

Nearly a billion ocean-dependent people at risk because of global warming

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A recent study published in *PLOS Biology* has analyzed the chemical changes in the Earth's oceans caused by excessive greenhouse gas emissions. It determined the cascade of events that are likely to occur if current ocean warming and acidification trends continue: the destruction of marine habitats, the extinction of ocean species and ultimately devastation of the livelihoods of nearly 1 billion people (the actual range is 470 million to 870 million) who depend on the ocean to survive.

The report was developed by an international team of collaborators, including climate modelers, biogeochemists, oceanographers and social scientists. They created global distribution maps of 32 marine habitats and biodiversity "hotspots" to assess their potential vulnerability to changes. In addition, researchers used available data on human dependency on ocean-based goods and services and included social adaptability in order to estimate the vulnerability of coastal populations to projected changes in the chemical makeup of Earth's oceans.

Among the many marine habitats studied were coral reefs, seagrass and shallow soft-bottom benthic beds. These habitats are predicted to experience the largest changes in ocean chemistry and will be affected first. Deep-sea habitats, where excess greenhouse gases take longer to percolate to, will most likely experience the smallest changes. However, the report makes clear that under the current trends, no part of the ocean will be untouched by 2100.

Lead author Camilo Mora of the University of Hawaii at M?noa pointed out that because greenhouse gas emissions are a global phenomenon, the rise in ocean acidification is also global, with simultaneous effects in every part of the world. In the press release for the paper, he stated, "The consequences of these co-

occurring changes are massive – everything from species survival, to abundance, to range size, to body size, to species richness, to ecosystem functioning are affected by changes in ocean biogeochemistry."

The research used the models of climate change developed for the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR5) to make their projections. Using data on the worldwide changes in ocean temperature, acidification and oxygen content, they developed two scenarios: the first where carbon dioxide emissions (CO₂) are left unchecked and reach a concentration of 900 parts per million (ppm) in the atmosphere by 2100; the second where CO₂ levels only reach 550 ppm, given a concerted effort to end CO₂ emissions immediately. World CO₂ concentrations stand at 394 ppm as of October 2013, up from 312 ppm in 1961.

In both scenarios, the researchers found that most of the world's ocean surface would be impacted. The report states:

"By 2100, global averages for the upper layer of the ocean could experience a temperature increase of 1.2 to 2.6° C, a dissolved oxygen concentration reduction of ~2% to 4% of current values, a pH decline of 0.15 to 0.31, and diminished phytoplankton production by ~4% to 10% from current values. The seafloor [is] projected to experience smaller changes in temperature and pH, and similar reductions in dissolved oxygen."

Essentially, the ocean food chain, the basis of life on Earth, is poised to completely break down.

It starts from the high amount of CO₂ emissions generated by current industry. Although the CO₂ is pumped into the atmosphere, about half of that eventually gets absorbed by the oceans. Until now, this has resulted primarily in slightly higher ocean temperatures and the subsequent rise in ocean levels of

about a foot over the past century. However, as more and more carbon dioxide is pumped into the oceans, it eventually forms the compound carbonic acid, which makes the surface of the oceans on average 30 percent more acidic.

Such a large change in the ocean's acid content has a profound effect on shell-based marine organisms. Crabs, oysters, mollusks and plankton create their shells or skeletons out of dissolved calcium carbonate in seawater and form two minerals, calcite and aragonite. Coral reefs use the same process. However, carbonic acid both blocks the process by which shells are built and dissolves already existing shells. This essentially kills these creatures, which, particularly in the case of plankton, lie at the base of many food chains.

This also has an impact on all types of fish and other harvested sea life. Increasing acidification can cause a build-up in body fluids, called acidosis. It causes problems in growth, reproduction and respiratory systems. Combined with overfishing, petrochemical discharges into rivers and oceans, and garbage, there is a growing risk of driving seafaring species to extinction.

Another danger to sea life is the dumping of fertilizers and sewage into oceans, which causes an explosion in algae growth. Higher algae content reduces the oxygen levels in water, which in turn creates "dead zones" where fish and other sea life cannot survive, let alone reproduce.

Polar regions are predicted to experience somewhat different problems. There is less acidification, but polar ecosystems will have to contend with sudden invasions of species from lower latitudes seeking to escape increasingly uninhabitable areas. This will result in threatening local organisms and the people who depend on them.

What is not as well known is what will happen to ecosystems on the deep sea floor, which covers most of the Earth's surface. They provide a variety of known environmental functions, including carbon sequestration in seafloor sediments, buffering of ocean acidity, and providing an enormous reservoir of biodiversity. However, there has been very little study of effects of climate change on these areas. It is generally thought that the consequences will be similar to the surface but on a slower timescale.

That hundreds of millions of people stand to lose everything as a result of climate change is a clear reason to marshal humanity's technical and social resources to overcome the impending environmental catastrophe. It cannot do so, however, under the unregulated and unrestrained pursuit of personal profit based off the capitalist system. Only under a rationally planned society based on social need can the preservation of the world's oceans be assured.



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