THE OCEANS: EXPLOITATION OF RESOURCES AND POLLUTION

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Let me begin with Byron's Childe Harold's Pilgrimage:

> *Roll on, thou deep and dark blue ocean roll!!*
> *Ten thousand fleets sweep over thee in vain;*
> *Man marks the earth with ruin his control*
> *Stops with the shore.*

And we can generally agree, that if control stops with the shore, nowadays the ruin certainly does not; but it decreases quite quickly away from it.

Approximately 71 percent of the Earth's surface is composed of the oceans together with the enclosed and fringed seas. There are three main zones of the sea: beyond the coastline there are the continental shelves, descending gradually to about 650ft (198m) below the sea level and the site of most human effects upon marine ecosystems. The next is the continental slope, falling steeply from the edge of the shelf to about 8,000ft (2,438m); and beyond that the deep ocean. Being most accessible to the land masses as well as the shallowest part of the ocean, the continental shelf is most often emphasized in studies of marine resources. These resources can be divided accordingly between the biological and mineral resources.

Biological resources

There is still a general trend for greater use of marine biological resources for food. Usually the eutrophic zone in which photosynthesis can occur is only about 60m deep and it is where we find the highest concentration of primary producers. The primary productivity upon which life depends is not uniform over the whole ocean area. The coastal zone has a high productivity because of its proximity to the sources of mineral nutrition. But direct harvesting of all the phytoplankton by man is technically difficult and hence costs are high. Largescale direct cropping of phytoplankton does not yet seem to be a very feasible food or fodder source. The removal of organisms would mean taking away nutrients and these would have to be replaced, just as if it were an agricultural system. Zooplankton presents similar cropping problems.

The third trophic level yields a great number of desired species. At each stage there is competition for the production by species which are not important resources of food for man. A further harvest comes from detritus feeders which scavenge from the sea-floor.

World fish landings ran at 70 million megatons and approximately half the crop is consumed directly by humans, the rest being used as livestock feed. Indian catches ran at 2.3 million megatons of live weight and consumption of fish is low. The consumption per head of fish is highest in developed countries, Japan and European countries and their livestock also being major users of fishmeal.

The potential for extending fisheries comes from three sources: the utilization of untapped species, the cropping of hitherto unattractive areas and the development of more novel methods of culture and harvesting. In the future, less direct ways of increasing the crop of marine resources could be systematically investigated. When nutrients are limited, fertilization by the addition of minerals to the sea may bring about higher productivities.

The first stage away from a hunting and gathering economy is that of herding as, for example, in Japan and Hong Kong. Such systems are very productive but they are very vulnerable to contamination, because their ability to concentrate substances toxic either to themselves or to consumers is very high. True aquaculture involves genetic manipulation of the chosen species by keeping them captive throughout their breeding cycle, a difficult though not impossible task. The requirements are unpolluted sea water and a suitable coastal site with adjoining land. A general disadvantage of aquaculture seems to be the considerable skill needed for success. This is yet another competition in the underdeveloped countries for scarce, trained manpower. I hope that the money would be better invested in aquaculture than larger fishing fleets!

In summary, the food resources of the sea can under the most optimal circumstances never be a panacea for all nutritional problems of the world. Only one quarter of the present world population could be fed of marine food. Because the main use of marine food is for protein, we assume that for the world population in the year 2000, world catches will supply about 30% of the world's minimal protein requirements but only 3 percent of its biological energy demands.

Mineral resources

The sea as mineral resources can be divided into three categories: those which are dissolved in the sea water itself; sediments present on the sea-bed at various depth; and those present at some depth below the sea-floor, beyond the sediments.
At present, only salt, magnesium and bromine are being extracted in commercial quantities and the sea does indeed seem to be inexhaustible for these elements. Some elementsömagnesium, sulfur, potassium, strontiumöoffer the highest chances of economically feasible recovery processes. For example, 34,000 x 10 liters of sea water, would yield 400 megatons of zinc. It may be possible to use the capacity of marine organisms to concentrate desired elements, and in the possible exploitation of zones along the sea-bed where fractures allow the escape of unusually high concentrations of mineral ions.

Sediments and sedimentary rocks in the continental shelves are sources of certain minerals. Placer deposits contain workable quantities of different metals such as gold, tin, nickel, cobalt. The land-use problems created by their extraction from the land would largely be obviated by the use of the sea as a source, provided that the ecosystems of the oceans were not too greatly damaged by the recovery processes, which create great quantities of silt and also eventuate an imbalance in the sedimentary systems of the sea-floor. Further resources of the continental shelves are fresh water, petroleum and natural gas, which are already exploited in many offshore waters up to depths of 2 to 2.5 km. The minerals of the deep ocean basins are difficult to appraise.

Ocean pollution

Industrialization and agriculture are now introducing pollutants into the oceans in quantities which are beginning to cause significant deleterious effects on resources and the environment. The residence time in the oceans of the pollutants is minimally a matter of decades. The process of transport to the ocean and accumulation to detectibility, but not necessarily ineffectual levels is also in many cases a matter of decades or centuries.

Productivity of marine resources can be reduced by destruction on or change of habitat as well as bio-accumulation of chemicals, especially in the coastal zones. Long-distance atmospheric transport of pollutants is also affecting the open ocean environment far from the sites of direct discharge and origin. Because of their enormous volume, sea waters are potentially capable of much dilution of polluting wastes. However, the ocean waters themselves are not the ultimate resting place for many wastes entering the oceans. There are two basic kinds of marine ecosystems: coastal and oceanic.

Pollution of coastal ecosystems

Coastal waters, including coastal wetlands and reefs, account for only 10 percent, whereas the relatively less productive open oceans constitute 90 percent of the total area of the global marine environment. The coastal waters and ecosystems are highly productive biologically and very important for human society.

In the next two decades, a significant consequence of many projections will be a dramatic growth in coastal development. Population pressures will lead to rapid rates of coastal settlement and urbanization, especially in less developed countries (LDCs). Coastal dredging is likely to be extensive. Dredging, filling, paving and construction of terminals, factories, settlements and roads will increase water pollution, and will greatly reduce productivity, diversity and stability of coastal and adjacent ecosystems. Increasing marine traffic transport may bring chronic pollution.

The introduction of non-native species into coastal ecosystems may bring biological pollution. Estuaries and coastal wetlands accumulate natural, riverborne as well as wastes from nearby industrial and urban areas. It is estimated that 60 to 80 percent of the commercial marine fisheries species are dependent upon estuarial ecosystems. Salt marshes and mangrove communities are distributed all over the world and are either associated with estuaries or coastal barrier islands. The marsh environment creates an area of biological productivity that then yields 10 megatons of organic material per acre per year. The tropical mangrove communities are highly productive as well.

Salt marshes have been regarded globally as prime areas for industrial siting. Mangrove ecosystems are also facing destruction through development. There is widespread and rapid degradation or destruction of extensive mangrove areas along the coasts of Africa, Malaysia, Indonesia, India and Australia.

Coral reefs are among the most extensive and productive shallow marine communities. The coral reefs have been damaged or destroyed entirely as a result of poorly planned and managed dredging.

Coastal waters constantly receive polluting materials through river discharge, coastal outfalls, dumping and atmospheric transport. The agriculture, population, minerals, forestry and energy projections suggested that the amount of waste materials entering the coastal zones will increase between now and the year 2000. Toxic chemical contamination is largely uncontrolled. The projected increases of pesticide and herbicide use have serious implications for the coastal environment. The impact of sewage, silt, and fertilizer nutrients will grow and have critical local and regional consequences. Collectively, the anticipated amount of coastal pollution is seen to be a major problem for the marine environment in the future.

Toxic waste pollution is one of most serious threats to the health of the coastal oceans. Toxic substances include those that are carcinogenic, mutagenic and teratogenic. Only few chemicals are adequately tested for toxicity and environmental hazards. Studies to determine environmental persistence, transport, and long-term biological effects are expensive and synergistic effects complicate analysis of the data. Pollution of the United States and European rivers is a dramatic illustration of toxic substance contamination that ultimately is transported to the seas. Synthetic organic chemicals (DDT, PSB) have been reported as causing a reduction in the photosynthetic rate of marine algae at very low concentrations. In some cases DDT has proved to be toxic to fish. PSBs compounds are now widespread pollutants. Besides being dangerous to human health, they are toxic to some marine organisms.

The other toxic substances are heavy metals. The heavy metals pollution is most evident in the coastal zones, especially where mixing processes are slow. Most heavy metals are bioaccumulated in different components of the marine food web. The effect of heavy metal concentrations on the development of marine organisms is only beginning to be understood. Ultimately, most reactive heavy metals are deposited relatively rapidly in the sediments of the coastal zones, seemingly out of the water layers where they may play a determinate role in biological processes.

Artificial radioactive materials are the other sources of the toxicity for the marine ecosystems. The largest source of radioactive materials entering the oceans has been nuclear explosions. Although the nuclear tests ban has reduced the rate at which radioactive materials enter the seas, nuclear energy production and the use of radioactive materials has continued the flow of radioactive isotopes into the terrestrial environment and into the oceans.

In the decades ahead, the total artificial radioactivity in the oceans is projected to be the same order and magnitude as it was in 1970, i.e., about 10 EBq. Transuranics, fission products, and induced radioactive species are now found in sea water and in ocean biota almost universally. The biological or environmental significance of this contamination is virtually unknown.

The fossil fuels are the next serious contaminants into the marine environment. As oil exploration continues worldwide, increasing numbers of extraction facilities will be established in coastal zone areas. Sublethal and long-term damage to marine ecosystems may result from chronic discharges and accidents during normal offshore and dockside operations, from disposal of drilling muds and cuttings, and from disturbance of the sea-bed and coastal wetlands by platform and pipeline construction. The influence with which fossil fuel pollutants affect the marine environment varies. Although the long-term implications of low-level oil contamination are just beginning to be understood, it is now well-established that petroleum hydrocarbons adversely affect a wide variety of marine organisms.

There are plenty of the other problemsösewage, fertilizer nutrients, solid waste and sedimentation on a global scale of the marine environment pollution.

Summary

Even under ideal institutional conditions the sea is not an inexhaustible provider of food and mineral resources. The projection of past trends in landings into the future assumes that coastal fish harvesting will not rise more rapidly than in the past. We must be very careful and not ignore geographical differences in population and income growth and the effects of these different rates of growth on world fishery products.

The total world harvest of marine renewable resources, based on exploiting natural production, could be increased substantially by the next two decades, perhaps to as much as 100 million megatons. To achieve this, however, will require overcoming severe social and economic constraints.

The balance and equilibrium of the marine ecosystem cannot be radically perturbed. We will need more information to evaluate the real possibilities of sustained increases in yield, especially in marine aquaculture. Dredging and deep-sea mining will disrupt coastal and oceanic ecosystems. Industrial, agricultural, domestic and energy-related pollutants, will adversely affect biological productivity in coastal waters and interfere with aquaculture. Continued deforestation will lead to destructive silt deposition in river estuaries, deltas and on coastal shelves. Coastal zones everywhere will be affected in one way or another.

In the 21st century we will need no dead or dying global oceans but the healthy and productive marine environment. We must therefore look for a revolution in technology and the human spirit which will reverse the destructive trends now threatening us all.

Dr. **Vaclav Mejstrik**, botanist and ecologist, graduated from the Agricultural University of Prague with a degree in agronomy and has also received a degree in natural science and biology from Charles University. He obtained his Ph.D. and D.Sc. at the Czechoslovak Academy of Science. Dr. Mejstrik continued his studies at the University of Canterbury in New Zealand, at the University of New Brunswick in Canada and at the Institute of Soil Microbiology at the Academy of Sciences in the former U.S.S.R. In the course of studying and researching his fields of interest, Dr. Mejstrik has travelled to twenty-five different countries. He has also published close to four hundred different scholarly titles as well as several books. Dr. Mejstrik, currently Director of the Institute of Landscape Ecology of the Czech Academy of Sciences, was formerly also the Director of Technical Management for the South Bohemia Biological Centre in Ceske Bodejovice.