HUMAN USES OF THE OCEANS

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Contents

1. Introduction
2. Human Use and Ocean Circulation
3. Ocean Regeneration
4. Coral Reef Regeneration
5. Management Options for Ocean Conservation
6. International Cooperation
Glossary
Bibliography
Biographical Sketches

Summary

Humans are highly dependent on the seas since they nourish us, provide us with a range of essential and novel chemicals for use in medicine and are responsible for climate cycles and other global processes that sustain life. They are the source of life on Earth and are now home to a vast array of organisms more diverse than those on land. They support a growing tourism and recreation industry. On top of that, transport by sea is still the mainstay of world trade. For coastal countries, the seas are also necessary for development. Yet throughout the world the seas are suffering degradation. Too many fish are caught unsustainably, sometimes by using poisons or dynamite. Too much rubbish is dumped into the seas, and too many pollutants from the land end up there.

Threats are most acute in the coastal zone, and, in particular, these stem from increasing human populations. In much of the tropics, marine productivity of the seas is concentrated in small areas of coral reefs, sea-grass beds and mangroves around the coasts, which provide rich feeding and breeding grounds for all kinds of marine organisms. Corals reefs are especially at risk from cyclones, storm surges, El Niño fluctuations, global warming, sea-level rise, excess ultraviolet radiation, coastal erosion, mining for building materials, land-based pollutants and siltation, red tides, over-fishing and unregulated tourism. While coastal areas are small in comparison with the open oceans, they are, on the one hand, the most diverse and the source of much of the livelihood of coastal communities; on the other hand, they are the most threatened, being more and more at risk due to Human activity.

The impact of climate change is truly a global one. There is already evidence of an increased number of El Niños, typhoons and hurricanes. The subsequent sea-level rise in many parts of the world will lead to the loss of coral reefs, and intertidal habitats, such as mangroves, salt marshes and productive mudflats. Furthermore, increasing sea temperatures can lead to shifts in thermoclines and changes in productivity as well as in the spatial distribution of marine species. Warm water species may spread polewards, interacting with local species which they may possibly deplete their numbers or may even be displaced. The species composition and structure of many marine habitats, particularly in temperate regions, may change.

The most serous danger lies in the rate of climate change and the consequences of this on the seas. In fact, it may ultimately represent the last straw in the already polluted and overfished oceans. The adaptive capacity of marine ecosystems may have already been or may soon be exceeded. Clearly, conservation of the seas is vital and can no longer be put off.

1. Introduction

Certain uses of the oceans and their resources are traditional, going way back to the earliest days of human settlements along the coast. The oceans are a reliable source of extractable resources, living and non-living, and still a multitude of resources remain unexplored and are yet to be developed. The oceans provide a medium for shipping, communication and national defense. They modulate the climate, receive wastes from domestic, agricultural and industrial activities, and of course, they continue to welcome those seeking recreation, or just plain rest and tranquility.However, the intensity of ocean use, by Humans of course, has increased in accordance with the number of users, and this has been most dramatic in the present century. In light of this, Humans have tried to keep pace by enhancing the usefulness of the oceans. For instance, we have built artificial reefs which have proved effective in attracting fishes and invertebrates and in upgrading the local aquatic environment to improve fishing catches.

One example of this is seen with marine anglers in the United States who have used artificial reefs to enhance their fishing efforts since at least the 1850's. The first reference attesting to this was published in Charleston, South Carolina, USA in 1860. The author quotes from a publication by the Honorable William Elliott of Beaufort, SC, entitled, "Carolina Sports, by Land and Water". The quote is taken from a section discussing fishing for sheepshead (*Archosargus probatocephalus*):

> *"They were formerly taken in considerable numbers among our various inlets, into which large trees had fallen to which the barnacles soon became attached; but as the lands have been cleared for cultivation of sea-island cotton, the trees have disappeared, and with them the fish; and it has been found necessary to renew their feeding grounds by artificial means. Logs of oak or pine are formed into a sort of hut without a roof, five or six feet high; it is floored, and then floated to the place desired, and sunk in eight feet of water, by casting stones or live oak timber within; as soon as barnacles are formed, which will happen in a few weeks, the fish will begin to resort to the ground."*

Sunken ships, scrap tires, light poles, cement blocks and even fly ash from coal combustion are now being used for artificial reef construction. Notwithstanding such efforts, in the case of oil and other wastes, there is already the fear that in certain places the limits of full capacity for these wastes are being approached if they have not already been exceeded. Additionally, eutrophication due to excess nutrient input to coastal waters is becoming a major problem.

Although not exactly a "use" of the oceans, the capacity of the seas to regulate the green house effect-at least to some extent-must be mentioned. The importance of the interactions among the oceans and the atmosphere with regard to weather and climate have long been recognized. By way of releasing a large quantity of fossil fuel CO_2 into the atmosphere, Humans have enhanced the greenhouse effect, making the Earth warmer. About half of this excess CO_2, however, has gone into the oceans. As more and more excess CO_2 is stored in the oceans and at a more rapid rate, the greenhouse effect is reduced (see , Role of the Oceans in Global Cycles of Carbon and Nutrients).

We live at a time when we must distribute our limited means to fulfill our ever-expanding number of needs. In this way, we can sustain our economic development while preserving our marine environment. In fact, it is time that we restore some of our damaged marine environments, which would prove beneficial to fisheries, among other oceanic activities. The means of regeneration, management options and international cooperation are discussed in this article.

2. Human Use and Ocean Circulation

In about the year 1769, the Board of Customs in Boston filed a complaint with the Lords of the Treasury in London, saying that the packet boats between Falmouth, England and New York generally took a fortnight longer in their passage than did merchant ships from London to Rhode Island. In response, the Board of Customs proposed that future packets be sent to Rhode Island instead of New York. This is how Benjamin Franklin commented in 1786:

> *"The power of wind to raise water above its common level in the sea, is known to us in America, by the high tides occasioned in all our sea-ports when a strong northeaster blows against the gulph stream..."*
> *"…The conclusion from these remarks is, that a vessel from Europe to North-America may shorten her passage by avoiding to stem the stream, in which the thermometer will be very useful; and a vessel from America to Europe may do the same by the same means of keeping in it. It may often happen accidentally, that voyages have been shortened by these circumstances. It is well to have the command of them".*

This demonstrates that even back in the time of Benjamin Franklin some people were aware of the Gulf Stream, as we now call it. They knew that it is warm, that it flows from somewhere off New York towards England and that Rhode Island is off its path. The Gulf Stream is part of wind-blown surface ocean circulation. Most winds and currents are more or less steady, but notable exceptions are monsoons and monsoon-influenced currents which change direction. Long before there was mention of the Gulf

Stream, ancient sailors took advantage of such changes in monsoon. For instance, Chinese merchants in the 11th century AD departed for India and the Arabian Peninsula in winter when the northeast monsoon winds developed. They returned to China in summer when the winds turned southwestwardly.

The transportation of goods is now routine in all oceans, and unfortunately, so is the transportation and release of pollutants into all parts of the marine environment. Particularly since the days of Benjamin Franklin, if not before, detrimental effects on marine ecosystems have been caused by the use of water as a transport medium for organic waste, harmful micro-organisms and nutrients emitted from households in urban areas and from agricultural activities. For instance, in 1993 alone, Beaches in the United States were temporarily closed and swimmers were advised not to go in the water over 2400 times because of sewage contamination. Even DDT, the powerful insecticide long banned in the U.S., can still be detected on the eastern seaboard because currents carry it from certain Caribbean nations.

The coastal zone is a region of intensive bio-geochemical and physical activity comprising the most productive biosystems and the major fishing grounds, especially in the tropics. Seagrass beds, coral reefs and mangroves exemplify such ecosystems. They supply two billion people with animal protein, yet they are under increasing pressure due to human activities and growing populations because over half of the world's population and most urban centers are situated in the vicinity of a coast. Obviously, damage has been far from insignificant. About 70 per cent of the mangrove forests in Southeast Asia, South Asia and the Caribbean, for example, have been destroyed in the last four decades, and some 90 per cent of the coral reefs in Southeast Asia have been severely affected by global warming, eutrophication and sedimentation. It goes without saying that this is reducing the productivity of the coastal areas, and most local fishing communities are now facing decreasing catches. Coastal marine pollution is also detracting from the biological diversity of coral reefs and other coastal marine habitats.

Many governmental bodies are increasingly concerned about these trends. For one, the U.S. Coastal Zone Management Act of 1972 declares that the increasing and competing demands upon the land and waters of our coastal zone occasioned by population growth and economic development, including requirements for industry, commerce, residential development, recreation, the extraction of mineral resources and fossil fuels, transportation and navigation, waste disposal as well as the harvesting of fish, shellfish, and other living marine resources, have resulted in the loss of living marine resources, wildlife, nutrient-rich areas, permanent and adverse changes to ecological systems, decreasing open space for public use and shoreline erosion. The coastal zone, the fish, shellfish, other living marine resources and wildlife therein are ecologically fragile and consequently extremely vulnerable to destruction by man's alterations. Moreover, important ecological, cultural, historic and aesthetic resources of value in the coastal zones, which are essential to the well-being of all citizens, are being irretrievably damaged or lost.

Another problem is discussed under Role of the Oceans in Global Cycles of Carbon and Nutrients. The damming of major rivers has upset the freshwater budget of marginal seas, which may even affect circulation in the open oceans. A case in point concerns the

Aswan High Dam in Upper Egypt. It has been estimated that reduced river flow from the Nile has had a profound influence on the freshwater budget entering the Mediterranean which is particularly sensitive to climate change. Changes in seawater temperature and salinity have already been observed and are thought to be caused by changes in heat and water budgets across the sea surface as a result of not just the increased greenhouse effect but also the decreased freshwater input.

The Mediterranean has changed before, and it has recently been suggested that one such change, some 120 000 years ago, triggered the last ice age in the Northern Hemisphere. The catalyst for this, it is postulated, was a large deficit in the Mediterranean Overflow Water. The water that flowed out of the Mediterranean became saltier and denser and could have displaced the warm North Atlantic water west of the British Isles, warming the Labrador Sea and resulting in a persistent low-pressure system, increased moisture supply and the onset of glaciation in Canada. The higher salinity in the Mediterranean that is thought to have initiated these events was brought on by a substantial reduction in Nile River outflow because of climatic shifts which reduced the intensity of the African monsoon. Such a glaciation theory has been a subject of debate, but it does point out that there may be unforeseen implications caused by Human's tampering with Nature in such activities as drawing water out of the Aswan Dam. In a similar way, the completion of the giant Three Gorge's Dam on the Yangtze River (Changjiang) in China may also reduce upwelling of the nutrient-rich subsurface seawater from offshore. The current flow pattern, biological productivity and thus fish catch in the East China Sea will also then be affected.

3. Ocean Regeneration

They called it King Cod when the Europeans began to invade of the New World. In the late 15th century, the island we now know as Newfoundland in eastern Canada was called Baccalaos a Portuguese word which means "land of cod". It was reported that the fish there could be taken not only with a net but also in buckets let down with a stone in the Grand Banks which were swarming with cod. In short, Newfoundland was a fisherman's version of the Promised Land.

By the early 20th century, the annual catch of cod in Newfoundland approached a million tons with 400 000 tons being exported annually. Exports peaked at about 430 000 tons a year by 1907. Soon, however, overfishing took its toll. The catch dwindled down to a mere 80 000 tons a year by 1956. In a salvage effort, modern fleets equipped with fish-finding sonars and factory ships came and increased the annual catch to two million tons. No sooner had than it all collapsed. Gradually, year after year, the size of the fish decreased while their numbers diminished, until finally in 1992, the Canadian government had to temporarily close the Newfoundland cod industry, putting over 50 000 people out of work and costing the government millions of dollars in compensation.

Although the oceans provide between only 5 and 10 per cent of total global food production, they supply between 10 and 20 per cent of the world's animal protein. Clearly, overfishing, such as in the case of King Cod, is not sustainable. In a report published in 1967, the Food and Agriculture Organization of the United Nations warned, "…at the present rate of development, few substantial stocks of fish accessible to today's types of gear will remain in another 20 years". It is clear by now that this statement was indeed correct, and many stocks of fish have declined throughout the world's fisheries because of overfishing as well as the deterioration of the marine environment.

Many marine environments, notably mangrove swamps and seagrass beds, are damaged because of ignorance. The most affected are coastal waters, which provide 90 per cent of the living harvest of the seas and yet are subjected to tremendous stress. Most wastes from land end up in the sea but beforehand are trapped near the shore, poisoning marine life. Coral reefs-the tropical forests of the oceans and home of up to a third of the world's fish species-are being destroyed by pollution and overexploitation, and so are other vital nurseries for fisheries and wildlife, such as the mangroves and seagrass beds. Along with their demise go not only irreplaceable sources of food, but also protective shields against coastal erosion.

Mangrove swamps line the shores of many tropical and subtropical regions. The salt-tolerant plants with their tangled roots and dense branches help to protect the coasts from erosion and stabilize shorelines by trapping sand and absorbing wave energy. Mangrove forests serve as nurseries for fish, mollusks, crustaceans, sea birds and many other land and marine organisms. Not only do they provide shelter, but also they act as recycling factories for nutrients by decaying detritus. Fallen leaves, bird and animal droppings and dead fish become food for small animals or insects and are finally broken down by bacteria and fungi. Nutrients and organic matter released are mostly retained and reused.

Seaward of the mangroves on the sandy bottoms of the shelf are frequent sea grass beds, where sea turtles, manatees and fish forage. Dense sea grass also provides shelter and food for shrimps, horseshoe crabs, mollusks, sea urchins, sea cucumbers and all sorts of marine life. Just as mangroves hold the shoreline in place, see grass roots help stabilize the sandy bottom by trapping and holding sand in place. These rich ecosystems, however, are becoming endangered because of contaminated water from river outflow and inadequately treated sewage, storm runoff, ocean outfalls and industrial effluents. Coastal development projects have motivated landowners and developers to cut mangroves down to improve waterfront views and make room for docks and marinas. Denser populations also means an increased demand for firewood, fishing ponds and farm land. Unquestionably, so-called useless mangrove forests frequently become easy prey (Table 1).

Not unlike mangrove forests, seagrass beds are not spared, either. Recreational activities, involving water vehicles with rapidly turning propellers or dragging anchors can uproot seagrasses and carve grooves into the sea bed, which impedes regrowth, leading to bottom erosion. Lobster and crab traps pulled across the beds have the same effect. Similarly, sand is often dredged for reclamation purposes, or simply to deepen a shipping channel. At the same time, the dumping of such dredged material, for example from a marina, can smother the ill-fated seagrass.

Type	Spatial extent	Magnitude of impact	Duration	Frequency	Reversibility
Biological impact Invasion and establishment of populations of exotic species	May eventually cover the entire region	Absolute or relative abundance	Long-term	Continuous new state	Often irreversible
Chemical impact Non-point source; chronic poisoning	May be on a local scale or in whole region	Biological effects (e.g. death of fish)	Long-term	Continuous	Slowly reversible
Accidental, point source; acute poisoning	Local	Biological effects (e.g. death of fish)	Short-term	Low frequency	Reversible for individuals and population
Physical impact Structural change due to hydrological changes and mechanical disturbances	Local	Magnitude of change in forest cutting; discharge of pollutants; and distribution of discharge over time	Long-term	Variable, depending on types of regulation	Often reversible
Thermal impact Discharge of cooling water, mainly from power plants	Local	Biological effects (too warm for some species)	Long-term	Continuous	Often reversible
Human impact Fire wood collection; reclamation of land	Local	May lead to total loss	Long-term	Continuous	Lost land often non-reversible

Table 1. Some Examples of Different Factors with Impact on Mangrove Swamps (modified from Kumar and Hader, 1999).

Measures have been taken in many places to control such environmental hazards and to restore degraded habitats, restock fingerlings and establish artificial reefs in order to increase marine productivity. However, enforcing new laws has often been met with opposition. Ocean regeneration (see , Ocean Regeneration) requires a coordinated and integrated plan. There is a necessity to monitor the overall quality of the marine environment and properly control land-based pollution discharged into the oceans. Fundamentally, education programs for fishermen and the general public should be provided because these programs are essential to the long-term benefits of coastal communities as well as marine ecosystems. It has also been recommended that involvement of the private sector be sought to establish and facilitate a cost-effective co-management strategies of the marine environment in the coming century.

Nonetheless, only when those who depend on the oceans for food are adequately fed, will there be meaningful conservation of the marine environment. Innovative means to replenish fish stocks are also necessary. Aquaculture now contributes more than 20 per cent to global aquatic food production. Total annual production of fish and shellfish is slightly in excess of 100 million tons. New technology, such as artificial upwelling of deep-ocean nutrients, has further enhanced biological productivity unencumbered by limitations on the land-based aquaculture.

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Biographical Sketches

Born in Changhwa, Taiwan, on 22 April 1949, **Prof. Chen-Tung Arthur Chen**, his wife and two daughters are currently residing in Kaohsiung, where he has been Professor at the Institute of Marine Geology and Chemistry since 1986. After receiving his B.Sc. degree in Chemical Engineering from National Taiwan University in 1970, Prof. Chen was awarded his Ph.D. degree in Chemical Oceanography from the University of Miami in 1977. In the same year, he was appointed Assistant Professor in the College of Marine Sciences of Oregon State University, where he was later promoted to Associate Professor in 1981. He served as visiting professor at National Sun Yat-Sen University (NSYSU) in Kaohsiung, Taiwan, and as Chargé de recherche (CNRS), Université Pierre et Marie Curie in Paris during 1984-1985. During this period, he founded the Institute of Marine Geology at NSYSU, and served as its director until 1989 when he was made Dean of the College of Marine Sciences, a position he held until 1992.

Prof. Chen has sat on numerous international committees, including the Scientific Committee on Oceanic Research and the World Ocean Circulation Experiment. He also served as one of the executives of the Scientific Steering Committee of the Joint Global Ocean Flux Study (JGOFS) between 1992-1995. Just prior to that, he had helped to form the Joint JGOFS / LOICZ Marginal Seas Task Team in 1991, and served as its chairman until 1995. Prof. Chen is at present one of the editors of *Oceanography Journal* and associate editor of *Marine Chemistry*. Besides having more than 150 of his own scientific papers published, Professor Chen was awarded the highly-coveted Biowako Prize for Ecology from Japan in 1997.

Wen-Yan Chiau is an Associate Professor in the Department of Marine Environment and Engineering at National Sun Yat-sen University in Kaohsiung, Taiwan. After earning his B.Sc. in Urban Planning (1976) and L.L.M. (1980) in Taiwan, he was granted his M.A. in Urban Planning (1989) and Ph.D. in City and Regional Planning (1991) from the University of Pennsylvania. Dr. Chiau's expertise is in the field of environmental planning and management, especially in the areas of coastal zone management, wetland conservation, coastal tourism, ocean policy and environmental law. He is author of the first book on coastal zone management in Chinese entitled, *Coastal Management: Theory and Practices*, published in November 2000. During his some 20 years as a planner and conservationist, he has served as both project manager and principal advisor on a wide range of projects related to the marine environment. In addition to giving lectures, conducting research projects and advising graduate students, he actively participates in related governmental affairs and serves as a member of various governmental *ad hoc* committees. Currently, he is a member of the Council of Agriculture's Wildlife Conservation Committee, the highest-level agency formulating conservation policies in Taiwan. He also serves as an advisor for the Subcommittee on Sustainable Development of the Legislative Yuan (Congress), as reviewer of the "National Biodiversity Report" and as vice coordinator of the committee on "National Oceans Policy". As part of his active involvement in international matters vis-à-vis the marine environment, Dr. Chiau has been one of the representatives of the Chinese Taipei Delegation in the APEC Meeting of the Marine Resource Conservation Working Group since the sixth meeting in Sydney, B.C. in 1994.