WHITE PAPER

Oceans, Climate Change and Human Health

A Briefing Organized by the Center for Health and the Global Environment, Harvard Medical School

Mounting pressures degrading marine ecosystems include: 1) excess nutrients from fertilizers, sewage and fuel emission aerosols; 2) loss of coastal wetlands (that filter wastes and provide nurseries for marine life); 3) toxic chemicals and heavy metals from industry, farms and fossil fuel extraction and use; and 4) oil spills and leaks. Now, growing evidence indicates that climate change is compounding these threats by: 1) increasing sea levels and storm surges; 2) warming oceans and changing ocean circulation patterns; 3) endangering species that hold potentially useful pharmaceuticals; and 4) driving more extreme weather that threatens coastal communities, ground water supplies, and generates pulses of micro-organisms, nutrients and toxic chemicals into waterways.

These combined stresses threaten human health, livelihoods and economies, as well as the stability of climate, itself – the system that underlies water distribution and quality, food security, and public health. Health outcomes include: an increased incidence, intensity and duration of harmful algal blooms ("red tides"); numerous "dead zones" (e.g., the Gulf of Mexico, Malakoff 1998); increasing contamination of seafood with biotoxins and infectious agents; closures of beaches and shellfish beds; salinization of ground water, especially in Gulf States; reduction of key food elements (zooplankton) for penguins, seabirds, marine mammals and fish; and severe weather affecting agriculture and disease incidence. These impacts also carry economic costs for the seafood and allied industries, such as trade, tourism, and insurance.

Scientific analyses (Epstein et al., 1993; Harvell et al., 1999; See: http://heedmd.org/) suggest that extreme weather and warmer oceans contribute to harmful algal blooms (HABs) and marine-related diseases. Heavy rains flush nutrients into waterways, helping to trigger HABs (whose occurrence has increased five-fold along U.S. coasts since the 1970s), while runoff from storms can introduce pathogens into shellfish beds (Dowell et al., 1995; McDonnell et al., 1997). Beach closures from algal blooms, fecal contamination and oil spills are also common. In 2001, a record 13,000 beach closures were officially reported in the U.S. (Surfrider Foundation Beach Report, 2002).

Prolonged warming and hypoxic (low-oxygen) conditions from blooms harm coral reefs and seagrass beds, affecting nursery habitat for finfish and shellfish. Since 1985, "brown tides" (non-toxic blooms that cause hypoxic conditions) have suffocated seagrasses and shut down shellfish beds in Long Island, where landings of scallops dropped from a value of $1.2 million in 1984 to $2,400 in 1988 and have remained at low levels ever since (http://heedmd.org/). Stresses are impacting marine life: in 2002 the California Department of Fish and Wildlife reported an unusually large number (over 1,000) of marine mammals stranded or dead on state beaches, along with blooms affecting hundreds of seabirds, including endangered brown pelicans, with the neurotoxin domoic acid.

Ocean Circulation

Climate change, a National Academy of Sciences panel warned, will be full of surprises. Weather patterns have become more variable and extreme and the World Meteorological Organization reports that this is attributable to increased heat in the climate system. Disproportionate warming near the poles and increased ocean temperatures are melting sea ice. In the past three decades, North Polar floating ice has shrunk from ten to five feet thick during summer, and Greenland is losing 9% of its ice cover each decade.

The "deep water pump" involves the sinking of cold, *salty*, water and pulls the warm Gulf Stream north, driving the ocean conveyor belt that has stabilized climate over millennia. Now, fresh water from the thawing ice and increased rainfall in the northern ocean is layering across the surface of the North Atlantic, decreasing salinity. Dr. Ruth Curry and colleagues at the Woods Hole Oceanographic Institution have also reported that the tropical Atlantic is concurrently become saltier.

These large-scale changes in ocean circulation have potentially huge ramifications for the stability of our climate in the future with large-scale effects on human welfare. Even now, evidence suggests that anomalous sea surface temperatures are related to prolonged droughts, spurring fires and respiratory disease, and heavy downpours encouraging clusters of mosquito-, water- and rodent-borne disease.

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Sea Level Rise

Sea level rise (SLR) associated with global warming is already being noted in the Gulf States. Global SLR is projected to accelerate two- to four-fold during the next century, increasing storm surges. Recent projections of sea-level rise during the next 100 years (480 millimeters) coupled with recent monitoring show that areas of New Orleans and vicinity that are presently 1.5 to 3 meters below mean sea-level will likely be 2.5 to 4.0 meters or more below sea level by 2100. Some of this is due to geological settling of landmasses (subsidence); most is due to SLR.

The U.S. Gulf of Mexico coastal zone is particularly vulnerable to inundation because of its low elevation, rapidly deteriorating coastal barrier islands and shorelines, and relatively high rates of subsidence. Natural coastal resources including estuaries, wetlands, forests, fisheries, and wildlife are tightly linked to sea level, tidal flooding, and the exchange of saline and fresh water. SLR and storm surges can have health consequences that include salinization of ground water, loss of shellfish beds, increased mosquito breeding grounds, and property and infrastructure damage.

Methylmercury

Life cycles of fossil fuels (see http://www.med.harvard.edu/chge/oil.html) have other marine and health consequences beyond climate change alone. Methylmercury is a common seafood contaminant that illustrates the complex interactions between marine pollution, accumulation in food chains, and human health. Because fish is an affordable source of essential nutrients and calories, and including fish in the diet may help prevent cardiovascular disease and other ailments, contamination is costly. While mercury, in small amounts, occurs naturally in the marine environment, anthropogenic mercury emissions contaminate marine food chains. According to an EPA report to Congress in 1997, coal-fired power plants contribute about 33% of the atmospheric mercury emissions in the U.S, with medical and municipal waste incineration providing significant, additional contributions. Direct sources include industrial plants that emit mercury into soil and waterways, and contaminations of muds from oil rigs that use mercury as a lubricant in the Gulf of Mexico (U.S. Department of the Interior, Minerals Management Service, 2001 http://www.gomr.mms.gov/homepg/regulate/environ/ongoing_studies/gom-fe.html).

Recent research in several countries has shown that even small amounts of mercury from seafood may have adverse effects on health. In particular, methylmercury interferes with the development of the brain in the fetus and the small child. Even small deficits may be of substantial importance, because complete brain functions are so crucial for quality of life and success in society. Furthermore, changes incurred during development are likely to be permanent, thus leading to lasting deficits. These new insights emphasize the potential serious consequences of marine pollution.

Costs

There is increasing volatility and rising risks from extreme weather. Yearly losses from natural disasters (primarily from extreme weather events) increased from $4 billion annually in the 1980s to $40 billion in the 1990s; reached $55 billion in 2002 and $60 billion in 2003. The United Nations Environmental Programme estimates that annual losses from extreme weather events could reach $150 billion by the end of this decade if current trends continue. Swiss Re, the world's second-largest re-insurance company, recently announced that it plans to become a greenhouse neutral company and has opened a Washington, DC office to advance policies to mitigate climate change.

Additional References:

Dowell SF, Groves C, Kirkland KB, et al. Multistate outbreak of oyster-associated gastroenteritis: implications for interstate tracing of contaminated shellfish. J Infect Dis 1995;171:1497--1503.

Epstein, P. R., T. E. Ford, and R. R. Colwell. Health and climate change: Marine ecosystems. The Lancet 1993; 342:1216-1219.

Harvell CD, et al. Diseases in the ocean: emerging pathogens, climate links, and anthropogenic factors. Science 1999: 285:1505-1510.

Mallakoff D. Death by suffocation in the Gulf of Mexico. Science 1998; 291: 190-192.

Steinberg EB, Greene KD, Bopp CA, Cameron DN, Wells JG, Mintz ED. Cholera in the United States, 1995–2000: trends at the end of the millennium. J Infect Dis 2001;184:799–802.

Burkett, V.R., Zilkoski, D.B., and Hart, D.A. 2003. Sea-level rise andsubsidence: implications for flooding in New Orleans. U.S. Geological Survey Subsidence Interest Group Conference, Proceedings of the Technical Meeting, Galveston, Texas, November 2729, 2001. Keith R. Prince and Devin

L. Galloway, Editors. U.S. Geological Survey, Water Resources Division OpenFile Report 03-308, pp. 63-70.

Curry, B Dickson and I Yashayaev 2003. A change in the freshwater balance of the Atlantic Ocean over the past four decades. Nature 426: 826-829.

Grandjean P, White RF, Weihe P, Jørgensen PJ. Neurotoxic risk caused by stable and variable exposure to methylmercury from seafood. Ambul Pediatr 2003; 3: 18-23.

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