Effects of Bleaching and Water Pollution on dying Beauty of Coral Reefs

Coral reefs are made of calcium carbonate, which corals secrete. Construction of a Habitat for millions of animals that live under water takes several years, and it's a beautiful work of nature. This may sound interesting, but it has recently become a nightmare after scientists revealed that coral reefs are on the brink of extinction. Many ecosystems, water sources, underwater water banks, and now even coral reefs have been threatened by environmental hazards. The Great Barrier Reef is a big one, and Qatar has a huge one as well.

Pakistan is one of the lucky countries to have coastlines. Astola, a small island near Baluchistan, has been described as a wonderful place to visit with an unharmed and protected coral reef. Corals are commercially used in coastal countries as herbal remedies and for other purposes. People in Pakistan, on the other hand, are unaware of the beauty and significance of corals. Another explanation for the island's protection is that it is largely uninhabited and has very little tourism. Tourism has a huge effect on the Coral Reef.

For a Coral to grow an inch, it takes 100 years. Corals, like many other natural resources, are permanent. It is difficult to recover them after they have been destroyed. Coral reefs provide a large amount of oxygen to the ecosystem, so we must control their losses and damages in order to protect our environment. That if one life form is disrupted, the others are affected as well. Corals are filter feeder species that filter rock fragments from the atmosphere and extract calcium from the water in order to secrete their calcium carbonate shell. Polyp is the term for the coral's living organism.

Millions of polyps clump together to form the enormous structure known as a coral reef. Hundreds of years pass, and the dead corals collect in the water, creating this incredible natural ecosystem that has served the life of the earth for decades. However, they are being affected by water contamination, overfishing, plastics, and losses to water sources due to high temperatures.

Nearly all of the world's coral reefs are expected to be extinct in the next 25 years. (Coral reefs off the coast of Pakistan face no threats, according to Dr. Tahir Qureshi, a marine ecologist with the International Union for Conservation of Nature (IUCN).

Scientists have recently discovered coral reefs in Balochistan at Churna (near the Karachi coast), Astola Island, Pasni, and near Jevani, according to Qureshi. When it comes to the geographical position of coral reefs, Qureshi says that there is neither a rise in pollution nor a reduction in biodiversity. Is there any construction activity that could have an impact on these reefs?

He says that foreign teachers and researchers continue to visit Pakistani coasts to see whether sea level rise, pollution, and construction activities are having an impact on coral reefs. As a consequence, he asserted, a swift assessment in this regard is urgently needed. However, he maintained that there is currently no direct scientific evidence that global warming is endangering corals.) as stated in THE Press.

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Review of Literature:

Status of coral reefs of the World: 2000:

After the previous GCRMN study in 1998, the world's coral reefs have started to decline. The late 2000 assessment indicates that 27 percent of the world's reefs have been essentially destroyed, with 1998's major climate-related coral bleaching event being the largest single cause. During the biggest El Niño and La Niña climate changes, about 16 percent of the world's coral reefs were lost in 9 months. Although there is a fair chance of gradual recovery for many of the 16 percent of damaged reefs, perhaps half of these reefs will never recover properly. These would add to the 11% of the world's reefs already lost due to human impacts such as sediment and nutrient contamination, sand and rock mining and construction over-exploitation and mining and 'reclamation' of coral reefs. (Wilkinson, 2000)

Climate Change, Human Impacts, and the Resilience of Coral Reefs:

To the extent that reefs are threatened globally, the diversity, frequency, and scale of human impacts on coral reefs are increasing. Carbon dioxide and temperature projected increases over the next 50 years exceed the conditions under which coral reefs have flourished in the past half a million years. Instead of disappearing entirely, however, reefs will change, with some species already showing far greater climate change tolerance and coral bleaching than others. It is necessary to vigorously implement international integration of management strategies that promote reef resilience, and to complement them with strong policy decisions to reduce the rate of global warming. (Hughes et al., 2003)

Climate change, coral bleaching and the future of the world's coral reefs:

Over the past 100 years, sea temperatures have increased by almost 1 ° C in many tropical regions, and are currently growing at ~ 1-2 ° C per century. Coral bleaching occurs when corals and their photosynthetic symbionts (zooxanthellae) exceed their thermal tolerance. In association with episodes of elevated sea temperatures over the past 20 years, mass coral bleaching has occurred and involves the loss of zooxanthellae following chronic photo inhibition. In many parts of the world, mass bleaching has resulted in significant losses of live coral. The biochemical, physiological and ecological perspectives of coral bleaching are considered in this paper. It also uses four outputs from three global climate change models that simulate sea temperature changes and thus how the frequency and intensity of bleaching events will change over the next 100 years. The findings indicate that over the next few decades, the thermal tolerances of reef-building corals are likely to be surpassed each year. Within 20 years, incidents as serious as the 1998 event, the worst on record, are likely to become commonplace. Much of the knowledge indicates that the coral acclimatization ability has already been surpassed and that adaptation would be too slow to avoid a decrease in the condition of the world's reefs. The pace of the expected changes indicates a major problem for tropical marine habitats and shows that without the destruction and deterioration of coral reefs on a global scale, unrestrained warming cannot take place. (Hoegh-Guldberg, 1999)

Biological destruction of coral reefs:

It is possible to distinguish the main agents of biological degradation of coral reefs into grazers, etchers and borers. Each of these classes, along with the mechanisms by which they kill the coral substrate, is reviewed on a worldwide basis. The bioerosion rates assigned to the key agents of grazers, etchers and borers, along with the limitations of some of the measurements, are given. The variability in bioerosion rates over time and space is illustrated by recent work. Factors are mentioned that may be responsible for this variability. Bioerosion is a major factor affecting reef morphology and it addresses in some detail the ways in which this is accomplished. Although the study focuses primarily on today's reefs, several attempts are being made to consider the effect of bioerosion on older reefs. (Hutchings, 1986)

Philippine Coral Reefs Under Threat: The Economic Losses Caused by Reef Destruction:

Coral reef fisheries in the Philippines provide livelihoods for more than a million small-scale fishermen who contribute almost US$ 1 billion to the country's economy per year. Growing numbers of fish and other marine species are required by the rapidly increasing population. However, several reef habitats have been weakened or killed by overfishing, harmful fishing practices and sedimentation. Fish catches have dropped far below the standards of healthy reefs that are sustainable. The economic losses are considerable for the coastal fishing population. By developing environmental management regimes, numerous projects have and are attempting to tackle coral reef loss. It seems that the economic benefits of such programmes outweigh their expenditure costs. The start-up and maintenance costs of a successful island marine reserve project were compared, for instance, to the losses incurred by the degradation of reefs and the benefits from the management of reefs. The findings clearly show that, due to higher catches and revenues from small-scale tourism, the economic benefits of a controlled reef area far outweigh the cost. For a rising number of local and foreign visitors, coral reefs are also a big attraction. These reef tourists are also able to contribute to reef maintenance expenses, in addition to generating revenue for the tourism industry. The annual willingness to pay calculated in three common diving locations is significant. In Mabini, Batangas alone, an estimated US$ 300 000 could be obtained as entrance fees or donations annually. It is estimated that in their depleted state, the 27 000 km2 of reef still contribute at least US$ 1.35 billion per year to the economy. A cost-effective way to alleviate the burden on the various endangered coral reefs is to maintain reefs involving local fishing groups, local governments and other interested organizations. In addition, economic valuation and cost-benefit analysis will provide important evidence to encourage further coral restoration investments. (White et al., 2000)

Coral Reefs: Present Problems and Future Concerns Resulting from Anthropogenic Disturbance:

Since their emergence millions of years ago, coral reefs, with their large diversity of invertebrate, vertebrate and algal species, have certainly been subject to natural disruption. For a fraction of that duration, anthropogenic destruction has been a factor affecting reefs, but may be of greater concern in terms of overall effects. Data on habitat loss, pesticide and heavy metal deposition, fertilizer loading, sedimentation, runoff and related effects of human activities suggest that these processes threaten many coastal reefs through changes in animal-algal symbiosis, changes in competitive interactions, direct mortality, reproductive failure, and inadequate recruitment. Reef populations are critically affected by coral death, as corals provide an essential trophic connection as well as the key structure of the ecosystem. Although natural disturbance is a significant factor influencing coral interactions, diversity and evolution of species, chronic anthropogenic disturbances are of great concern, combined with unsuitable recovery conditions. In addition to direct mortality, physiological stress may be assessed in corals, allowing the effects of particular disruptions to be evaluated. Enough data is becoming available to separate specific issues from temporal fluctuations, enabling scientists to concentrate on realistic solutions to problems in coral reef management and restoration. (Richmond, 1993)

Environmental Economics of Coral Reef Destruction in Sri Lanka:

Coral reefs are a vital resource for a large number of people, especially coastal communities in developing countries. The available coral reef information in Sri Lanka and Southeast Asia has been used to assess the ecological services offered by coral reefs and to assess the long-term economic benefits extracted from certain functions of the ecosystem. Over a 20-year period, the minimum economic value of coral reefs in Sri Lanka is estimated at USD 140 000-7 500 000 km-2. The economic effects of coral mining have been studied and the economic costs (USD 110 000-

7 360 000) have been found to surpass net benefits (USD 750 000-1 670 000) by as much as USD 6 610 000 km-2 when evaluated in tourism areas over 20 years. Decreased tourism (USD

2-3 million) and increased erosion were correlated with the highest costs (USD 1-4 million). However, there is still a strong incentive for coral mining in rural areas, as coral mining offers a more lucrative business compared to fishing and agriculture in the short term. The findings have management implications and indicate that Sri Lankan legislation banning the mining of coral in the coastal zone is beneficial for the economic development of the region. (Berg et al., 1998)

Biodiversity of Coral Reefs: What are We Losing and Why?

Numerous anthropogenic effects are threatening coral reefs, some of which have already had significant global implications. Corals, coral invertebrates, birds, and other animals and plants flourish in these special tropical ecosystems. Since several species have yet to be collected and identified, the species diversity of reef-associated organisms is poorly understood in most taxa. There is a limited understanding of similar organisms since many of the species have yet to be collected and identified. Natural disasters such as hurricanes, predator attacks and high temperature periods have been correlated with high coral mortality, but they have also resulted from excess nutrients in sewage and from particular contaminants. The risk of global warming, which will result in increasing sea levels and periods of elevated temperature stress, and which may also contribute to increased storm frequency and severity, is also threatening reef corals and associated species. Although the recent extensive episodes of coral bleaching in the Caribbean and Eastern Pacific can at this time not be causally connected to global warming, the near correlation between temperature and bleaching implies that global warming will result in significant changes in the assembly of corals. In the Pacific, outbreaks of the predatory seastar Acanthaster planci have wreaked havoc on reefs. While this is known to be part of a natural disturbance cycle, there are signs that human actions may have increased the severity of outbreaks by altering land use patterns and reducing predators on this seastar. Recreational and commercial use of reefs, particularly near areas of high population density, has also increased and has caused extensive damage. The decline of fish stocks caused by intensive overfishing in most coral areas around the world is one of the most noticeable and widespread losses to reef biota. Extreme overfishing for both local and export purposes has occurred on coasts without properly maintained reefs, to the point that the beneficial effects of fish on such reefs have been damaged. In all localities, the combination of these disruptive factors has modified reefs, and those that were once considered covered by distance and low population density are now also being exploited. On the positive hand, in combination with intensive conservation initiatives, increased knowledge of ecological processes on reefs has helped to secure several large reef areas for the future. (Sebens, 1994)

Confronting the coral reef crisis:

The global collapse of coral reefs calls for an immediate re-evaluation of existing management activities. To cope with large-scale disasters, management efforts must be scaled up significantly, based on a deeper understanding of the ecological processes that underpin reef resilience. Managing for better resilience, which takes into account the effect of human activities on habitats, provides a framework for dealing with instability, future changes, and environmental surprises. We study the ecological functions of essential functional groups (both corals and reef fishes) in understanding resilience and preventing phase changes from coral supremacy to less favorable, degraded habitats. The species richness and composition of functional groups reveal striking biogeographic variations, demonstrating the vulnerability of Caribbean reef ecosystems. These results have profound consequences for the regeneration of degraded reefs, fishery management and the emphasis on marine protected areas and biodiversity hotspots as conservation priorities. (Bellwood et al., 2004)

Modelling the effects of destructive fishing practices on tropical coral reefs:

A literature review of the use of underwater explosives found that near the surface of the water lies the largest lethal zone for swim bladder fish. The swim bladder ruptures due to negative pressure caused by cavitation of the near-surface water volume caused by a subsurface explosion, resulting in death in this region. Observational blast fishing experiments in the Philippines revealed that the primary targets were important pelagic species rather than standard coral reef species. Inputs to the nomographic model of the reef ecosystem were provided by empirical evidence on the extent of various harmful fishing activities (blast fishing, anchor damage and use of poisons), as well as coral regrowth estimates. Under various conditions, the model provided time graphs of fish diversity and coral regrowth. The simulation model studies showed that the sum of all current destructive activities was adequate to sustain loss of diversity and live coral cover for another 25 years before any recovery could be expected. On the other hand, a decrease in the rate of destructive fishing to approximately 30 percent of the current level will allow a gradual recovery of both the diversity and the cover of live coral to continue. Based on available evidence, it appears that attempting to reduce the use of poisons (such as cyanide) in reef areas, as well as reducing anchor damage and blast fishing in coral areas, could be the most successful way to achieve this. In the past, the potential results of the above may have been overstated. (Saila et al., 1993)

An economic analysis of blast fishing on Indonesian coral reefs:

Blast fishing's characteristics, impacts, and economic costs and benefits have received little publicity, so they were investigated in Indonesia, at the level of individual fishing households

and Indonesian society as a whole. Blast fishing, despite being illegal and highly damaging to coral reefs, provides revenue and fish to a significant number of coastal fishermen who say they have no other means of subsistence. Crew members in small-, medium-, and large-scale blast fishing operations earned net monthly incomes of $55, 146, and 197 dollars, respectively. In the same types of activities, boat owners received US$ 55,393 and US$ 1100, respectively. These earnings were equivalent to the top earners in typical coastal fisheries. The discrepancies between the three forms of operations at the household level indicate strong incentives for scale expansion. An economic model was used to measure the cost-benefit analysis at the systemic level. After 20 years of blast fishing, this study found a net loss of US$306800 per km2 of coral reef where tourism and coastal protection are high potential values, and US$33 900 per km2 of coral reef where tourism and coastal protection are low potential values. The most quantifiable costs are the loss of coastal protection, foregone tourism benefits, and foregone non-destructive fisheries benefits. In areas with high potential value for tourism and coastal security, the social costs of blast fishing are four times higher than the overall net private benefits. This study of the characteristics, consequences, and economics of blast fishing in Indonesian waters should help to reinforce the political will to prohibit blast fishing in the country's waters. Furthermore, it enables an assessment of alternative management options, taking into account their costs as well as the socio-economic context that contributed to the use of explosives by coastal fishermen. (PET-SOEDE et al., 1999)

Fishing, Trophic Cascades, and the Process of Grazing on Coral Reefs:

Parrotfishes have been the dominant grazer on Caribbean reefs since the mass extinction of the urchin Diadema antillarum in 1983. If marine reserves achieve their long-term aim of restoring large consumers, some of which prey on parrotfishes, the grazing ability of these fishes could be harmed. On parrotfish within reserves, we equate the negative effects of increased predation with the positive effects of reduced fishing mortality. Since large-bodied parrotfishes are not at risk of being eaten by a large piscivore (the Nassau grouper), grazing was reduced by just 4 to 8%. The increase in density of large parrotfishes overtook this effect, resulting in a net doubling of grazing. Increased grazing resulted in a fourfold reduction in macroalgae cover, highlighting the potential value of reserves for coral reef resilience because macroalgae are the main competitors of corals. (Mumby et al., 2006)

Effects of Fishing on the Ecosystem Structure of Coral Reefs:

One of the top three threats to coral reef habitats is overfishing. Reefs are under immense pressure as a food source due to exponentially growing human populations in the tropics. Fishing has significant direct and indirect effects on the population structure of fishes and other species at high intensities, known as ecosystem or Malthusian overfishing. It decreases species diversity and triggers local extinctions, not only of target species but also of non-target species. It's possible that it might even result in global extinctions. The loss of keystone species, such as echinoderm predators, due to fishing can have a significant impact on reef processes, such as

calcium carbonate accretion. In the end, heavy fishing could result in the extinction of entire functional groups of species, compromising the potential ecosystem functions given by those groups. Overfishing has been shown to interfere with other causes of disruption to limit reefs' ability to rebound from natural disasters including hurricanes. Successful fishing management would necessitate a greater understanding of the consequences of exploitation than we currently have. Fish species' responses to fishing, and in general, responses to defense from fishing, are being examined in research projects. However, there is a pressing need to look beyond fisheries and understand the whole reef ecosystem. Studies that combine population and community biology with ecosystem processes can help us understand the impact of biodiversity loss on reef function and strengthen our ability to manage these complicated systems. (Roberts, 1995)

Kenyan coral reef lagoon fish: effects of fishing, substrate complexity, and sea urchins:

Fish species from eight common coral reef-associated families were studied in three marine parks with complete protection from fishing, four sites with uncontrolled fishing, and one reef that recently gained protection from fishing (referred to as a transition reef). Coral cover, reef topographic complexity, and sea urchin abundance were all measured and compared to fish abundance and species richness. The most striking finding of this analysis is a persistent and important decline in population density and species richness in five families (surgeonfish, triggerfish, butterflyfish, angelfish, and parrotfish). Parrotfish's slow recovery in the transition reef, compared to other fish families, is viewed as evidence of sea urchins' competitive exclusion of parrotfish. Parrotfish have a low recovery rate in the transition reef compared to other fish families, which has been interpreted as proof of sea urchin competitive exclusion. Reef substrate complexity is correlated with fish abundance and diversity, but data indicate that protected versus fished reefs have different responses, with protected reefs having higher species richness and numbers of individuals for the same reef complexity. While fishing versus no fishing appears to be the strongest variable in predicting numbers of individuals and species of fish, the interrelationships between sea urchins, substrate complexity, coral cover, and management make it difficult to allocate a fixed percent of variance to each factor—while fishing versus no fishing appears to be the strongest variable in predicting numbers of individuals and species of fish and their community's resemblance Many species on fished reefs have undergone localized extinction (for the sampled area of 1.0 ha). On unprotected reefs, 52 of the 110 species present on protected reefs were not found. (McClanahan, 1994)

Effects of Artisanal Fishing on Caribbean Coral Reefs:

Although the impacts of industrial fishing are commonly known, artisanal fisheries typically consider marine habitats to be less endangered. We researched six Caribbean islands to see how artisanal fishing affects coral reef fish assemblages and benthic populations. Fishing pressure

ranged from practically zero in Bonaire to very high intensities in Jamaica. Using stationary-point fish counts at 5 m and 15 m depth, the lengths of all non-cryptic, diurnal fish species within replicated areas of 10 m diameter were counted and estimated. We measured the percentage of coral and algae cover, as well as the complexity of the reef structure. For the five most commercially important families, the mean fish biomass per count was determined from fish numbers and lengths. Groupers (Serranidae), snappers (Lutjanidae), parrotfish (Scaridae) and surgeonfish (Acanthuridae) showed variations in biomass between islands in order-of-magnitude. As fishing pressure grew, the biomass dropped. Just grunts did not follow this trend (Haemulidae). Larger-bodied species decreased within families as fishing increased. On little-fished islands, coral cover and structural complexity were maximum and lowest on those most fished. In comparison, algal cover in Jamaica was an order of magnitude higher than on Bonaire. These findings indicate that herbivorous fishes have not managed algae overgrowth corals in heavily fished areas, but have limited growth in lightly fished areas, following the Caribbean-wide mass mortality of herbivorous sea urchins in 1983–1984 and subsequent declines in grazing pressure on reefs. In short, variations in the composition of fish and benthic assemblages between islands indicate that intensive artisanal fisheries have transformed Caribbean reefs. (Hawkins & Roberts, 2004)

Coral bleaching, reef fish community phase shifts and the resilience of coral reefs:

The 1998 global occurrence of coral bleaching was the largest historical invasion of coral reefs reported and resulted in extensive loss of habitat. Over a 12-year period spanning the bleaching case, annual censuses of reef fish population structure showed a consistent phase change from prebleach to postbleach assemblage. Surprisingly, we noticed that there was no observable impact of the bleaching event on the abundance, diversity or species richness of the local population of cryptobenthic reef fish. In addition, even after 5–35 generations of these short-lived animals, there is no evidence of regeneration. These findings have important consequences for our understanding of the reaction of coral reef habitats to global warming and highlight the importance of selecting suitable parameters for reef resilience assessment. (Bellwood et al., 2006)

References:

1.Hoegh-Guldberg, O. (1999). Climate change, coral bleaching and the future of the world’s coral reefs. Marine and Freshwater Research, 50(8), 839–866. https://doi.org/10.1071/mf99078

2. Hoegh-Guldberg, O. (1999). Climate change, coral bleaching and the future of the world’s coral reefs. Marine and Freshwater Research, 50(8), 839–866. https://doi.org/10.1071/mf99078

3. Hughes, T. P., Baird, A. H., Bellwood, D. R., Card, M., Connolly, S. R., Folke, C., Grosberg, R., Hoegh-Guldberg, O., Jackson, J. B. C., Kleypas, J., Lough, J. M., Marshall, P., Nyström, M., Palumbi, S. R., Pandolfi, J. M., Rosen, B., & Roughgarden, J. (2003). Climate Change, Human Impacts, and the Resilience of Coral Reefs. Science, 301(5635), 929–933. https://doi.org/10.1126/science.1085046

4. Hutchings, P. A. (1986). Biological destruction of coral reefs. Coral Reefs, 4(4), 239–252. https://doi.org/10.1007/BF00298083

5. White, A. T., Vogt, H. P., & Arin, T. (2000). Philippine Coral Reefs Under Threat: The Economic Losses Caused by Reef Destruction. Marine Pollution Bulletin, 40(7), 598–605. https://doi.org/10.1016/S0025-326X(00)00022-9

6. Richmond, R. H. (1993). Coral Reefs: Present Problems and Future Concerns Resulting from Anthropogenic Disturbance. Integrative and Comparative Biology, 33(6), 524–536. https://doi.org/10.1093/icb/33.6.524

7. Berg, H., Öhman, M. C., Troëng, S., & Lindén, O. (1998). Environmental Economics of Coral Reef Destruction in Sri Lanka. Ambio, 27(8), 627–634. JSTOR.

8. Sebens, K. P. (1994). Biodiversity of Coral Reefs: What are We Losing and Why? Integrative and Comparative Biology, 34(1), 115–133. https://doi.org/10.1093/icb/34.1.115

9. Bellwood, D. R., Hughes, T. P., Folke, C., & Nyström, M. (2004). Confronting the coral reef crisis. Nature, 429(6994), 827–833. https://doi.org/10.1038/nature02691

10. Saila, S. B., Kocic, V. Lj., & McManus, J. W. (1993). Modelling the effects of destructive fishing practices on tropical coral reefs. Marine Ecology Progress Series, 94(1), 51–60. JSTOR.

11. Mumby, P. J., Dahlgren, C. P., Harborne, A. R., Kappel, C. V., Micheli, F., Brumbaugh, D. R., Holmes, K. E., Mendes, J. M., Broad, K., Sanchirico, J. N., Buch, K., Box, S., Stoffle, R. W., & Gill, A. B. (2006).

12. PET-SOEDE, C., CESAR, H. S. J., & PET, J. S. (1999). An economic analysis of blast fishing on Indonesian coral reefs. Environmental Conservation, 26(2), 83–93. JSTOR.

13. Fishing, Trophic Cascades, and the Process of Grazing on Coral Reefs. Science, 311(5757), 98–101. https://doi.org/10.1126/science.1121129

14. Roberts, C. M. (1995). Effects of Fishing on the Ecosystem Structure of Coral Reefs. Conservation Biology, 9(5), 988–995. https://doi.org/10.1046/j.1523-1739.1995.9051332.x-i1

15. McClanahan, T. R. (1994). Kenyan coral reef lagoon fish: Effects of fishing, substrate complexity, and sea urchins. Coral Reefs, 13(4), 231–241. https://doi.org/10.1007/BF00303637

16. Hawkins, J. P., & Roberts, C. M. (2004). Effects of Artisanal Fishing on Caribbean Coral Reefs. Conservation Biology, 18(1), 215–226. https://doi.org/10.1111/j.1523-1739.2004.00328.x

17. Bellwood, D. R., Hoey, A. S., Ackerman, J. L., & Depczynski, M. (2006). Coral bleaching, reef fish community phase shifts and the resilience of coral reefs. Global Change Biology, 12(9), 1587–1594. https://doi.org/10.1111/j.1365-2486.2006.01204.x