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# Source found for missing water in sea-level rise

Human use of water contributes markedly to rising tides.

Amanda Mascarelli

20 May 2012

Climate change, with its associated melting ice caps and shrinking glaciers, is the usual suspect when it comes to explaining rising sea levels. But a recent study now shows that human water use has a major impact on sea-level change that has been overlooked.

During the latter half of the twentieth century, global sea level rose by about 1.8 millimetres per year, according to data from tide gauges. The combined contribution from heating of the oceans, which makes the water expand, along with melting of ice caps and glaciers, is estimated to be 1.1 millimetres per year, which leaves some 0.7 millimetres per year unaccounted for. This gap has been considered an important missing piece of the puzzle in estimates for past and current sea-level changes and for projections of future rises.



Human water use, for example in irrigation, makes a substantial contribution to sea-level rise.

IMAGEBROKER.NET / SUPERSTOCK

It now seems that the effects of human water use on land could fill that gap. A team of researchers reports in *Nature Geoscience* that land-based water storage could account for 0.77 millimetres per year, or 42%, of the observed sea-level rise between 1961 and 2003. Of that amount, the extraction of groundwater for irrigation and home and industrial use, with subsequent run-off to rivers and eventually to the oceans, represents the bulk of the contribution.

Taikan Oki, a global hydrologist at the University of Tokyo and an author on the paper, says that he was initially “astonished” at how well the team’s estimates of terrestrial water usage filled the deficit between the observed sea-level rise and what was accounted for by thermal water expansion and melting ice. “I didn’t expect that terrestrial water storage had such a big impact on sea level,” says Oki.

And, he adds, “I didn’t expect that human extraction of groundwater would matter so much”.

### Time of reckoning

Depletion of groundwater reserves has more than doubled in recent decades as a result of population growth and the increased demand on groundwater reservoirs for drinking water and the irrigation of croplands. Most of the water pumped up from deep pools is not replenished; it evaporates into the air or flows into river channels, feeding into the seas. Artificial reservoirs, such as the Hoover Dam on the Colorado River and the Three Gorges Dam on the Yangtze River in China, have the opposite effect, locking up water that would otherwise flow into the seas. Scientists once speculated that the effects cancelled each other out, but this study and other recent ones have shown that groundwater depletion has a larger net effect.

“The terrestrial contribution to sea-level rise is something that the sea-level community has to reckon with and really take into account,” says Marc Bierkens, a hydrologist at Utrecht University in the Netherlands. A study by Bierkens and his colleagues also found that groundwater depletion contributes significantly to sea-level rise<sup>2</sup>. But they concluded that the contribution of groundwater use to global sea-level change was markedly lower, increasing from 0.035 millimetres per year in 1900 to just 0.57 millimetres per year in 2000.

Both teams used models to simulate the contribution from groundwater extraction, but Bierkens’ team relied on reported data whereas Oki’s team computed the total amount of groundwater pumped around the world and cross-checked its findings in certain regions. Each team acknowledges that its simulations have limitations and says that more on-site measurements of groundwater use are needed.

Nevertheless, the message is clear, says Yadu Pokhrel, a postdoctoral researcher in global hydrology at Rutgers University in New Jersey and lead author of the latest study. “When people pump groundwater, they may think it’s only having local effects. But there are huge implications. If we think about the future, what will happen if we use groundwater in the same way as we are doing today? That’s a question we have to consider if we don’t think of some kind of proper management of water resources.”

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*Nature* doi:10.1038/nature.2012.10676

## References

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1. Pokhrel, Y. *et al. Nature Geosci.* <http://dx.doi.org/10.1038/ngeo1476> (2012).

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2. Wada, Y. *et al. Geophys. Res. Lett.* **39**, L09402 (2012).

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- Marc Bierkens
- Yadu Pokhrel

## Comments

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2012-05-20 06:49 AM

**eric dowler said:** I am puzzled by it all. Do tidal guages take into account variations in the tide height caused by sedimentation in their near area and also wind effects on the heght of the tide? Are there enough of them to cover the vast oceanic coast-lines? Fractions of a millimetre seem to me to be too small to measure in such circumstances. What about the undersea heating caused by volcanoes in Iceland? Can the diameter of the earth vary by the odd millimetre with corresnding changes in the total surface area and can it be includedithe models?

2012-05-22 08:44 AM

**James Dwyer said:** Your questions are very good – there's probably many more that should be answered.

However, the article states that "During the latter half of the twentieth century, global sea level rose by about 1.8 millimetres per year, according to data from tide gauges." Elsewhere the article mentions "the observed sea-level rise between 1961 and 2003." I hope then that the 1.8 mm per year represents measurements supporting around a total 80 mm increase for the duration of sampling.

2012-07-10 04:41 AM

**brown paul said:** Climate can be regional, just as weather is local. By cherry-picking a region where the climate was predicted to warm but where it is snowing because it is winter there, you can muddy the waters<sup>1</sup> even further. And it takes the wind right out of the sails of people who remind you that weather isn't climate. I firmly believe that this one policy has the potential to kill millions of people...possibly more since these companies are now invading some of the countries desperately in need of more food.

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