world ocean review
Living with the oceans.

Overall conclusion

In this first "World Ocean Review", we present a report on the state of the oceans which will be followed by periodic updates in the future. Our aim is to reveal the consequences of intense human intervention for the ocean realm, including the impacts of climate change. We already understand some of the effects, but many unanswered questions remain. What is certain, however, is that human society must change its behaviour with the goal of achieving sustainable interaction with the environment and the oceans in particular. Worldwide, the winter of 2010 was the warmest in the past 131 years. Global climate change has caused a gradual rise in the Earth's average temperatures. In the coming years the rate of glacial melting will probably accelerate. Sea-level rise will become more rapid. Present calculations indicate that there will probably be a rise of at least 80 centimetres within this century, with as much as 180 centimetres being predicted for the worst-case scenario.

The immense water masses of the ocean act as a buffer, storing considerable amounts of carbon dioxide and heat from the atmosphere. Climatic changes therefore only gradually become noticeable. Scientists anticipate that if greenhouse gas emissions continue unchecked, the sea level could rise by as much as 5 metres by the year 2300. Most of the "mega-cities", with populations greater than 10 million, are located on or near the coasts. It would require enormous sums of money to protect them, and presumably many of them will have to be abandoned. The ocean may be buffering the most severe consequences of climate change for now. But in the long run we can only hope to avoid these if we strictly curb greenhouse gas emissions today. Experts are concerned that hundreds of thousands of tonnes of methane hydrate could break down due to the warming of seawater – gas masses that are lying inertly in solid, frozen form in the sea floor sediments today. A portion of the methane, which is a powerful greenhouse gas, could then rise into the atmosphere and further accelerate the process of climate change – a vicious circle.

The oceans absorb many millions of tonnes of carbon dioxide annually. They are the largest "sink" for anthropogenic CO_2 emissions. The excess carbon dioxide, however, upsets the chemical equilibrium of the ocean. It leads to acidification of the oceans, the consequences of which are unpredictable. Acidic water disrupts the sense of smell in fish larvae, carbonate formation by snails, and the growth rates of starfish. The phytoplankton, tiny algae in the ocean and vital nutrient basis for higher organisms, are also affected by acidification.

The coastal environment is still being damaged by effluent and toxic discharges, and especially by nutrients conveyed to the ocean by rivers. Thousands of tonnes of nitrogen and phosphorus compounds flow into the ocean around the world, causing an explosion in algal reproduction. In many coastal regions the catastrophe begins with the death of the algae. Bacteria feed on the algal remains and consume oxygen in the water. In these oxygen-depleted zones all higher life forms die off. Efforts to reduce nutrient levels have been successful in Western Europe. Worldwide, however, the input of nutrients is becoming increasingly problematical. People are, without a doubt, abusing the oceans in many respects, and this is increasing the stress on marine organisms. Through overfertilization and acidification of the water, rapid changes

in water temperature or salinity, biological diversity in the ocean could drop worldwide at increasing rates. With the combination of all these factors, the disruption of habitats is so severe that species will continue to disappear.

It is still uncertain what consequences will ensue from the gradual poisoning of the marine environment with pollutants such as polyfluorinated compounds, which have been used for years as components in non-stick surfaces for pans and in outdoor jackets. These substances become concentrated in the nutrient chain and have recently been detected in the tissue of polar bears. Clearly the oceans continue to be the "last stop" for the dregs of our civilization, not only for the persistent chemicals, but also our everyday garbage. Six million tonnes of rubbish end up in the ocean worldwide every year. The trash is a fatal trap for dolphins, turtles and birds. Plastic is especially long-lived and, driven by ocean currents, it collects in the central oceans in gyres of garbage covering hundreds of square kilometres. A new problem has been identified in the microscopically small breakdown products of plastics, which are concentrated in the bodies of marine organisms.

In the medium term, however, there is a positive trend with regard to ocean pollution. The number of oil spills has decreased. Spectacular tanker accidents now only contribute around 10 per cent of the oil contamination in the oceans. Less conspicuous oil pollution, on the other hand, continues to be a problem. Around 35 per cent of the worldwide oil pollution originates from everyday shipping operations. This source is much more difficult to deal with. As was demonstrated by the explosion of the "Deepwater Horizon" drilling rig, new problems may arise with the trend towards producing oil and gas from wells from greater water depths.

Humans are destroying the marine environment not only through pollution, but also through greed. 80 million tonnes of fish with a market value of around 90 billion US dollars are caught every year. As a result, the fish stocks are now severely overfished or are completely depleted. This situation has been caused by a flawed fisheries policy that strongly subsidizes fishing. Protection of jobs has always been more important than the protection of living resources. This is an extremely shortsighted view. The Common Fisheries Policy (CFP) adopted by the European Union is a notorious example. The European Union's Council of Ministers has regularly set the catch quotas too high, overriding the recommendations of fishery biologists who have long been warning of overexploitation and depletion of stocks.

Fish are not the only living resource that humans harvest from the ocean. The recovery of medically and industrially useful materials from the sea is becoming more interesting for scientists and commercial enterprises. In recent years substances extracted from marine organisms have been used in cancer therapy and to fight viruses. Businesses have long resisted joining in the expensive search for active agents in the oceans. But with the establishment of new start-up companies, the commercialization of marine medicine has accelerated. The young businesses, however, rely heavily on government subsidies initially.

The large oil and mining companies are looking for very different kinds of marine resources. Drilling for oil in the oceans has been going on around the world for decades. The proportion of gas and oil extracted from the ocean has been growing steadily, and today it represents around one-third of worldwide production. Moreover, in the coming years the mining of ores and manganese nodules will likely begin on a large scale. Methane hydrates are also becoming increasingly interesting. If the industrial production of methane becomes viable, we will have tapped a gigantic energy reservoir. In theory, the hydrates would be dissolved at the sea floor under controlled conditions and the methane extracted. However, it is not sure that this will work. Critics are concerned that large quantities of methane could escape uncontrolled from the sediments.

Humankind is forging into the deeps as never before. Because of the scale at which resources on land are being depleted, mining in the ocean depths is becoming more attractive and potentially lucrative. In 2007 and 2008, before the economic crisis, mineral resources had reached exorbitant prices. The mining of the ocean, which experienced a period of high interest in the 1970s

before becoming inactive for a time, thus became attractive again in spite of the subsequent crisis. Presently, the precious-metal rich ores near once-hot submarine springs and manganese nodules in the central Pacific appear to be especially promising. Mining of the ore deposits could begin in the near future. Environmentalists, however, fear that this could cause the destruction of deep-sea habitats. The large-scale harvesting of manganese nodules is also viewed critically by some. The first claims in the Pacific have already been awarded to various countries, including Germany.

The development of renewable energy in the oceans as an alternative resource, on the other hand, harbours much less risk. Present approaches include systems for wind and wave energy, tidal and ocean-current power plants, and even plants that use salinity and temperature differences to produce electricity. All of these technologies combined could satisfy a considerable proportion of the world's energy needs. As a general principle, however, before environmentally friendly techniques of energy production can be established, their potential impacts on the marine environment need to be investigated. Some marine regions will undoubtedly be excluded from development for ecological reasons. Scientists recommend that regions be identified where different technologies can be combined, such as wind turbines and ocean-current systems.

Just a few decades ago, no one took it for granted that ocean regions could be surveyed and exploited. There was frequent controversy over the ocean regions. The international community was not able to find any common ground until the adoption of the United Nations Convention on the Law of the Sea (UNCLOS) in 1982. This convention is the most comprehensive agreement in international law that has ever been achieved in the history of humankind. It regulates the areas of interest for coastal nations as well as exploitation of the high seas. A UN agency, in turn, oversees the extraction of resources from the sea floor and equitably allocates claims for the mining of manganese nodules, for instance. In spite of these regulations, there has long been a smouldering controversy among the Arctic countries over who can exploit the resources of the floor of the Arctic Ocean if the sea ice continues to melt.

On the other hand, shipping traffic, which has undergone huge changes in recent decades, is efficiently regulated today. One important milestone was the introduction of the standard shipping container, which has so expedited the loading and unloading of ships that the shipping companies can run their freighters under tight schedules not unlike those of a city bus line. There are now over 53,000 cargo ships, tankers, bulk freighters and container ships carrying goods around the world. The total carrying capacity of the commercial fleet amounts to over 1000 million tonnes.

It is both fascinating and unsettling to think that climate change could open up the legendary Northern Sea Route through the Arctic. Because the Arctic sea ice now thaws extensively in the summer, the sea route from Europe to the Pacific Ocean along the Siberian coast will be open in the future for several weeks a year. This route is much shorter than travelling through the Suez Canal or around the Cape of Good Hope, but its cost-effectiveness, considering stray sea ice and possible passage fees, is not yet clear. Nonetheless, it would allow traffic to avoid the dangerous route through the Gulf of Aden and past the Somali coast, at least in the summer. The number of pirate attacks there has greatly increased recently. The situation in the waters east of Africa, however, should not detract from the fact that piracy has been declining worldwide in recent years.

During the more than two years of work on this report, we have often asked ourselves whether it is possible to portray the ocean in all of its facets. The only honest answer to this question is "no". The oceans are too large and the subject matter too complex to even begin to claim complete coverage of the topic. Moreover, many scientific questions are still unresolved. We have nonetheless tried to draw as comprehensive a picture of the state of the oceans as possible. We hope that this report will make at least a small contribution towards steering a sustainable course.

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