

WARMING

WARMING WATERS AND RISING RISKS

The ocean is far, far away from Springdale, Arkansas, located at the foot of the dusty Ozark Mountains. And yet the city is feeling the effects of the rising sea level. Seeking safety, 10,000 of the 72,000 inhabitants of the Marshall Islands have made the city their new home.

The Marshall Islands lie in the Pacific between Hawaii and Australia. The island nation is one of the first countries whose existence has been threatened by climate change. It is only a matter of time before it is overwhelmed, and nearly a third of the population has already left for the safety of the USA.

The reason for their flight is the quickly rising sea level. One factor driving the rise is the melting of glaciers on the mainland. The other is the warming of the ocean: 93 percent of the additional heat that results from global warming is absorbed by the ocean. Since water expands when it gets warmer, the sea level rises. The melting and the warming now contribute in nearly equal measure to the sea level rise. Since 1900 the sea level has risen 20 centimeters on average. It is expected to continue rising at a rate of 3 additional millimeters per year. That may not sound like much, but for a scattered, flat island country like the Marshall Islands it will be fatal. In the past the atolls, which often rise only a meter above the waves, were only flooded by the ocean every couple of decades. That trend has changed: they were swamped three times in 2014 alone. That is too frequent to allow the islands to recover – the land becomes too salty, the freshwater reserves in the lagoons become undrinkable, and the islands themselves can no longer support human habitation.

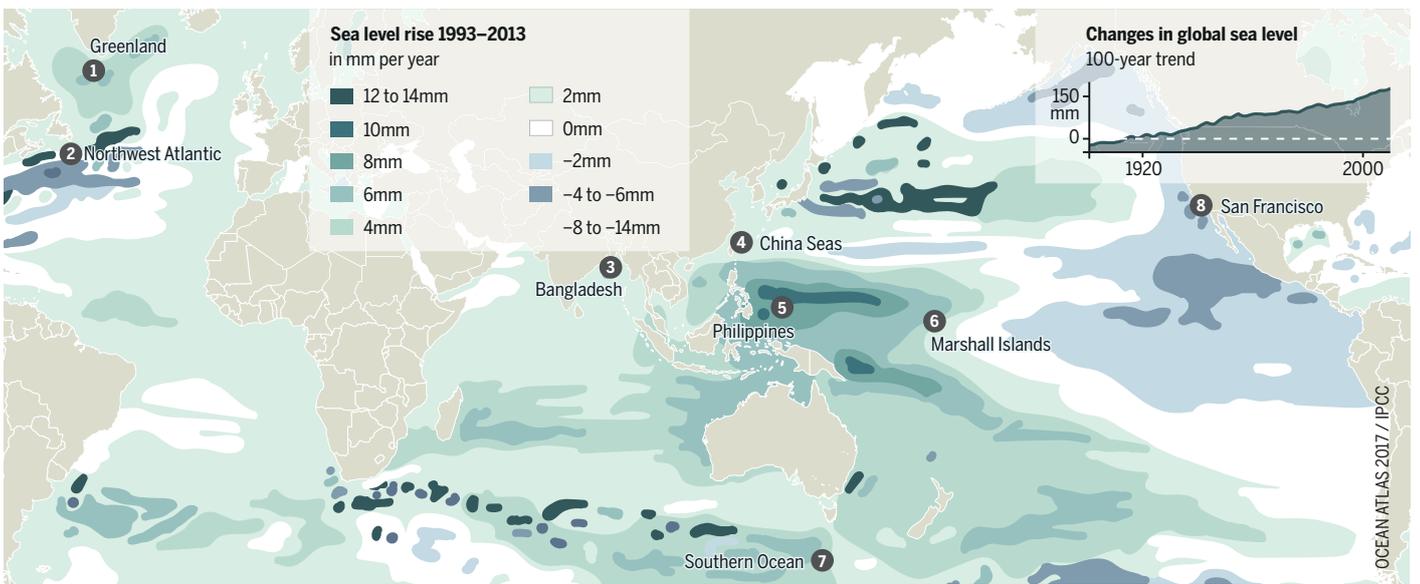
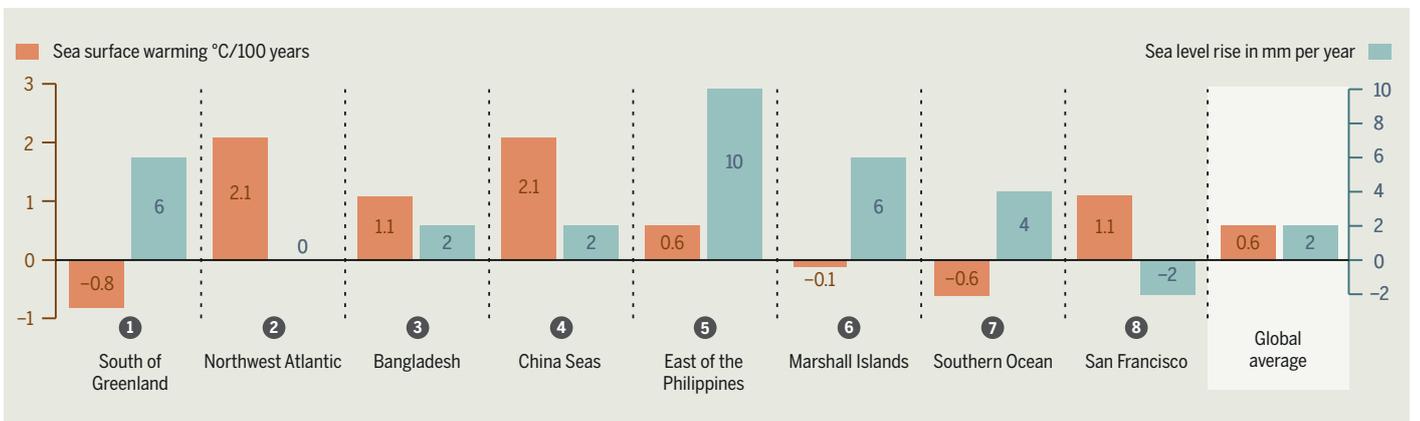
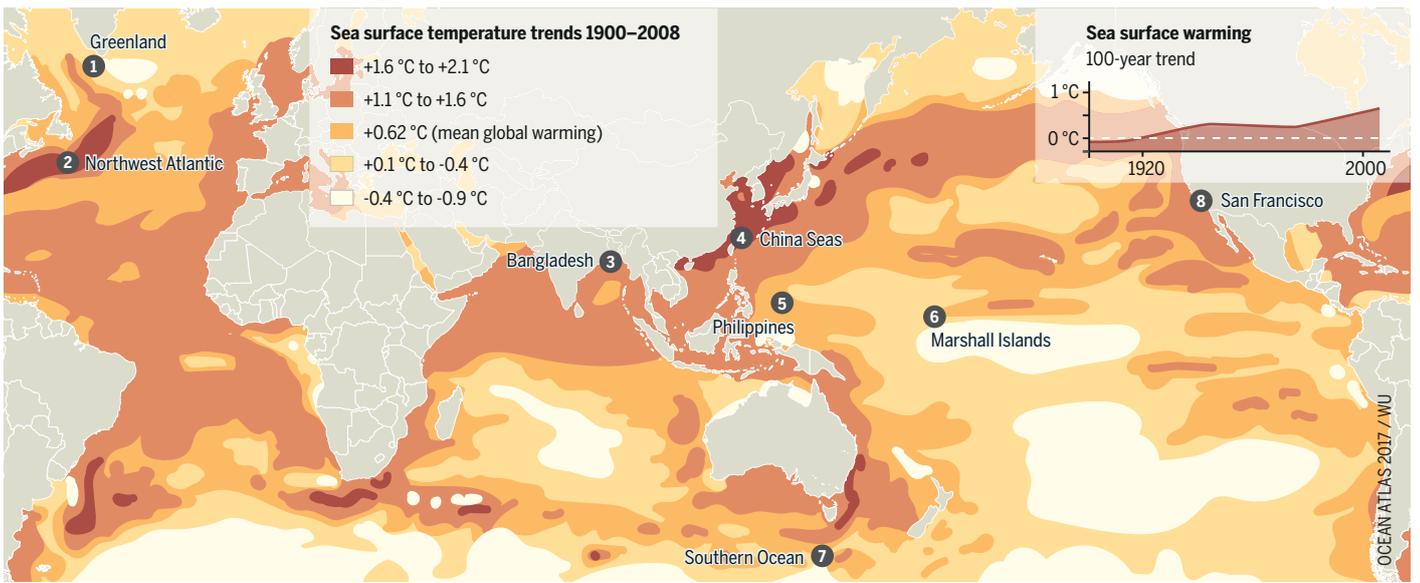
The sea level does not rise at the same rate everywhere, and long-term measurements show significant local variations in the ocean's surface temperature. Some regions in the area of the Gulf Stream have warmed four times more than the global average, while other areas in the South Pacific have cooled slightly. The Marshall Islands themselves lie in a region of weak warming. That is because the sea level does not necessarily increase the most where the warming is strongest. Why? The prime cause of the regional variations in sea level is the wind. For example, in the Pacific, strong trade winds press volumes of water from the east to the west, causing the sea level in the western Pacific to rise at an above-average rate while that of the west coast of the USA actually falls. And this dependence on the wind makes it very difficult for science to provide the answers that people need: What's going to happen in our region in the future? And what do we need to do to adapt? The problem is that reliable predictions about how regional sea levels will change do not exist yet, because the long-term behavior of the wind system is difficult to predict.

Rich states like the Netherlands are investing in research on new, sustainable forms of coastal protection. For example, instead of building dikes they now rely on a constant cycle of sand replenishment whose intensity can be changed based on actual sea level increases in the future. Many poorer countries do not have such means of preparing for the consequences of a warmer ocean and a rising sea level. Consider Bangladesh: it is one of the most densely populated countries in the world, with 160 million inhabitants. In order to make room for the growing population, Bangladesh's gigantic mangrove forests, the Sundarbans, have been partially cut down, with the new living space protected from the surrounding sea by dikes.

The region lies at sea level – and the sea level there has risen at twice the global average over the last two decades. The 13 million inhabitants of the Sundarbans are thus especially vulnerable. In 2009 they were struck by Cyclone Aila. The dikes broke and large portions of the low-lying land were flooded. What remained was a destroyed, salted landscape. Tens of thousands of refugees fled to cities in the interior. In the future, when the dams burst, millions of people may become climate refugees. And the chances of that happening are increasing: meteorologists in Bangladesh record that storms in the region are constantly growing stronger, probably as a direct consequence of the above-average warming of the Indian Ocean.

Rising sea levels, accompanied by more violent weather phenomena and the resulting stronger storm tides present the coast and island dwellers with special challenges. Will it be possible to preserve all the island and coastal cities? This question was strongly debated in the USA when New Orleans was flooded in 2005. Rich countries have protective options while poor countries are struck especially hard. Yet if one considers the causes of these new and adverse climate conditions, it is the industrialized nations that bear a special responsibility for all the world's coastal inhabitants. One step towards shouldering that burden and protecting vulnerable regions is the creation of the UN's Green Climate Fund – it will enable affected countries to take adaptive measures like improving their coastal protection systems. For this to work, though, the industrialized nations must be the ones to provide the necessary resources, and in turn they must be effectively utilized. ●

Global Variations—The Rising Sea Level and Surface Warming



Climate change has accelerated the warming of the ocean and caused a dramatic sea level rise since the beginning of the 20th century.

But the level does not rise at the same pace everywhere in the world; there are regional variations. The sea surface temperature

has increased up to 2°C in some places, while the temperature has actually fallen in others. The global sea level rise was on average 20 cm over a period of 100 years.

Satellite measurements from the last 20 years, however, show strong regional variations in sea level increase.