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Reservoirs May Be Hiding Extent of Global Sea Level Rise

The impact of climate change and other factors on global sea level rise may be greater than expected. According to a recent study in *Science*, approximately 2,600 cubic miles (10,800 cubic kilometers) of water lie in reservoirs, and the on-land sequestration of that water has reduced the magnitude of sea level rise by approximately 1.2 inches (30 millimeters). By factoring that volume of impounded water into calculations, the study's authors—Ben Chao of the National Central University in Taiwan and colleagues—demonstrated that instead of proceeding in an uneven manner as had previously been believed, global sea level has been increasing at an average rate of approximately one-tenth of one inch (2.46 millimeters) every year.

Sea level rise is attributed primarily to thermal expansion of the top layers of the ocean and to mass addition of water from the melting of mountain glaciers and the Antarctic and Greenland ice sheets. Tide gauge data show that global sea level has risen on average by approximately 0.7 inches (1.7 to 1.8 millimeters) a year during the 20th century, almost 0.3 inches (0.7 millimeters) less than would be the case if the removed water were factored into the equation.

Chao and his co-authors note, however, that although on average dam construction has soared during the past 50 years, it has distinctly slowed down during the last three decades, primarily due to environmental concerns. Furthermore, they

note, such a slowdown is likely to continue. As a result, the impoundment of water in reservoirs is not likely to remain a consistent counter to observed rates of sea level rise, and it is therefore possible that those rates will spike upward during coming years and decades.

Source: Chao, B.F., et al. 2008. Impact of artificial reservoir water impoundment on global sea level. *Science* **320**: 212-214

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Review Examines Resilience of Mangroves to Tsunamis and Climate Change

Do mangrove forests provide protection from tsunamis?

The notion is a popular one, and a recent review in the journal *Estuarine Coastal and Shelf Science* concludes that it may be true—depending on the circumstances. The review, by Daniel Alongi of the Australian Institute of Marine Science, notes that the factors determining the extent that mangroves can protect land from tsunamis include: the width of the forest, the slope of the forest floor, tree density, tree diameter, proportion of above-ground biomass vested in roots, tree height, soil texture, forest location (such as whether it is on the open coast or in a lagoon), the type of adjacent lowland vegetation and cover, the presence of foreshore habitats such as seagrass meadows, coral reefs or dunes, the size and speed of the tsunami, the distance from the tectonic event and the angle at which the tsunami hits the coastline.

The idea that the presence of mangroves along the Tamil Nadu coast of southeast India saved lives during the Indian Ocean tsunami of December 26, 2004, has become accepted wisdom, Alongi writes. However, he contends that this conclusion was based on a study that used “inappropriate statistical tests.” Even so, several studies appear to support the notion that mangroves offered “significant defense against the full impact of the tsunami.” Analyses of the entire Tamil Nadu coast pre- and post-tsunami did indicate less destruction of man-made structures located directly behind the most extensive mangrove forests.

Alongi also considers the evidence in support of speculated impacts on mangroves as a result of climate change. He finds that in many cases, mangroves are likely to keep pace with sea level rise, while in experimental conditions, increased atmospheric CO₂ and warmer air temperatures generally led to increased transpiration efficiency and increased rates of photosynthesis respectively.

However, he notes, responses and impacts depend on such factors as humidity, regional human development or freshwater input from rivers (which would counteract increased salinity from sea level rise). “Clearly,” he writes, “some mangroves will survive and perhaps even thrive with the predicted changes in climate. But it is just as clear that some won’t survive.”

In the meantime, he points out, mangroves are at risk from “a more predictable and insidious threat.” Deforestation is causing mangrove loss at an average rate of one to two percent per year. As a result, Alongi concludes, “most of the world’s mangrove forests may be lost before the peak impacts from climate change will be felt.”

Source: Alongi, D. 2008. Mangrove forests: Resilience, protection from tsunamis, and responses to global climate change. *Estuarine, Coastal and Shelf Science*. **76: 1-13.**

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Australian Government Pushes Vision for Future of Whaling Commission

Twenty-six years after the International Whaling Commission (IWC) voted to adopt an indefinite global moratorium on commercial whaling, such whaling continues. Japan alone has killed approximately 10,000 whales in the Antarctic and North Pacific under a provision in the IWC convention, which allows Member States to “kill, take, and treat whales for purposes of scientific research.”

Although Japan insists it is conducting legitimate scientific research that addresses issues of importance to the management of whale populations, independent researchers have frequently criticized the quality of the science. An IWC Workshop, held in Tokyo in December 2006, reviewed the first decade of Japan’s “research whaling” program in the Antarctic and delivered a damning indictment. It found, for example, that the program’s attempts to estimate natural mortality rates of minke whales were so imprecise that they could not rule out the possibility of those mortality rates being zero—could not, in other words, discount the notion of minke being immortal.

A document released by the Government of Australia at an IWC meeting in London in March posits that, “The

conduct of scientific whaling has created significant tension at the Commission,” and that the “unilateral killing of whales” by countries using either the research whaling loophole or conducting openly commercial whaling under objection to the moratorium “remains the greatest impediment to moving the Commission forward in the future.”

That the Commission does indeed need to move forward is highlighted, says the report, by the changes that have taken place since the IWC Convention was written in 1946: Many whale populations have decreased dramatically as a result of commercial whaling. New threats to whales have arisen, including overfishing, toxic and noise pollution, ship strikes and global climate change. And the public attitude worldwide toward whales has changed to one that is now overwhelmingly supportive of their conservation.

The document notes that, although the Commission is considered the preeminent authority on conservation and management of whale populations, that management is presently restricted to setting catch limits for directed hunts of the great whale species. It presently has no mechanism in place to, for example, reduce bycatch or regulate whale-watching operations.

The Australian government proposes that the IWC address some of these shortcomings by developing conservation management plans that address, for example, the recovery of South Pacific humpbacks, the highly endangered status of northwest Pacific gray whales or the impact of climate change on whales in high latitudes. This would link the IWC with other international fora such as the Convention on Migratory Species and the United Nations Convention on the Law of the Sea.

However, the document argues that perhaps the most significant and immediate step the Commission must take is a “reformed approach to science.” It points out that the IWC has adopted more than 30 resolutions calling for an end to “scientific whaling” and for all further research to be conducted using nonlethal techniques. However, under the rules established in 1946, any Member State that wishes to kill whales for science can do so without seeking the Commission’s approval. That, say the Australians, has to change.

The document recommends that all scientific research under IWC auspices be brought directly under the control of the Commission, and that the IWC should agree a set of criteria to which all such research should conform. Such criteria might include quantifiable measures of success, use and availability of nonlethal methods, and a transparent and open process. In addition, all governments should commit not to issue scientific whaling permits except with the approval of the Commission.

The document concludes that such measures “would strengthen the Commission by increasing collaboration on science and would remove the most serious source of tension that presently impedes the Commission’s work.”

For further information: The document, *Whale Conservation and Management: A Future for the IWC*, is available online at <http://www.environment.gov.au/coasts/publications/pubs/iwc-future-paper.pdf>

Scientists Plead for Action to Protect Vaquita

Now that the baiji, or Yangtze river dolphin, is considered extinct, the vaquita, or Gulf of California porpoise, is the most endangered species of cetacean in the world. It has the smallest range of any porpoise, dolphin or whale; like the baiji, it has long threatened by being caught accidentally in fishing gear. According to a team of scientists writing in the journal *Conservation Biology*, the vaquita may soon be extinct if urgent steps are not taken to ensure its survival.

The scientists sought to answer three questions: How many vaquitas are remaining; how much time is left to find a solution to the bycatch problem; and are further abundance surveys or estimates necessary to justify the *immediate* removal of all entangling nets from the range of the vaquita?

To find out how many remain, they began with a 1999 estimate that 567 vaquitas were present in the northern Gulf of California in 1997. A paper published in 2000 calculated that two of the three main fishing villages in the area each took about 39 vaquitas annually in the course of their fishing operations; the third is believed to be responsible for minimal vaquita bycatch. By assuming vaquitas' birth rate is similar to that of other porpoises, about 4 percent a year, and that the number of porpoises taken per net remains constant while the number of boats setting nets has roughly doubled, the scientists concluded a mere 150 vaquitas remain in the Gulf, a decline of more than 400 in 10 years.

Not surprisingly, their answer to the second question—how much time is left to find a solution to the bycatch problem—was “not very long.” They calculated that it would take approximately two years for the population to decline to only 50 adults, and that risks to survival (as a result of, for example, inbreeding) beyond this time would multiply. “To say that time is running out,” they write, is “an understatement.”

They argue that additional abundance estimates are unnecessary as they are highly unlikely to be more precise: sightings are low because of the vaquita's small body size and group size; because when vaquitas surface they do so inconspicuously; and because they tend to stay clear of boats.

The solution, they urge, is to buy out the fisheries responsible for the incidental entanglement of vaquitas, and to do so quickly. Such a buyout plan, they note, must be developed by socioeconomists with input from local communities and the local and federal Mexican governments. They note that the ministries of environment and agriculture are developing such a plan. Thereafter, a cooperative multinational agreement, including governments, nongovernmental organizations and private donors will need to fund the buyout.

If such a plan fails and the vaquita joins the baiji as an extinct species, they conclude, it “would represent another failure of our

community of scientists to explain in simple terms the plight of a critically endangered species and thus convince decision makers to act decisively and urgently.”

Source: Jaramillo-Legoretta, A., et al. 2008. Saving the vaquita: Immediate action, not more data. *Conservation Biology* 21(6): 1653-1655.

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Increased Ethanol Production May Lead to Even Bigger “Dead Zones” in Gulf of Mexico

Last year, U.S. farmers planted more than 90 million acres of corn for the first time in 60 years because of rising corn prices and a growing demand for ethanol, which is frequently derived from corn, as a gasoline additive. Corn-based ethanol production has risen faster than recent U.S. Department of Agriculture (USDA) projections and has already surpassed the year 2012 target of 7.5 billion gallons per year set in the 2005 Energy Policy Act. The most recent U.S. Energy Bill set a target of 36 billion gallons of renewable fuels by the year 2022, of which 15 billion gallons can be produced from cornstarch.

However, a recent paper in the *Proceedings of the National Academy of Sciences (PNAS)* notes that fertilizer applied to cornfields in the U.S. Midwest is a primary source of nitrogen carried by the Mississippi and Atchafalaya Rivers into the Gulf of Mexico. This nitrogen, largely in the form of nitrate, is a major contributor to a “dead zone” in the Gulf of Mexico. This zone is formed when excess nitrates stimulate the growth of phytoplankton, which can then grow into dense blooms. As this phytoplankton dies, its dead and dying cells sink to the seafloor where bacteria and other microbes decompose them. These bacteria consume large amounts of oxygen from the water, potentially causing “hypoxia,” or oxygen levels too low to support most animal life.

The Gulf of Mexico dead zone presently measures approximately 7,800 square miles (20,000 square kilometers); the Mississippi Basin/Gulf of Mexico Task Force has set a goal of reducing nitrogen export by the Mississippi and Atchafalaya Rivers by 30 percent in hopes of reducing it to under 2,000 square miles (5,000 square kilometers) annually.

However, as the *PNAS* paper notes, an increase in corn production to meet ethanol targets will almost certainly run directly counter to that goal. The paper's authors, Simon Donner of the University of British Columbia and Christopher Kucharik of the University of Wisconsin, observe that, “Producing 15 billion gallons or more of corn-based ethanol from conventional methods by 2022, without any change in cultivation practices, will require

either a large reduction in the use of corn for feed and exports or a large increase in corn cultivation and, in turn, nitrogen loading to the river system.”

They emphasize that reducing the cultivation of animal feed, the primary domestic use of corn and soybean, would be the most effective way to free up land for corn production for ethanol. However, they point out, “that would require a substantial change in culture and the reduction of an industry that provides income and employment to a large number of Americans.” As a result, meeting ethanol targets will almost certainly require a significant increase in the amount of cultivated land given over to corn production.

The authors suggest one way to mitigate the increased nitrate flow into the Gulf would be to construct riparian wetlands (wetlands along the banks of running water systems, such as rivers, streams and drainageways) adjacent to corn and soybean fields. The wetlands would be able to filter out a portion of the nitrates and prevent them from reaching the Gulf. However, Donner and Kucharik calculate that the amount of wetlands that would be required to help reduce this dead zone would be in the order of 8,500 square miles (22,000 square kilometers), which they acknowledge “would not be trivial to implement.”

Source: Donner, S.D., and C.J. Kucharik. 2008. Corn-based ethanol production compromises goal of reducing nitrogen export by the Mississippi River. *Proceedings of the National Academy of Sciences* **105**(11): 4513-4518.

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About Ocean Update

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