.*, 2015, doi: http://dx.doi.org/10.1016/j.envdev.2015.06.003.

[79] S. Zahedi, "Tourism impact on coastal environment," vol. 99, pp. 45–57, doi: 10.2495/CENV080051.

[80] D. A. Fennell, *Routedge Handbook of Ecotourism*, 2022nd ed. Oxon, 1999.

[81] D. G. Pearce, "Tourism and environmental research: a review," *Int. J. Environ. Stud.*, vol. 25, no. 4, pp. 247–255, 2007, [Online]. Available: https://doi.org/10.1080/00207238508710233

[82] L. Kelleher A. and Klein, "Global perspectives, a handbook for understanding global issues.," *Internet Arch. , Prentice Hall, New Jersey,USA.*, 1999.

[83] S. J. Craig-Smith, "Global warming and tourism in Oceania.," in *CABI Digital Library*, C. M. H. C. Cooper, Ed., Channel View Publications, 2004, pp. 353–361 ref. 13.

[84] R. Chawala, *Ecotourism planning and management, Sonali Publications, New Delhi, India*. Sonali Publicaion New Delhi India, 2006.

[85] A. and S. M. Lockwood, *Tourism and hospitality in the 21st century*, 2001st ed. Burlington: Elsevier, 2003.

[86] M. L. Narasaiah, *Tourism and development*, 2006th ed. Discovery Publishing House, 2007.

[87] M. J. Spalding, "The New Blue Economy : the Future of Sustainability," vol. 2, no. 2, 2016.