

US cities to sink under rising seas

We are committed to sea level rise that will flood land that is home to 10 million people

Michael Le Page

IF WE carry on as we are, the land on which nearly 30 million people in the US live will end up below the sea's high-tide line. Even with drastic action to slash carbon emissions – more drastic than some think possible – 10 million homes will be submerged.

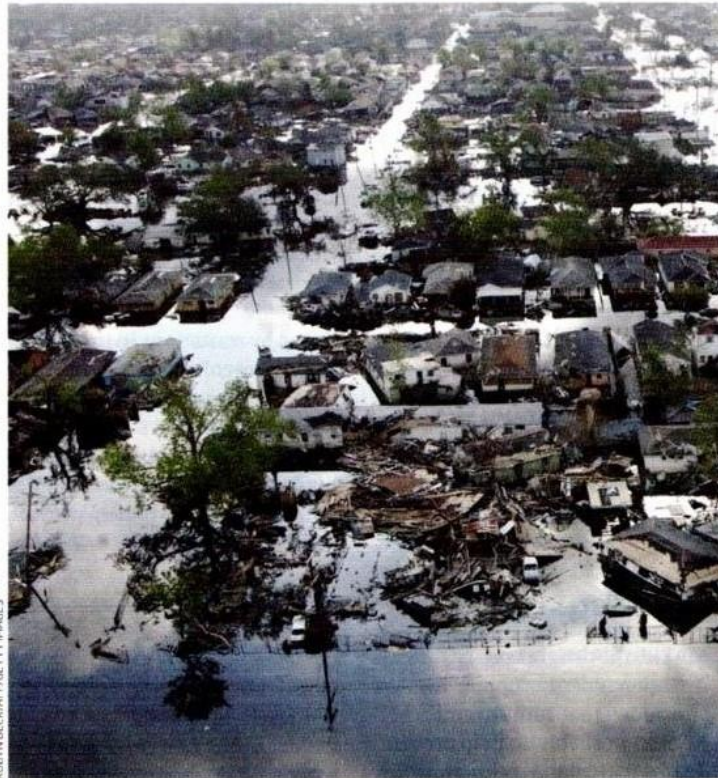
That's the conclusion of the latest study to look at how much sea level rise we are committing ourselves to over the coming centuries. "It's hard to imagine how south Florida and New Orleans can survive in the long run," says Benjamin Strauss of Princeton University. The US is set to lose a state-sized chunk of land, he says. "That should concern any American of any political stripe."

As things stand, sea level is likely to go up by around a metre

by 2100, but the waters will keep rising for centuries or even millennia. According to an earlier study by Anders Levermann of the Potsdam Institute in Germany, every 1°C of warming will lead to a rise in sea level of roughly 2.3 metres over the next 2000 years.

Now Strauss, Levermann and their colleagues have updated this study and worked out what it means for the US (see map, below). Half their scenarios assume that the West Antarctic ice sheet collapses, as several recent studies suggest is now inevitable.

If that happens, we will experience nearly 5 metres of sea level rise (PNAS, DOI: 10.1073/pnas.1511186112). This figure will rise even higher if we don't curb our emissions – in line with what an analysis by *New Scientist* concluded earlier this year.



ROBYN BECK/AFP/GETTY IMAGES

Going, going... gone?

Some coastal cities are already **doomed to disappear beneath the waves** if we carry on emitting carbon dioxide as we are and the West Antarctic ice sheet collapses – and others will join them on the destined-to-drown list later this century



The best case, according to Strauss and Levermann, is that sea level could be limited to an increase of around 2 metres (see graph, right). This depends on a number of optimistic assumptions. The first is that the rapid melting of parts of the West Antarctic ice sheet already under way stops. This could happen if changes in ocean circulation prevent warm currents reaching the base of the ice, Strauss says.

But without "aggressive action" to curb emissions, they say, not even changes in ocean circulation will stop the ice sheet's collapse. So to limit sea level rise to 2 metres, there must be rapid emissions cuts to keep global warming below 2°C.

Cuts on that scale look increasingly unrealistic. Reducing emissions by this much requires either immediate action to curb the lifestyles of the jet-setting elite producing most emissions – which would be politically unacceptable – or sucking carbon dioxide out of the atmosphere, which would be exorbitantly

costly on the scale required, says Kevin Anderson of the University of Manchester, UK.

Another assumption is that Earth's climate sensitivity – a measure of how much warming the planet will experience with a doubling of CO₂ in the atmosphere – is 3°C. However, some studies suggest that over timescales of several centuries or more, sensitivity could be as high as 4.5 or 6°C.

It is possible that sensitivity could be higher because of effects such as the release of methane – a potent greenhouse gas – as

"It's hard to imagine how south Florida and New Orleans can survive in the long run"

permafrost melts, Levermann says. "But the uncertainties are large."

Rob DeConto of the University of Massachusetts-Amherst says his computer models of Antarctica back the idea that slashing emissions might prevent the loss of the West Antarctica ice

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As sea levels rise, flooding looms

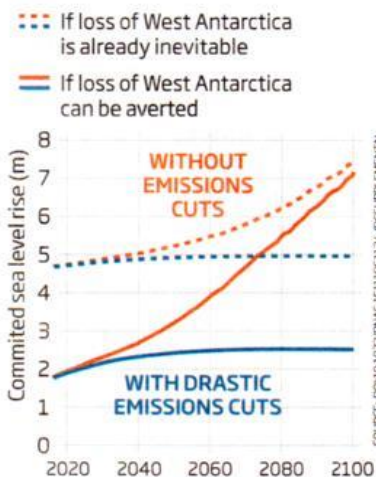
sheet. "It hangs in there," he says.

But for continued high emissions – the path the world is on – DeConto's work suggests there will be much higher sea level rises than Strauss and Levermann expect.

What's more, Strauss's study

Up to our necks

Big rises in global sea level are now unavoidable. Just how high the seas will rise depends on how fast we cut emissions and whether the West Antarctic ice sheet collapses



doesn't take into account temporary changes in sea level due to changes in ocean currents. Freshwater from melting Greenland ice is expected to shut down the Atlantic overturning circulation, leading to local sea level rises of up to 1 metre on the US East Coast.

No protection

Most think this won't happen for another century, but some think it could happen sooner. A temporary sea level jump of 128 millimetres on the US East Coast in 2009 and 2010 is thought to be partly due to a slowdown in the overturning current.

If the world fails to curb emissions and we end up committed to sea level rises of 5 metres or more, what can be done to save cities? That's far from clear. Flood barrier schemes like London's Thames Barrier and the Mose flood barrier in Venice are designed to protect against sea level rises of less than a metre.

This type of barrier can't simply be made ever higher, because most cities have rivers flowing through them. If the barriers have to be kept closed for longer periods to keep sea water out, the river water will dam up behind them and cause flooding that way.

They are also extremely costly. A proposed barrier scheme for New York City would cost around \$20 billion. Many settlements are likely to be abandoned because it will be too costly to protect them. The UK is already allowing some villages to fall into the sea along parts of its coastline.

"We are committing ourselves to changes that will take several centuries to millennia to appear," says Alexander Robinson of the Complutense University of Madrid, Spain. "It's not that in 2100 there will be 7 metres of sea level rise, but if we continue with high CO₂ emissions, we will guarantee that future generations will have to deal with such consequences." ■