International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Ocean Resources and its Sustainable Development

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Abstract: ***The ocean is a vast and complex ecosystem that covers over 70% of the Earth's surface. It plays a critical role in regulating the Earth's climate, providing food to millions of people, and supporting a rich and diverse array of plant and animal species. This marine ecosystem provides a range of valuable resources to support human well - being and economic development. These resources include food, energy, minerals, and transportation, among others. The economic sector that conserves aquatic environment while using in a sustainable way to economic growth development refer as Blue Economy. The blue economy encompasses a wide range of sectors and activities, including fisheries, aquaculture, shipping, tourism, renewable energy, and biotechnology. The global fish market is worth billions of dollars each year. The ocean is a significant source of oil and gas, and offshore drilling is an essential industry in many countries. The oil and gas industry are worth trillions of dollars globally. The ocean floor contains a variety of minerals, including copper, nickel, and cobalt. These minerals are essential for a range of industries, including electronics and renewable energy. The ocean is a significant tourist destination, with many coastal communities relying on tourism for their economic development. Beaches, water sports, and marine life are some of the attractions that draw tourists to the coast. The economic development of marine biotechnology has put positive impacts. The development of marine biotechnology has also created new job opportunities in research and development and boost economy globally. This Blue economy is a concept that refers to the sustainable use and management of ocean resources to promote economic growth, social inclusion, and environmental sustainability. Sustainable use of this marine resources is critical for the long - term health and wellness of the ocean ecosystem and the people who depend on it. It is essential to manage these resources responsibly, balancing the economic, social, and environmental aspects of resource use.***

Keywords: Marine resources, Blue economy, Ocean resources

1. Introduction

Marine ecosystems support a rich biodiversity of plant and animal species, many of which are still undiscovered and poorly understood. They also play a vital role in regulating the Earth's climate and carbon cycle, producing oxygen, and supporting the livelihoods of millions of people who depend on marine resources for food, jobs, and cultural traditions [1]. The marine world plays a crucial role in regulating the earth's climate, supporting biodiversity, and providing resources and services that sustain human well - being [2].
The blue economy and the marine world are intricately linked and it provides a vast array of resources that are essential to human and the global economy [3]. Sustainable economic activities depend on the health and resilience of marine ecosystems [4]. The sustainable use of ocean resources can be contributed to economic development and poverty reduction, while protecting and conserving the marine environment.

The development of marine - based blue economy sectors involves various activities such as fisheries, aquaculture, tourism, renewable energy, transportation, and biotechnology [5]. For example, sustainable fisheries and aquaculture practices can provide a reliable source of nutritious food and create jobs for coastal communities.
Renewable energy technologies such as offshore wind, tidal and wave power can provide clean energy and reduce reliance on fossil fuels. Marine tourism can provide economic benefits to coastal communities while promoting conservation efforts.

Ocean is considered to be an important driver of economic growth [6]. Sustainable ocean based economic activities carried out are always depends on the resources found in the ocean. These resources includes both biological resources, such as fish, shellfish, and seaweed, as well as non - biological resources like minerals, oil, gas and renewable energy sources like wind, wave, and tidal power. It is important to manage these resources sustainably to ensure that they can continue to support economic activity in the long term, without causing harm to the ocean ecosystem.

2. Marine Resources

The ocean is among the most important natural resource confer upon mankind. It is categorized in two types i. e Biological and non - biological resources. Biological resources consist of living animals and plants which form an important food resource. Non biological resources are made of physical and chemical matter. Its physical form mainly consists of energy resources, and chemical form includes minerals and metal resources. These resources have help in upgrading economy of earth and generated various usable products [7] Fig.1.

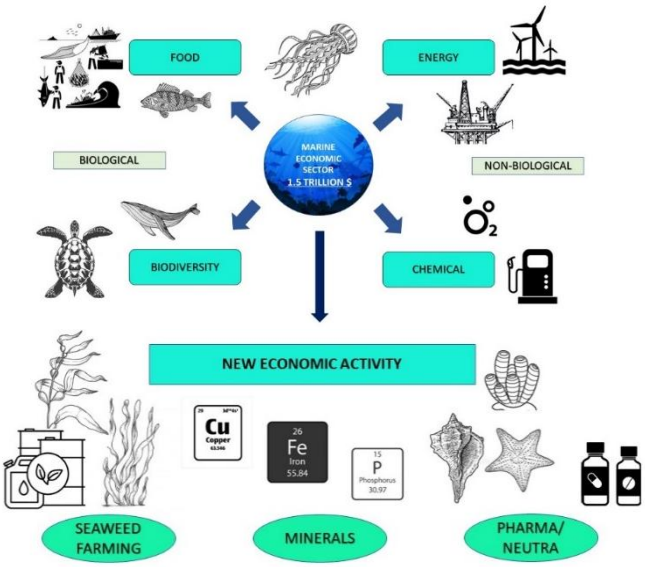

Figure 1: Schematic representation of Marine resources

Along with the biological and non - biological form of resources there are many other benefits we get from sea which also has made new avenues in commercial resources which includes cargo shipping, maritime transport, and recreational resources that are comprises of variety of tourism activity along the seashore or into the deep water.

2.1. Biological resource

Marine biological resources are live organisms found in the ocean and can be benefited to human beings. These resources include fishes, plankton, and algae served as food, as well as medicines or cosmetics derived from them.

2.1.1 Food

The ocean has always been a source of food for man. Food from the sea is mostly produced from the wild varieties of fish and the fishes farmed in the ocean (mariculture) accounts for 17% of global production of edible meat and their products [8]. The fishery and aquaculture sector are sources of income and directly contribute to their food security. Along with sources of protein, food from the sea also contains bioavailable micronutrients and essential fatty acids that are not easily found in land - based foods stock [9].

A) Fish

Fish has high - quality proteins. It is a source of omega - 3 fatty acid and vitamins like D and B2, rich in calcium and phosphorus, and a great source of minerals like zinc, iodine, magnesium and potassium. Docosahexaenoic acid (DHA) from fish is important for the functioning of nervous system and eye development [10]. Surimi is a paste from fish, a good source of omega - 3 fatty acid which aid in weight loss and to fight inflammation.

Apart from fin fishes' prawns, shrimps, cephalopods, bivalves are also commercially important shell fishes. Indian prawns have high economic value worldwide. Crab meat is often considered a delicacy and can be quite expensive, which is why it is highly prized by fish dealers and seafood enthusiasts. It has high protein contained and essential amino acids, vitamins and minerals.

B) Algae

Over a recent year there has been an increasing interest for sea weeds as food in many parts of country. Sea weeds are recognized by its nutritional value also many of them used as flavouring agent, colour pigments. Algal culture shows significant potential to overcome the challenge of increasing food demand. Some microalgae are cultivated for nutritional supplements in food additives [11]. They are primary source of Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA) for zooplanktons, fish and other multicellular organism.

2.1.2 Biodiversity

Biodiversity also mitigate climate change, supports human health and provides jobs. Together, biodiversity and healthy ecosystem increase resilience and serve as natural buffers against extreme weather events such as droughts, storms, and other disaster. Out of over 33 animal phyla known today, a total of 32 phyla are incorporated in the marine environment; out of these 15 varieties are exclusively marine [12. It serves as important repository of the world's biodiversity, contains approximately 300, 000 described species, which represent 15% of all described species [13].

Majority of bony fishes like blue fin tuna, snappers and mackerel's, cartilaginous fish like sharks, skates and rays, mammals like orcas, dolphin, dugon and manatee, reptiles like sea snakes, many crustaceans and molluscs are marine dwellers. There are few which either leave or enter seas for resting or breeding purposes, such as turtles, seals, penguins and iguanas. Corals and sponges attached to rock substratum or seabed are typically considered under the benthic communities. Sea birds also can be considered as marine fauna because they rely on fish for their food.

2.2 Non biological resource

Marine non - biological resources include minerals, salt, sand, gravels which can be drilled out for crude oil and gas hydranth. It also includes physical factor of sea such tides and waves. These resources can be broadly classified into energy resources and chemical resources.

2.2.1 Energy resource

Marine energy, also known as ocean energy or hydrokinetic energy or marine renewable energy source. The energy that is derived from the movement of water, including waves, tides, and ocean currents, known as physical energy. Energy can also be harvested from temperature difference of warm surface water and cold deep water to produce electricity, process known as ocean thermal energy.

A) Physical energy

Marine physical energy that can be harnessed from various physical processes occurring in the ocean, such as waves, tides, currents, and temperature gradients. It has a potential to provide a significant source of renewable energy and reduce reliance on fossil fuels.

i. Wind: Wind is a form of physical energy that is produced by the movement of air. Wind speeds over open ocean areas are often higher than over a land, these factors make offshore wind energy a promising source of renewable energy, which can be harnessed and converted into an electricity [14].

ii. Wave: The process of converting wave energy into electrical energy involves the use of wave energy converters (WECs) (Fig 2.), which are devices that convert kinetic energy from waves and into electrical energy. Some of the main areas where wave farming is carried out are Portugal, the United Kingdom, Australia, and the United States. Among all Portugal has the very first wave farm, the Agucadoura Wave Farm its about 3 miles offshore, north of Porto [15]. In 2010, United Kingdom also launched a wave farm in Scotland [16].

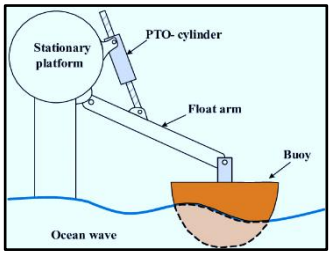

Figure 2: Wave energy convertor (Image source: Zhao A et al., 2019)

B) Thermal energy

It is an energy that is produced by the movement of particles within a substance. It is associated with the temperature of the substance, and can be harnessed and converted into energy form. Ocean thermal energy conversion (OTEC) is technology for producing energy by harnessing the temperature differences between ocean surface waters and deep ocean waters to power a turbine for producing electricity [17]. The by - product in the ocean thermal energy conversion is cold water i. e desalinated water which can further used for island communities where there is fresh water scarcity.

2.2.2 Chemical resource

Chemical resources are substance that can be extracted or synthesized for various application. Ocean is rich source of chemicals like metals, petroleum products or even source of oxygen we breath which have a wide range of application in medical, material science and in energy production.

A) Oxygen

It is always easy to think that, the world's forests as the planet's lungs where air get filter and a source of pure oxygen. The bigger the tree is, a more oxygen it releases in surrounding environment. But most of our breathable oxygen doesn't come from land but it comes from the oceans. It is fundamental to biological and biogeochemical processes in the ocean [18]. Scientist estimates that around 80% of oxygen is generated on the earth is solely comes from ocean. The majority of this oxygen generates from oceanic phytoplankton's, algae and some photosynthetic bacteria by the process of photosynthesis [19].

B) Petrochemical Fuel

The Petroleum and Petrochemical industry are home to the most traded commodity in the world, i. e., crude oil, is a fossil fuel 32% of crude oil and 24% of natural gas production comes from sea bed like coal and natural gas. Fossil fuel which is a hydrocarbon that were formed from the remains of plants and animals that lived millions of years ago is a carbon - rich substances, a raw material for fuel and a wide variety of products. Natural gas is primarily composed of methane, it also contains hydrocarbons [20]. Methane hydrates, also known as methane clathrates, are ice - like solid non - stoichiometric crystalline compounds. It forms when methane gas gets trapped in a lattice of water molecules at high pressures and low temperatures, such as those found in deep ocean sediments or permafrost regions. Methane hydrates are thought to be a vast potential source of natural gas, with estimates suggesting that there may be more methane trapped in hydrates than in all other fossil fuel sources [21]. Along with the production of fuel and natural gases it also serves as important raw material source in industrial and medical field.

i. Industrial: Petrochemicals are widely used in industrial applications due to their diverse range of properties. Petrochemical solvents, such as benzene, toluene, and xylene, are used in a variety of industrial applications, including paint and coating production, printing inks, and adhesives [22]. Monton wax are mineral wax are fossil - based waxes derived from derived from coal and ozokerite. paraffin, and microcrystalline waxes are known as hydrocarbon waxes and petroleum waxes from petrolatum. Paraffin waxes are typically obtained as a by - product during the production of lubricating oils [23]. Marine based bio - lubricants are also available in the market that can be used in shipping industry non - toxic to humans and other living organisms, especially in aquatic environments [24.

ii. Medical: Petrochemicals have a wide range of applications in the field of medicine. It is used in production of synthetic materials such as plastics and rubber, which are used to make medical devices such as syringes, catheters, and IV bags. Petrochemicals also play a role in the development of new medical technologies, such as biodegradable implants and nanoscale drug delivery systems.

2.3 Transportation

Marine transport drives 80 to 90 % global trade. Moving over 10 billion tons of containers, solid, liquid bulk cargo across the world's ocean annually [25]. Marine transport can move any good via waterway by ships. This marine transport sector has raising standards constantly for bigger ships to allow trading worldwide. The global marine transportation market size was valued at $54.51 billion USD in 2019 [26].

2.3.1 Shipping /cargo

Container transportation is one of important way to deliver good throughout different countries via water ways. The vastness of the use of this facility is due to many of its advantageous like, reducing the expenses of container traffic due to fast cargo handling, ensures the integrity and protection from harsh weather conditions, automated handling of container and warehouse modules which ensure the logistics [27]. In 2020 global cargo shipping market was 10.85 billion tons. The market is expected to grow from 11.09 billion tons in 2021 to 13.19 billion tons in 2028 [28].

2.3.2 Maritime transportation

Maritime transport refers to transportation of people via sea routes. The advantages of maritime transport are depended on its capacity and the continuity of its services. Ships, towboats, ferries and tugboats are the common marine transportation system. Maritime transport forms an

important part of economic activities that can create economic value added. The global market size of maritime industry was USD 168.56 billion in 2020, and it is projected to reach USD 188.57 billion by 2028 [29]. So massive importance is relied on maritime economic.

2.4 Recreation

Marine recreational activities such as fishing, diving and whale watching are economically vital to many countries, generating nearly $47 billion a year in expenditures and supported more than 1 million jobs [30]. Swimming in the ocean can provide a unique and exciting experience, with the waves, currents and forms popular ocean recreation. Snorkeling or scuba diving, is a form of diving in which the diver swims near the surface or at the bottom of the water.

2.4.1 Marine Tourism:

Marine environment has nowadays become a new frontier and fast - growing industries in world tourism. It has become a flourishing sector of tourism industry at global, national, state and local level. Marine tourism includes a range of recreational activities that occurs on or near coastal water area. It includes various recreational activities like marine based ecotourism, recreational fishing, snorkeling, diving, water sports activity, recreational boating and cruise (Fig 3.). Such ocean - based tourism economy accounts of $66 billion and earning and 2.5 million employments with $ 143 GDP per year [31].

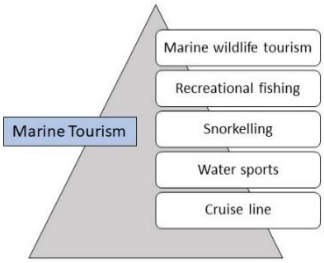

Figure 3: Schematic Diagram representing the Components of Marine Tourism

A) Marine wildlife tourism

Marine wildlife tourism is a type of tourism that involves visiting natural marine environments such as oceans and seas to observe and interact with marine wildlife. This can include activities such as whale watching, dolphin encounters, swimming with sharks, and snorkeling or scuba diving. It also embraces tourists to visits seal colonies, swimming with sea lions and manatees, as well as watching and swimming with whales and dolphins [32]. Observing animal species in the wild has increased with the 79 and 440 million number of participants, and estimated to double in next 50 year [33]. Marine wildlife tourism is a significant global industry that generates billions of dollars in revenue each year, the industry was valued at approximately $120 billion USD in 2019 [34].

B) Recreational fishing

Marine recreational fishing is quite popular globally specifically in western world and benefits coastal economies [35]. It is a kind of fishing using variety of gears like rod and line, bow and arrows and traps during leisure time and most of the catch is release back to the sea. People engage in such activities mostly for psychological outcomes. There are many psychological, health and nutritional benefits that seen in an individual participating in recreational fishing [36].

C) Snorkeling and diving

Snorkeling and diving are popular recreational activities that involve exploring the underwater world. Both snorkeling and diving are global business revenue generators. According to a report by Allied Market Research, the global scuba diving equipment market size was valued at $3.8 billion in 2019 and is projected to reach $5.1 billion by 2027.

D) Water sports activity

Water sports activities are a popular and growing industry that generates revenue through various means such as equipment sales, rentals, lessons, and tourism. One of the most popular water sports activities is surfing. The global surfing equipment market size was valued at $3.1 billion in 2020 and is projected to reach $3.8 billion by 2027 [37]. Water sports activities also contribute to the tourism industry, global GDP of 10.4% in 2019, with a total of $9.2 trillion in economic activity [38].

E) Cruise line

Cruise line is service industry where people travel on ship for their holidays the main purpose is to provide accommodation and entertainment onboard. Cruise line industry has been through lot of transformation. It was being a declining industry 1960's, now it has turned out to become the fastest growing segment in the tourism industry [39]. In 1980 four million passengers were recorded by the end of 2019 there was increase in number of tourists to 28 million. This industry has great potential to develop new cruise regions and help in growing economy from tourism and also providing jobs [40].

2.5 New economic activity

Ocean has already shown a great economic potential to meet the requirements for growing population worldwide. It also has an increasing demand in the field of food, energy and technology. Such new economic activities are in exploration so as to harnessed its benefits.

2.5.1 Algae or seaweed farming:

Demand for seaweed farming for the food, pharmaceuticals and agriculturally based industries has increased from 11, 561 million tons in 2005 to 28, 952 million tons in 2016 [41]. Seaweeds in its dry or wet biomass has been made into use in many applications which has help in boosting the economic importance. One of the supremacies of seaweed farming is its sustainable and inexhaustible nature. USA leads in algal production with 47% followed by China and New Zealand (Fig 4). According to a report by Mordor Intelligence, the global market for algal production was valued at $3.7 billion in 2020 and is expected to reach $5.7 billion by 2026 [42].

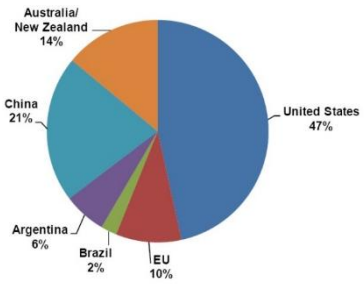

Figure 4: Algal production share by country 2020 (Image source: New Energy News, 2020)

Most of the seaweed cultivated, 80% processed to dry form, that can be used in production of carrageenan or as food supplements, and the wet form can be used in making fertilizers, extracting pigments and also in processing biofuels from it [43]. There are around 200 species of seaweed used, extensively for cultivation such as brown alga *Laminaria japonica*; red algae *Porphyra*, *Gracilaria* and green algae *Monostrema* and *Enteromorpha* [44].

A) Seaweed as food
Commercial production of seaweed has reached to a great height over past years, with variety of seaweed explored for food, animal feed, chemicals and dietary supplement. Pigments from alga are being used in the food industry as natural food colorants, most commonly used microalgae pigments in food are chlorophyll, astaxanthin and phycocyanin [45]. Blue pigments from *Spirulina spp*, yellow - red pigments from *Haematococcusspp* and yellow pigment extracted from *Dunaliellaspp* are produce extensively for application in food, pharmaceuticals, cosmetics and various industries [46]. Seaweed are packed with nutritious and a great source of protein, carbohydrates, fibres and polyunsaturated fatty acid. It also contain vitamins like C, B, A and E. It is rich in antioxidant and anti - inflammatory substances. In Japan annually 1.6 kg (dry weight) of seaweed is consumed as sea vegetable. *Porphyratenera* or *yezoensisspp*well known as nori is consumed largely in Japanese cuisine like sushi and onigiri, which are consider as delicacy [47]. seaweed has been an important part of the Japanese diet and culture for centuries. Others species of alga like *Gracilariaspp* and *Kappaphycusspp* are cultivated for chemicals like agar and carrageenan [48]. Annual consumption of seaweed in Japan is around 4.5 to 5 million tons and production of 389 k tons in 2018 [49]. Seaweed farming in India is a growing industry with significant potential for revenue generation. It has an market of approx. $150 million and gave employment over 1 million people [50].

B) Fuel
Microalgae are seen as third generation biofuel feedstock since they can grow rapidly and have ability to fix greenhouse gases. They have high lipid production capacity [51]. The most important aspect of microalgae is their ability to produce several different types of biofuels which has high lipid density, also they are good renewable type of energy [52]. Biofuels like bio methanol, biobutanol, biodiesel, bioethanol, biomethane, biohydrogen, and bio - oil are biofuel products from algal biomass [53]. Fatty acid produce by Scenedesmus obliquus in the presence antibiotic ofloxacin produces increased amount of saturated fatty acid (29%) to produce high quality bio diesel [54]. *Nannochloropsisspp* is good raw material for the production of biofuel with lipid content 28.7% [55]. Biofuels have become an increasingly important source of energy in India, with the government setting a target of achieving 20% blending of ethanol with petrol and 5% blending of biodiesel with diesel by 2030. This has led to a growing interest in the production of biofuels and related research in India. Biofuel policy in india has been successful in promoting the production, blending of biofuels in the country and to produce sustainable biofuel ecosystem [56]. India is currently the world's third - largest ethanol producer after the US and Brazil and has a significant biodiesel industry [57].

2.5.2 Mining of new raw material
The oceans hold a treasure trove of valuable resources. It contains a major amount and variety of geological processes within them. These processes results in the formation of variety of minerals. Marine mineral isaccumulating at or below the sea floor, from which metals, minerals and other elements can be extracted.

A) Minerals
Mineral resources from the marine realm includes sand, gravel and heavy mineral enrichments and occurrences of phosphorites. These are the resources of deep sea which forms the primary focus of marine resource exploration activities [58]. Recovery of such minerals from the seabed and possible exploration of new sources of marine minerals have developed rapidly during recent decades, yielding significant economic returns and promising potentially valuable additions to the world’s resource base.

Continental shelf of ocean contains valuable mineral resources, such zircon, monazite, manganese and cobalt nodules, gold placer, diamond, platinum, Sulphur, phosphorite etc. [59]. Sea also contain several type of construction material like sand and boulders. Monazite, a brown crystalline mineral formed by phosphates of cerium - group light rare - earth elements [60]. Monazites are present in metamorphic and sedimentary rocks and also in placer deposits. Monazite reserves are found in the coastal waters of India and also found in Sri Lanka, Australia, New Zealand, Brazil and USA [61]. Monazite is a rare - earth phosphate mineral. It is primarily mined for its rare earth content, which is used in a wide range of applications including electronics, catalytic converters, and renewable energy technologies. India has good reserve of monazite in the placer deposits near Kerala coast [62]. Australian coast is known for most heavy minerals and detrital rutile, zircon, ilmenite, and minor monazite placers along the coastline [63]. Phosphorites mixed in muds and sands from continental shelves and slopes, are found in nodule form, which are used in the manufacturing of phosphate - based fertilizers [64].

B) Freshwater harvesting
Safe and readily available fresh potable water is need for human health whether it is required for drinking or for domestic usage. Due to anthropogenic activity, there is depletion of fresh water supply Nowadays we are interested in desalination unit which can help to produce water suitable

for human consumption and irrigation [65]. This sector of blue economy that is gaining interest in harvesting freshwater from sea for water starved area.

2.5.3 Marine Based - Drug Discovery

The emergence of new diseases, drug - resistant strains of bacteria, and new targets for drug therapies requires the development of new bioactive molecules [66]. Marine environments represent a vast and diverse ecosystem hence genetic diversity is also very vast which renders chemical diversity which is promising for new drug development [67]. Marine drugs can be classified and manufacture as based on their action as pharmaceuticals and nutraceuticals

A) Marine pharmaceuticals

Marine Invertebrate groups like sponges, tunicates, ascidians, bryozoans, corals, and some molluscs, annelids, and echinoderms produce pharmacologically active substances which has been used in discovering new and potential drug [68]. Marine based pharmaceuticals have put great impact on modern pharmacology and different types of drugs extracted from marine animal and are approved for use such as cytarabine, vidarabine, ziconotide and trabectedin. Marine drugs like Ziconotide, a painkiller which are derived from the venom of the cone snail. Ara - C compound found in a marine sponge is use in cancer treatment. Trabectedin a chemotherapy drug derived from a tunicate, a type of sea squirt. Halaven a chemotherapy drug derived from a compound found in a sea sponge.

B) Nutraceuticals

The concept of nutraceuticals was given by Stephen DeFelice in 1989 by combining nutrition and pharmaceuticals, nutraceuticals are product derived from food sources with extra health benefits. These bioactive compounds include some polysaccharides, peptides, phytochemicals, vitamins and fatty acids which are naturally present in the food Omega - 3 fatty acids that are found in certain types of fish, such as mackerel, tuna, and sardines. They have shown to have health benefits, it helps in reducing inflammation and also in improving heart health [69]. Seaweed is rich in minerals, such as iodine, calcium, and iron, as well as antioxidants and other bioactive compounds, are good for gut health and also possess anti - cancer properties [70]. Marine collagen is a type of protein that is derived from the skin and scales of fish. It has been shown to have benefits for skin health [71]. Carbamide Forte a commercially available Marine Collagen, is a supplement that contains hydrolysed marine collagen peptides. Carbamide Forte claims to support joint health, improve skin elasticity and hydration, and promote healthy hair and nails. It is important to ensure that the harvesting of marine organisms for nutraceuticals is done sustainably and with minimal impact on the marine environment to ensure the long - term availability.

3. Threats to marine environment and its conservation

The quote "If the ocean dies, we die" is often attributed to Paul Watson, a marine conservation activist. The quote emphasizes the critical role that the ocean plays in supporting life on Earth, including human life. The ocean is not only a source of food, energy, and other resources, but it also provides vital ecosystem services such as regulating the global climate, producing oxygen, and supporting biodiversity. There are a number of threats to the marine environment, and these threats can have significant impacts on marine life, coastal communities, and the global economy.

Overfishing is a major threat to the marine environment, as it can lead to declines in fish populations and harm the health of the entire ecosystem. Conservation efforts to address overfishing include implementing catch limits, promoting sustainable fishing practices, and establishing marine protected areas where fish populations can recover [72].

Pollution in the form of plastic waste, chemicals, and other contaminants can harm marine life and ecosystems. Conservation efforts to address pollution include reducing single - use plastics, improving wastewater treatment systems, and promoting responsible use and disposal of chemicals. Plastic waste like fishing gears can entangle and kill fish, while chemicals release from plastics like polychlorinated biphenyls can affect their reproductive capabilities, even make them unsafe to eat [73]. Chemical pollution can have a significant impact on coral reefs and mangroves. Exposure to chemicals can lead to coral bleaching and harm the growth and reproduction of mangrove trees. As mangroves habitat provides nursery grounds for many fish and shell fish species. These areas offer protection from predators and provide an abundant source of food for juvenile fish. Destruction of such mangrove forests can have a significant impact on these nursery grounds. Ultimately it will lead to decline in fishery production.

Climate change is having significant impacts on the marine environment, including ocean acidification, sea level rise, and changes in ocean currents and temperatures [74]. Conservation efforts to address climate change include reducing greenhouse gas emissions and combustion emission for better air quality [75], promoting renewable energy sources, and protecting and restoring coastal habitats that can help to mitigate the impacts of climate change.

Habitat loss and degradation can result from coastal development, reclamation, and other human activities [76]. Conservation efforts are essential to protect and restore marine habitats and its biodiversity. One way to conserve marine habitats is to establish marine protected areas. These are the areas of the ocean that are set aside for conservation purposes and fishing related activities are prohibited [77].

4. Economy of marine resources

Marine economic development is a process of developing and utilizing the economic potential of the oceans, coasts, and other marine resources. This includes a wide range of activities such as fishing, aquaculture, shipping and transportation, offshore energy production, tourism, and biotechnology. The oceans and coasts are a vast resource with great potential for economic development. According to the Organization for Economic Cooperation and

Development the ocean economy is estimated to be worth over $1.5 trillion and is projected to double by 2030 [78].

The fishing industry is one of the most important marine resource - based industries, providing food and livelihoods for millions of people worldwide. The global seafood trade is worth billions of dollars each year, with countries like China, USA, and Japan being the largest consumers of seafood. FAO's report namely 'The state of world fisheries and aquaculture' analyses the status of global stocks as well as trends in fisheries and aquaculture. The report encompass work on aquatic food system from 2022 to 2023, which is a road map for blue transformation for sustainable fisheries. Coastal tourism is a significant component of the blue economy as it generates substantial revenues, creates jobs, and supports the economies of many coastal communities [79]. Coastal tourism is an important sector for India's economy, as the country has a long coastline of over 7, 500 km. According to the Ministry of Tourism India, the contribution of tourism to India's GDP in 2019 was 9.2%, and coastal tourism plays a significant role in this. In 2019, the total revenue from tourism in India was around $28 billion [80]. Globally, coastal tourism is a significant industry, and it is estimated to be worth around $7 trillion [81].

Marine mineral resources are important for the world's population as they are used in the manufacturing of a wide range of products that are used in our daily lives like copper a key component of electrical appliances, phosphate base minerals used in making fertilizer, gravels and stones in construction. The global market for marine minerals was estimated to be worth around $16 billion by 2022 [82]. In terms of fuel resources, the global revenue from offshore oil and gas exploration and production was estimated to be around $330 billion in 2019 [83].

The fishery industry faces a number of challenges, due to pollution, and climate change [84]. These issues have significant impacts on fishery and the overall health of the marine environment, which in turn can impact fishery revenues. To address these challenges, there is a need to focus on sustainable fishing practices and aquaculture, which aim to ensure the long - term viability of the industry [85].

Also, it is essential to manage these coastal activities sustainably to ensure long - term economic benefits while minimizing negative impacts. Sustainable coastal tourism management practices include measures such as waste management, sustainable transport, energy - efficient buildings, and the protection of natural and cultural resources [86].

Agriculture and fishery are both important sectors in the global economy, and they contribute significantly to the revenue of many countries. While both sectors involve the production and sale of food products, they differ in terms of the types of products they produce and the methods used to produce them. In 2021, the global agricultural market was valued at approximately USD 217.24 billion [87] and fishery market was valued at approximately USD 310 billion [88].
Top Fishery and aquaculture producers in the world include China, Indonesia, India, Vietnam, and the United States [89]. Fisheries sector is an important contributor to the Indian economy, both in terms of employment and revenue generation. India has a long coastline of about 7, 500 kilometres and an extensive network of rivers, lakes, and other water bodies, which provide abundant opportunities for fisheries [90]. According to the Ministry of Fisheries, Animal Husbandry and Dairying, the fisheries sector in India provides employment to over 16 million people [91].

In addition to employment and food security, the fisheries sector also contributes to the economy through exports. India is one of the largest exporters of fish and fish products in the world, exporting to countries such as the USA, China, and Japan [92]. India's department of biotechnology provides funding for research and development in various areas of biotechnology, including biomedicine, agriculture, bio - energy, and environmental biotechnology. Fellowships are given by such bodies to support research projects in biotechnology, includes basic and applied research in healthcare. in a view of above new drug discovery has the potential to boost economic growth in India.

India has emerged as a major player in the global fisheries sector in recent years. After China and Indonesia, total fishery market in India is around 14 million metric tons per year [93]. As of 2021, India has become the third - largest fish producer in the world, taking Brand India from 'Local to Global' [94].

The Indian fisheries sector has been recognized as a "Sunrise Sector" by the government [95], and it has demonstrated an impressive growth rate in recent years.

In the financial year 2021 - 22, the Indian fisheries sector achieved a record fish production of 161.87 lakh tons [96]. This represents a significant increase in production compared to previous years, driven by increased investment in the sector, adoption of new technologies, and favorable policies by the government.

The growth of the Indian fisheries sector is closely linked to the sustainability of the sector, which requires careful planning and management of resources. Sustainable management of fisheries involves ensuring that fish stocks are not overexploited. Such overexploitation can be caused by Purse seine operation where fish stocks can be caught without proper guidelines, particularly if they are used to catch juvenile or undersized fish.

It is important to enforce strict laws and regulations governing the use of purse seine nets, particularly to prevent illegal fishing practices that can harm the marine ecosystem.
Pollutants can harm fish stocks directly, as well as indirectly through the degradation of their habitats and food sources. Such pollution can be caused by a range of factors, including untreated sewage, industrial waste, and micro plastic pollution. Such microplastic can be present in water from 0.001 - 140 particles/m3 can bioaccumulates in animal tissue and ingestion caused blockage of digestive tracts of marine animals [97].

To ensure the long - term sustainability of the Indian

fisheries sector, it is important to develop and implement policies and programs that address challenges caused by pollution and overexploitation of resource. This could involve improving water quality in the coastline by treating sewage and reducing industrial waste, as well as promoting sustainable fishing practices, such as the use of selective fishing gear, and reducing by catch.

By protecting the marine ecosystem, including fish stocks and other marine species, we can not only ensure the sustainability of the fisheries sector but also source of many potential medicinal products that can be used to treat a variety of human diseases. The loss of marine biodiversity can have far - reaching consequences for chemical ecology, because marine organisms produce unique and complex chemical compounds as defense mechanism to get adapt in environment. Overall, marine chemical ecology offers a wealth of opportunities for the discovery of new drugs and natural products.

Marine - based pharmaceuticals and nutraceuticals products industry is still relatively small but its an emerging industry. This industry expected to grow in the coming years due to increasing demand for natural and sustainable sources of medicine and nutrition [98].

According to a report by Grand View Research, the global market for marine - based nutraceuticals was valued at $3.6 billion in 2020 [99]. The market for marine - based pharmaceuticals is also expected to grow in the coming years, the global marine - derived drugs market was valued at $4.4 billion in 2020 [100]. Recent scientific publication that demands for research marine - based drugs in the field of nutraceuticals and pharmaceuticals is demanding due to their unique chemical structure and biological activities. Therefore, it is important to preserve the marine environment through sustainable fishing practices, conservation efforts and the reduction of pollution to ensure the long - term viability of marine - based drug discovery and production.

Finally, it is important to preserving the marine ecosystem as it is essential for protecting the health and well - being of both humans and the environment. It requires a collective effort from governments, organizations, and every single individual around the world to take action to reduce the negative impacts on the ocean and promote sustainable practices.

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