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# Human Impacts on Coral Reef Ecosystem

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## Abstract

Healthy, Coral reefs are the most spectacular, diverse and economically valuable marine ecosystems on the planet, Complex and productive, coral reefs are extremely important for biodiversity, providing a home to 35,000–60,000 species of plants and animals (over 25% of all marine life), many of which are undescribed by science. They are also vital for people and business. They provide nurseries for many species of commercially important fish, protection of coastal areas from storm waves. They are providing hundreds of billions of dollars in food, jobs and significant attraction for the tourism industry. Yet coral reef ecosystems have undergone phase shifts to alternate, degraded assemblages because of the combined human activates of unsustainable overfishing, intensive tourism, urbanization, sedimentation, declining water quality, pollution and primarily from the direct and indirect impacts of climate change. Most coral ecologists confirmed that coral reef degradation has increased dramatically during the last three decades due to enhanced anthropogenic disturbances and their interaction with natural stressors. So, it is necessary to recognize the threats facing coral reefs from anthropogenic activities and try to minimize and mitigate these impacts.

**Keywords:** coral reef ecosystem, anthropogenic activities, natural threats, climate change, coral protections, proposed solutions

## 1. Introduction

Coral reefs are extraordinary living geological diverse underwater held together by calcium carbonate structures secreted by corals. They are represent the most conspicuous and magnificent community in the tropical and subtropical regions. Coral reefs are built by colonies of tiny living animals found in shallow subtidal marine waters that contain few nutrients. Most coral reefs are built from stony corals, which in turn consist of polyps that live together in groups. The polyps belong to a group of animals known as Cnidaria, which also includes sea anemones and jellyfish. The polyps secrete a hard carbonate exoskeleton which support and protect their bodies. Most reefs grow best in warm, shallow, clear, sunny and agitated waters. The oldest coral reefs on the earth were occurred about 500 million years ago, as well as the first relatives of recent corals developed in the south of Europe from about 230 million years ago. Most corals get their color from the symbiotic single-celled algae called zooxanthellae. Millions of these single-celled algae are living as symbionts within polyp tissues, intercellular in the gastrodermis layer. Zooxanthellae produce organic nutrient and oxygen through photosynthesis thus helping the coral in the growth and the process of producing limestone or calcium carbonate. Corals grow much

faster with the help of the zooxanthellae. Coral get up 90% of their nutrient from their zooxanthellae. Zooxanthellae produce pigments visible through the clear body of the polyp and give the coral its beautiful color [1, 2].

Coral reefs provide a home for at least 25% of marine origin fauna, including fishes, echinoderms, crustaceans, mollusks, sponges, tunicates, and other cnidarians and so on. Coral reefs ecosystem provides many services to tourism, fisheries in addition to coastline protection from wave action. The global economic value of coral reefs ecosystem is estimated between US \$29.8 and 375 billion per year. However, coral reef is fragile ecosystem, because it is very sensitive to elevations of water temperature. Coral reef ecosystems are exposed many threats most of them resulted from humans such as global warming, oceanic acidification, climate change, water pollution, Irrational tourism, blast fishing, overfishing, illegal fishing for aquarium fish, overuse of reef resources, harmful land-use practices including urbanization and agricultural runoff which may be harmful for reefs by enhancing algal overgrowth [3, 4].

Coral reef ecosystem degradation has increased dramatically during the last three decades due to enhanced anthropogenic disturbances and their interaction with natural stressors [5]. These stressors are thought to cause coral diseases and bleaching leading to a loss of coral cover. Unfortunately, very little is currently known about the prevalence, distribution and pathology of coral disease in the Red Sea [1, 6].

The annihilation of reef ecosystem will lead to disappear of 25% of marine habitats, and quarter of marine life that needs to productive and diversified this three-dimensional building to stay alive. Graham et al. [7] found a serious decline in coral reef fish populations as a result of climate change. Coral reefs provide a food and a source of income for hundreds of millions of people scattered in many countries. The loss of this ecosystem will lead to unexpected effects with serious damages already begun to appear. It has been estimated the volume of services and natural resources offered by the coral reefs to humanity from 10 years ago by about US \$30 billion per year, through the benefits such as fisheries, tourism and shore protection, and perhaps greatly increases about it now [8]. The mass coral bleaching and death of CRE is one of the most obvious effects of climate changes which warn us the world seriousness which we receive it with the climate warmness. The lost of the oceans to the most if not all effective CREs could be lead to unexpected disaster. Unfortunately, this disaster on the verge of us today, but it can be avoided if the necessary international efforts are combined for adverse impact mitigation [9].

## **2. The main components of the coral reef ecosystem**

Coral reefs form some of the world's most productive ecosystems, providing complex and varied marine habitats that support a wide range of other organisms. The coral reef ecosystem is a collection of diversified communities which interact together and with the environment. The primary source of energy for any ecosystem including coral reef is the sun. Phytoplankton, algae, and other plants use the sun light to do the photosynthesis. During the photosynthesis, the light energy from the sun in the presence each of water and nutrients is converting into chemical energy. The chemical energy that made by photosynthesis is passed from plants to animals then other animals then to simple nutrients by bacteria analyzing in what is called food chain. Although, the corals are the main organisms that form the basic structure of reef ecosystem, however, the members of all other animal phyla and classes may be found on coral reef, in addition to the significant role for certain species of algae in reef formation. The following is a short summary to the more important and abundant group shared in coral reef composition [9, 10].

1. **Algae:** Coral reefs are chronically at risk of algal encroachment. Overfishing and excess nutrient supply from onshore can enable algae to outcompete and kill the coral. There are three groups of algae, these are:
  - a. **The coralline algae:** These groups are very important in constructing and maintaining reef. They are belonging to the red algae, and can precipitate calcium carbonate as do corals, but tend to be encrusting and spreading out in thin layers over the reefs, cementing the various pieces of calcium carbonate together. These algae form what is called “the algal ridge” on reef which is the most rapidly calcifying zone on reef.
  - b. **Calcareous green algae:** These algae include certain species of green algae, such as *Halimeda*, which grow erect and secrete calcium carbonate, giving much of reef sand by breaking up.
  - c. **Other free living algae:** They include the free living algae exist just below the surface layers of calcium carbonate in the coral colonies themselves but are inconspicuous on the reef.
2. **Members of phylum Cnidaria**
  - a. **The stony corals:** These groups are belonging to Order Scleractinia (*Madreporaria*) and form the major structure of reefs.
  - b. **Order Gorgonacea:** Its members are commonly called sea fan and sea whip, which have an internal skeleton of spicules. They are abundant in Atlantic Ocean.
  - c. **Order Alcyonacea:** This order comprises the soft corals, which may be abundant in some Indo-Pacific regions than the stony corals, but very rare in Atlantic. Several species of soft corals have internal spicules of calcium carbonates.
  - d. **Order Hydrocorallina:** It includes the hydrocorals, which are belonging to the class hydrozoa, and called “Fire corals,” for their powerful nematocysts. The hydrocorals are conspicuous in Atlantic Ocean.
3. **Mollusca:** Mollusks have significant role in reef formation due to the ability of their species for calcium carbonate deposition. The most important of mollusk are the giant clam, *Tridacna* spp. and *Hippopus* spp. which may be up to 2200 individuals per square meter. Also there is a prominent role of other gastropods and bivalves in deposition of  $\text{CaCO}_2$  at the coral reefs.
4. **Echinodermata:** Some species of echinoderms have adverse effect on coral reef, particularly the sea star, *Acanthaster planci*, which predate the coral polyp and causing coral bleaching. However, other species of sea urchin, sea cucumbers, starfish and feather stars are found but their role in reef ecosystem is understood.
5. **Crustaceans and Polychaetes:** Members of these groups are very abundant on coral reefs but with little information about their role in reef formation.
6. **Sponges:** They are essential for the functioning of the coral reefs ecosystem. Algae and corals produce organic material. This is filtered through sponges

which convert this organic material into small particles which in turn are absorbed by algae and corals. It was recorded that, some species of Siliceous sponges (class: Demospongiae) may be important in holding coral and rubble together, and prevent loss from reef until it can be fused together by coral-line algae. Other sponges have symbiotic blue green algae responsible for net primary productivity.

7. **Coral reef fishes:** Fishes are very conspicuous and abundant and many of them may have an adverse effect on coral structure due to their feeding regime.

8. **Bacteria:** The role of these organisms is very important in reefs structures. This group is very abundant and is responsible for the decomposition and quick cycling of organic matter.

9. **Other communities:** Sea eels and snakes as well as marine birds; such as boobies, pelicans, gannets and herons, all feed on fish and other coral reef components. Land-based reptiles such as monitor lizards in addition marine crocodile and semiaquatic snakes as *Laticauda colubrina* can be intermittently associated with reefs and feed on some their components. Sea turtles, such as hawksbill sea turtles, feed on sponges between reefs.

### 3. The importance of the coral reef ecosystem

Coral reef ecosystems are one of the most diverse and beautiful natural environments on earth. Coral reefs have an important role in the marine and coastal environments. They provide valuable habitat (food and shelter) for a great diversity of plants and animals, including important breeding and nursery grounds for many marine organisms [10].

Coral reefs also provide protection from coastal erosion by acting as natural breakwaters for big waves and storms. Also, the breakdown of corals and other organisms living in the reef habitat creates beaches, which are an important resource for the survival of many coastal organisms, including endangered sea turtles and monk seals. Coral reefs are an important environmental and economic resource for people. In addition to shoreline protection, reefs provide food, recreational and employment opportunities, and are a potential source for new medicines [11, 12]. Coral reefs also provide economic benefits to coastal communities from tourism. The major benefits from coral reef ecosystem will be describing in the following lines:

#### 3.1 Reef as an income sources

The diversity of marine life and coasts protected and supported by coral reefs supply an attractive conditions and ambience for visitors, reef lovers, divers and snorkelers. Actually, there are more than 8.5 million certified divers in the USA who spend the money on diving during each year. The coral reef destruction generates a considerable loss of tourism employment, marine recreation industries and fishing activities. These can has huge impacts on inhabitants of coral reef areas that essentially rely on income from tourism [13, 14].

Coral reefs ecosystem has also a significant protein source for millions of people. The people inhabiting coral reef areas madly love coral reef, because of the coral reef

is considered as a part of their life, providing them with the major part of their food through fishing and tourism services. Coral reefs are also strongly linked with cultural, spiritual and traditional values of many people who live in reef nearest areas [10].

### **3.2 Coral reefs act as protector from storm and wave action**

The people receive another benefit from coral reefs is that they are act as the guard keep on our coast. They serve as a buffer and protection for the shore areas from the pounding of ocean waves. In the absence of coral reefs, many of beaches and coastal cities would become vulnerable to storm damage and wave action. In the Maldives, when the coral reef and sand was mined away the coast, it expense \$10 million American dollars for each kilometer to construct a wall for coastline protection. In Indonesia, the value of this protective service of coral reefs is estimated at 314 million American dollars [15].

### **3.3 Coral reefs save our lives**

Just as in the rainy forest species, the plants and animals life in reef ecosystem contain promising medicinal components, several of which are just being detected. Already, many important drugs have been developed from chemicals extracted from coral reef organisms. AZT is the most famous of these drugs, it is a treatment for HIV infections, which is rely on chemicals extracted from sponge inhabit Caribbean reef [16].

Several unique compounds extracted from coral reefs have also produced the treatments for skin cancer, leukemia, ulcers and cardiovascular diseases. In addition, the unique skeletal structures produced from reef have been used to produce the advanced forms of bone grafting materials. Surprisingly, more than half of all new research related cancer drug discovery focuses on marine organisms. The fragile and beautiful organisms of coral reefs have the potentiality to make even huge contributions to our lives through providing new treatments for diseases threats to our life [11, 12].

### **3.4 Coral reefs serve as a home for fishes**

Over the last 350 million years, coral reefs have developed to become one of the most and large complex ecosystems on the earth planet. Coral reefs provide shelter for about 25% of all known marine species. They serve as a home to 4000 fish species, 700 corals species and thousands of other forms of flora and fauna. The ecologist estimate that more than one million of biota species are associated with the coral reef ecosystem [15, 17].

## **4. Global threats facing reef ecosystems**

Coral Reef ecosystems are facing many of natural and anthropogenic threats. Many human impacts are resulting in the destruction and degradation of coral reefs ecosystem to cause biodiversity loss, fundamental supplies for food and reef economic revenue. Combined with threats from nature in the form of diseases, earthquakes, climate change, typhoons and storms; coral reefs are combating to survive. Natural stressors are increased worse by human disturbances. For example, the diseases may be presence at a higher level in corals stressed by human influences such as pollution and mechanical damage [18].

A majority of the problems threatening coral reefs are the direct (and indirect) result of human activities on land, and in the marine environment. Marine debris, water pollution, sedimentation, overfishing, careless recreation, and global warming are some examples of human-caused threats to the coral reef habitat. Each of these threats has a significant impact on the health of coral reefs. Coral reefs grow very slowly and can take hundreds of years to form. If damage to coral reefs continues at the current rate, over half of all reefs in the world could disappear in our lifetimes. Currently, millions of acres of reef have already been severely damaged or destroyed. Through education, awareness, and action, people can help to preserve and protect coral reefs [15]. The threats facing coral reef ecosystems can be summarized as below:

#### **4.1 Natural Impacts**

##### *4.1.1 Earthquakes and storms*

Disasters such as earthquakes and storms are occurred periodically and naturally and devastate massive areas of coral reefs. These natural events can be more severe if the communities of coral reef are already weakened by other influences and recovery is inhibited by algal overgrowth due to the lack of grazing organisms, removed by fishing.

##### *4.1.2 Climate change and acidification*

Climate change impacts have been identified as one of the greatest global threats to coral reef ecosystems. If the temperatures of sea water stay higher than the usual for some weeks, the symbiotic algae “zooxanthellae” that corals rely on it for their food leave the coral tissue. Actually, without zooxanthellae the corals turn to white color, because it gives corals their color. Unhealthy white corals are called bleached. Bleached corals are weak and loss their ability to combat diseases and then die [18]. As climate change continues, bleaching will become more common, and the overall health of coral reefs will decline [19, 20].

Since the late nineteenth century, the global temperature of oceans has risen by 1.3°F (0.74°C), causing more frequent and severe corals bleaching around the world. At the recent increasing of the emissions rate of greenhouse gases, the global temperature could rise up to 7.3°F (4.1°C). These changes in global temperature have already harmful effects on coral reef ecosystems and will continue to impact on coral reef ecosystems over the world during the next century. The decline and loss of coral reef ecosystems have significant social, cultural, economic, and ecological bad impacts on people and communities around the world [21].

As water temperature rise, infectious diseases and huge bleaching may be likely to become more frequent. In addition, carbon dioxide absorbed into the sea water from the atmosphere has begun to reduce the calcification rates in reef-building corals and organisms associated with coral throughout change of water chemistry by decreases in pH (ocean acidification). At the long term, the failure in carbon emissions addressed and the impacts of rising water temperatures and ocean acidification could make the several efforts to coral reef ecosystems managements are futile. A summary of the above, the climate change and ocean acidification have been identified as the most important threats to CRE on a global basis [22].

In the last decades, 33–50% of corals were significantly degraded, because of the negative impacts that accompanied with climate changes [10]. Newly, some areas have lost about half or more of its living coral and more deterioration can be occur over the next two decades due to continued temperature rise. Because of

the destruction of the CRE, 25% of marine species would be in danger while the economic losses will showcase hundreds of millions of people to the lack of food security and increasing poverty [23]. Wilkinson [10] was recorded bleaching and death of about 16% of the global reefs communities together with high average of surface temperature in 1998. Since then, the bleaching and death of coral occur on a large scale, with increasing severity of these effects over the successive decades [24].

The annihilation of reef ecosystem will lead to disappear of 25% of marine habitats, and quarter of marine life that needs to productive and diversified this three-dimensional building to stay alive. Graham et al. [7] found a serious decline in coral reef fish populations as a result of climate change. Coral reefs provide a food and a source of income for hundreds of millions of people scattered in many countries. The loss of this ecosystem will lead to unexpected effects with serious damages already begun to appear. It has been estimated the volume of services and natural resources offered by the coral reefs to humanity from 10 years ago by about US \$ 30 billion per year, through the benefits such as fisheries, tourism and shore protection, and perhaps greatly increases about it now [8]. The mass coral bleaching and death of Coral reef ecosystem is one of the most obvious effects of climate changes which warn us the world seriousness which we receive it with the climate warmth. The loss of the oceans to the most if not all effective Coral reef ecosystems could be lead to unexpected disaster. Unfortunately, this disaster on the verge of us today, but it can be avoided if the necessary international efforts are combined for adverse impact mitigation [9].

Other reasons for coral bleaching are the extreme lowering in tides levels, increased UV radiation and changes in salinity and nutrient levels. Coral reefs may recover but this extreme incident is generally presumed to be weakened it. The death may be occurring largely due to starvation, although it is thought that some autolysis (tissue destruction) occurs. The physiological mechanisms involved with bleaching are not fully understood and are currently a source of investigation.

#### *4.1.3 Crown-of-Thorns*

Historically, tropical cyclones and poor water quality that cause outbreaks of crown of thorns starfish have been the major causes of coral loss. Current increases in the Crown-of-Thorns starfish populations that eating coral are considered as another natural threat to reefs. When occurred in huge numbers, these stars are able to destroy massive areas of coral reef. Recovery of the coral reef from the outbreaks of Crown-of-Thorns may take up to 20–40 years, whereas the damage is not severe. However, coral recovery in some world areas may never occur when the coral is being taken over by sponge, algal cover and other coral species. *Acanthaster planci* can produce many million babies during 1 year. People has participated to their population increase through increase the nutrients from sewage and over harvesting of their natural predator Triton Trumpet and so on. Crown-of-Thorns babies gave more plant food (seaweed) for to survive and become to devastating adults for coral [25].

#### *4.1.4 Coral diseases*

Predominantly, coral reefs when are under stress, they suffer many of bacterial infections as a result of growing production of protective mucus. The coral production for excessive mucus due to natural and man-made influences (e.g., global warming, toxic chemicals, increased sedimentation and so on) can also promote many of blue green algae to grow, this algae thought to be responsible about black band disease (Intense black band of filaments across coral colonies). This disease



kills the Coral polyps and the black band advances then leaving the reef as a white limestone behind it [16].

Although this disease is rare, but the pathogenic bacteria and parasites resulting from fecal contamination may cause some disease in coral reefs, particularly if corals are stressed by unfavorable environmental conditions. Naturally, the diseases occur for corals in healthy ecosystems, but the pathogen-containing pollution inputs could exacerbate the intensity and frequency of disease outbreaks [16].

A change of environmental conditions such as higher temperatures or a change in salinity but also disease can cause the polyps to expel the zooxanthellae algae. The coral becomes totally white (= coral bleaching). If the coral regains some algae it might survive, but bleaching can be irreversible and then the coral dies. Coral bleaching is the loss of intracellular endosymbionts (zooxanthellae) from coral tissue, when corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn completely white [2].

#### *4.1.5 Invasive alien species*

Alien invasive species are non-native (exotic) species that may cause huge environmental damages and can effect on fisheries stock, economy and even on human health. It should not be confused between them and introduced species which are also non-native and have been deliberately introduced for a benefit or purpose within the limits imposed on them. It is estimated that of the several introduced species to different habitats and different climes have threats to native ecosystems. These alien invasive species have the ability to rapidly grow, vigorously compete with the native species. These species in the absence of their natural predators can be led to pushing out native species and finally to ecological havoc. They can be able to change and threaten native biodiversity and participate to economic hardship and social instability, placing constraints on environmental conservation, economic growth and sustainable development [26]. Actually, the threat to global biodiversity from Invasive Alien Species is the second after habitat destruction. Ballast water is the major channel of spreading Invasive Alien Species in marine habitats. Ships discharge their cargo of ballast water at ports, with this discharge; they also release organisms that were taken in accidentally with the ballast water from other ports [27].

## **4.2 Anthropogenic impacts**

### *4.2.1 Use the coral reefs in construction and curio trade*

Coral reefs are used as a construction tool for many purposes. They may be used for the construction of house foundations, canals, streets, embankment of fish ponds and lime kilns. Large businesses also are keen on collecting coral reefs for selling them as a souvenirs or the aquarium trade.

### *4.2.2 Chemical pollution*

Coastal waters suffer from huge amounts of a variety of agriculture and industry chemicals that released into them. Fertilizers and pesticides which used in agricultural development projects are discharged to the sea and might lead to coral reef destruction. Pesticides pollution may destroy or harm to reef communities. They lead to further deterioration through accumulating in tissues and may affect physiological processes of animals. Herbicides may impact the basic food chain; they can

destroy and damage symbionts zooxanthellae algae in coral reef, other algal, sea grass and even free living phytoplankton communities.

The chemicals spillage from oil tankers, harbors and pipelines have heavy impacts on feeding, growth rate, reproduction, defensive responses and even on cell structure in coral reefs. Industrial activities such as dredging, mining and refining produce heavy metals and hydrocarbon pollutants that release into coastal waters. Many coral species are more sensitive to these pollutants, which can be damage the ecosystem of coral [28]. Herbicides and pesticides can affect coral reproduction, growth, and other physiological processes, in particular, can affect the symbiotic algae (plants). This can damage their partnership with coral and result in bleaching.

#### *4.2.3 Nutrients loading/sewage*

The discharge of aquaculture and agriculture requirements such as fertilizers, herbicides, pesticides, feed waste and other materials can result in more nutrients loading into coastal areas. These organic compounds lead to increases of eutrophication status of coastal areas and subsequent oxygen depletion. When the nutrient loading into coastal areas and occur of eutrophication, the community becomes dominated by algae and seaweed, to the limit transcend grazing organisms' capacity to control. These can leads to light reduction, oxygen depletion and perhaps death of the communities living there. When coral reef ecosystems subjected to huge quantities of nutrients, they are easily consumed and overcome by algae and may be strictly damaged, if not killed.

#### *4.2.4 Fishing and overfishing*

Illegal fishing such as blast "dynamite," cyanide or poison (duva) fishing and hunting by gum boots, all destructive any ecosystem. Other injury practices of fishing including reef structure disintegration in order to remove hiding places, weight traps and herd fish into nets by beating coral surfaces. Accidental grounding of boats and anchor damage may be significant threat to coral reef ecosystem. Such practices lead to annihilation and degradation of habitat of coral reef ecosystem. For instance, 3150 km<sup>2</sup> of coral reef were destroyed when one cruise ship anchoring on one occasion [29].

Overfishing may alter food-webs structure of coral reef ecosystem and cause cascading impacts, such as decrease the grazer fish numbers that remove algal overgrowth and keep corals clean. Blast fishing (kill fish by explosives) may create physical damage to coral reefs [30].

The vast majority of the world's reefs are affected by over exploitation of resources. This may leads to decrease of size average of the fish and reduction of target predatory fish. Removal of main predator and herbivores species may result in change of large scale reef ecosystem. When grazers are removed from reef ecosystem, quickly the algae are taking over and dominate, particularly if the ecosystem is also suffering from organic pollution [31].

#### *4.2.5 Construction and sedimentation*

Sedimentation is an extremely important cause of destruction of coral reef ecosystem. Predominating, Coastal development and construction can lead to load of heavy amount of sediment. There are another effects are caused by inadequate land management and deforestation, where sediment run off from farms and land and settling on the reefs. In this context, Watersheds that cleared of their vegetation cover is vulnerable to flooding and erosion and can lead to increase of

sedimentation levels that reaching to coral reefs. As well, the agriculture chemicals also take their way reaching to coral reef through run off from land, streams and rivers [32].

Dredging has several serious impacts on coral reefs ecosystem. The most spectacular effects are produced by sedimentation, turbidity, silt suspension, reduction of oxygen and release of bacteria and toxic substances. Great quantities of either fine or coarse particles will cover the corals, which are unable to withstand cover for more than 1 or 2 days [33].

The corals secrete of protective mucus in a bid to rid themselves of the sedimentation. This process requires high energy levels, which have to be diverted away from essential processes. If this problem is exacerbated by other stresses, for example, temperature change; then, the reefs become extra stressed and may die. The mucus secretion to sediment clearing makes the reefs more susceptible to infected by bacteria and therefore more probable to suffer from diseases [15]. The higher level of sedimentation that exceeds the clearing capacity of mucus secretion of coral reef can reduce light breakthrough and may change the vertical distribution of plants and animals on coral reefs [34].

#### *4.2.6 Cutting of mangrove*

The mangroves destruction by obvious cutting or pollution has resounding consequences on reef ecosystem. Mangroves removal leads to remove the main source of leaf litter, a food resource for the set of reef animals. Also, mangroves provide the nutrient rich feeding grounds for several marine species. Moreover, mangroves protect the shoreline against storms and cyclones and give it stability against land loss by erosion.

#### *4.2.7 Rubbish/litter*

Trash such as discarded fishing gear, bottles and plastic bags that takes its way into the coast may settle on reefs and prevent the sunlight required for photosynthesis or decompose and kill reef organisms and damage or break corals. Degraded plastics and small pieces of plastic can be ingested by coral, turtles, fish and other reef animals, this can block their digestive tracts and kill them.

Litter and rubbish is one of the largest problems facing any ecosystem. The decomposition of this artificial rubbish takes a very long time. Plastic bottles decomposed in 150 years, plastic bags 50 years, batteries in 200 years, paper in 1 year and cigarette in 75 years. If a turtle facing a plastic bag similar to jellyfish may swallow it and can choke it. Batteries leak poisons as they breakdown and can contaminate the fish we eat, as well as kill corals and other marine life. Rubbish should be disposed of properly, by recycling or taking it back to the mainland dump. If rubbish is left lying around, it can easily get blown into the sea.

#### *4.2.8 Tourism*

Tourism has a large potential to contribute to sustainable socio-economic development and environmental conservation. It can support the protection of natural resources, as local residents realize the value of their assets and try to preserve it. Tourism can also provide another form of land use (other than agriculture) which supports land conversion. It can also contribute to maintaining livelihoods and preserving cultural practices. Opportunities arise for education and awareness-raising to understand and respect cultural diversity along with biodiversity. All these benefits can be derived from the tourism if the optimal utilization is used and

controlled in the required form to preserve the environment, biological diversity and natural habitats. The uncontrolled and misuse of tourism can lead to the degradation and collapse of ecosystems and biodiversity that are essentially the real attraction of tourism [4, 14, 35].

Tourism and biodiversity are closely linked both in terms of impacts and dependency. Many types of tourism rely directly on ecosystem services and biodiversity (ecotourism, agritourism, wellness tourism, adventure tourism, etc.). Tourism uses recreational services and supply services provided by ecosystems. Tourists are looking for cultural and environmental authenticity, contact with local communities and learning about flora, fauna, ecosystems and their conservation. On the other hand, too many tourists can also have a negative, degrading effect on biodiversity and ecosystems. Therefore, the tourism sector has both a strong influence on biodiversity loss and a role to play in its conservation [36]. Regrettably, the tourism-environment relationship is unbalanced: tourism is depending on environment that is vulnerable to the tourism impacts [37]. Yet it's not easy to achieve sustainable development in many developing countries that heavily rely on tourism income, particularly in ecologically sensitive areas. More influences were coming from the tourists services area such as domestic wastes, garbage and many bad practices from site visitors. The main human bad activities that can be destroy the biodiversity stock in any area that resulting from uncontrolling tourism and fishing activity [1].

#### *4.2.9 Coral harvesting for the aquarium trade*

Coral harvesting for the aquarium trade, jewelry, and curios can lead to over-harvesting of specific species, destruction of reef habitat, and reduced biodiversity. The practice of keeping marine aquaria as a hobby has increased in the last decade. It is reported that, globally, between 1.5 and 2 million people keep saltwater aquaria [38, 39]. Murray et al. [40] confirmed that the areas of southern California rocky shores which have been used by humans intensely for recreational activities such as fishing, exploration, walking, enjoyment of the out-of-doors, and educational field trips had suffered from reduction of species abundance and diversity due to visitors collection of intertidal organisms for consumption, fish bait, home aquariums and other purposes. The most direct effects of intense collecting are decreased abundances of exploited species and because humans preferentially collect larger individuals, altered population size structures. El-Naggar et al. [4] attributed the reduction of certain gastropod shells (Cypraeidae) from Aqaba Gulf to them intensive collecting by visitors because they have beautiful shell.

#### *4.2.10 Fish-feeding*

The feeding behavior of reef fishes, eels, sharks and even rays has come to a selling point through commercial fish feeding dive tours and “interactive diving.” However, many do not realize the harmful effects this activity has on these animals. Studies done around the world have indicated that fish feeding significantly alters behavioral patterns by “training” these wild creatures with human food handouts. In addition, fish feeding causes health problems for the fed animals and disrupts the natural processes within the marine community. Here in the Mamanucas, particularly at sites where fish feeding occurs, there has been an increase in aggressive behavior within schools of surgeonfish, fighting amongst themselves and causing injury, even to the point of destroying their own reef habitat by breaking hard corals. Triggerfish have also been observed biting and destroying the reef structure. Sergeant Damselfish swarm around snorkelers or divers expecting to be fed. The fish that are fed often “peck’ at the snorkelers or divers entering the water, taking

away the pleasure of observing the reef and its inhabitants in a calm and inoffensive manner. By feeding the algae eaters that control algae growth, they become handout feeders that soon neglect their important role of eating algae, which in turn can overgrow coral. Major conservation organizations, including UNEP, DAN, WWF and Environmental Defense, encourage passive interaction with marine life and avoiding feeding and petting, which may lead to accidental injury.

## **5. Proposed solutions to mitigation of the coral reef threats (methods for conserve the coral reef)**

The aggregate effects of these stressors can decrease resilience of the reef overall and increase susceptibility to disease and invasive species. The anthropogenic activities stressors on coral reef ecosystem are suggested potential factors responsible for the degradation and instability of any ecosystem. Any bad practices from human; directly and indirectly can be effected on coral reef ecosystem. So, it is should create new strategies to protect coral reef ecosystems. Given that 20% of the coral reefs in the world have already been destroyed much has to be done in the future for the preserve of coral reef ecosystem.

### **5.1 Establishment of marine protected areas**

One of the key techniques of conserve coral reef ecosystem is the establishment of Marine Protected Areas (MPAs). Marine Protected Areas (MPAs) are important tools for marine conservation and management. Although there are many types of MPAs, in all them, there are areas set aside unlimited human activities. When the MPAs restriction is highest, they are considered as “no-take” areas, where the dealing with all forms of marine life is prevented; even recreation, research and education are restrictive. Many of MAPs were constructed specifically for management of a special purpose (for instance, for biodiversity preservation, as a refuge of a certain species to breed, for conserve of a historical site or even for recreation). Multiple use management protected areas are zones to permit for complete limitation on dealing in some areas and managed use in other [41]. However, a main problem in MPAs is that they are fail to achieved their management objectives and be parks on paper only [42]. Even though MPAs may be gazette legally, enforcement of relevant laws (zoning, prohibiting certain activities) is often poor.

### **5.2 Prevention of over-harvesting through legislation**

Many species are protected under general species protection laws across the region. Most of this protection is afforded to marine vertebrates, but some countries—such as India and Sri Lanka—have laws protecting several species of coral, molluscs and echinoderms. In India, all Stony corals, all Black corals, all Fire corals, and all Sea fans are protected by law [43]. In Sri Lanka, all Stony corals are protected by law [44].

### **5.3 Monitoring**

Coral reefs monitoring is substantial process for developing of efficacious strategies of the management. Through monitoring only, it is possible to assessment of patterns and trends of coral reefs health and use. There are many worldwide organizations that specializing in monitoring of coral reefs status. The Global Coral Reef Monitoring Network (GCRMN) devote their efforts and coordinates in

order to improvement of coral reefs management in whole the world, this through capacity building and knowledge sharing and works and closely works with Reef Base (Global database about coral reef related information) and Reef Check. After coral bleaching event in 1998 and with the continuous threat of coral degradation as a result of other anthropogenic activities, Coastal Ocean Research and Development in the Indian Ocean (CORDIO) was commenced in 1999. CORDIO supports and funds the scientists and organizations in the Indian Ocean Region, for assurance of monitoring of coral reefs status in the region with focus on both socio-economic and ecological impacts of coral reef degradation. Monitoring plays a critical role in managing Marine Protected Areas. The importance of monitoring and research is management of the fisheries and biodiversity resources. It should be that develop a long term monitoring plan for management of abundance and diversity of biota and coupled with an assessment of fishing and habitats quality including coral reef [1].

#### **5.4 Building awareness**

Building awareness about coral reef ecosystems, their biodiversity, services they provide and their business are highly supports in mitigation of the threats that facing these fragile ecosystem of coral reefs. Awareness at the community levels is extreme efficient as it may help to encouragement of coral reefs users for change their behavior to sustainable using of these ecosystems. On the other hand, the awareness at national level through conservation education by the media and other means is necessary to guarantee that decision makers integrate coral reef preservation into all development stages. It is also important to ensure that some environmental issues, such as poorly planned or unplanned inland development and pollution, are prevented in order to protect coastal ecosystems such as coral reefs. Worldwide, 1997 was designated as International Year of the Coral Reef Because of growing threats to coral reefs at whole the world. Also, 2008 was designated as International Year of the Coral Reef.

#### **5.5 Support of sustainable livelihoods and participation in reef dependent communities**

The relationship between reef ecosystems and poverty is very significant, whereas 67% of all countries having reef areas are developing countries and about 25% of these countries are lowest developed countries [45].

Coral reef ecosystems contribute to the national economies and provide significant resources for poor people. The current direction of growing threats to coral resources is prospective to impact poor communities dependent on reef ecosystem. To make matters worse, the reef ecosystem management for preservation objectives predominating restricts community access to their resources thus reducing livelihood options for these communities. Oftentimes, these restrictions are not followed by communities which may have weak understanding or low participate in the process of reef management.

It is well now recognized that these communities need to be offered alternates for livelihoods in order to assure that reefs are not further damaged, as well as to mitigate poverty for these communities. Therefore, managers of coastal areas are highly switching toward more integrated as well contributory approaches for coral reefs conservations and managements. These approaches such as, identifying and supporting alternate livelihoods for reduce its reliance on reef components, in addition to promote the activities of current livelihood to make them more effective cost and resource use. Rather than comprehensive restrictions on reefs resources use, recently, there are Limited and controlled uses of these resources are advocated in

certain circumstances. The reef access rights, resolution of struggles over resource uses, local community involvement and cooperative reef management are now being integrated in to reefs resources management [46].

## **5.6 New management initiatives**

It is now understand that the standard approaches of management of coastal zone have not been successful in realizing of sustainable developments and reef preservation aims and that is needed to change in approaches [16].

The shifting from small and isolated efforts of management to large-scale networks using cooperative management is newly trend. Increasing of reefs area under high conservation is a main propulsion for this shifting, thus now 33% of Great Barrier Reef has been declared as a highly protected areas or as no-take zones, where is not permit of any activities except in the narrowest limits. The cooperating for create greater network of Marine Protected Areas is another methods that has been favored by main Non-governmental organizations (NGOs) such as Conservation International, The Nature Conservancy and the World Wildlife Fund who are developing training modules to identify and develop a network of Marine Protected Areas in Asia depending on zones of highest biodiversity. Another shifting is in the effort to focus researches on real-life problems that resource managers face [16].

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