

## THE ATTACKING OCEAN

Brian Fagan in “The Attacking Ocean: the Past, Present and Future of Rising Sea Levels” (2013) shows that, so far, humans have never more than briefly protected our coastlines against the vastly powerful and unpredictable forces of wind, tide, and earth. Instead we flee the attacking ocean – if we can.

Of the rich and inventive Dutch, whose sea defenses are as sophisticated as anything humans have devised, Fagan asks, will they be enough? Can we ever control the tides?

Even when rising fastest, with the warming following the last glaciation, the seas rose no more than a centimeter or so a year. Thus the greatest immediate threat is not from cumulative sea level rise, but from earthquakes, tsunamis, tropical storms – the last becoming more frequent and devastating as the oceans warm.

And of course from the aftermath of sea surges – destroyed cropland, fouled fresh water, disease, homelessness.

For at least 750,000 years ocean levels have risen and fallen. 15,000 years ago they were 221 meters below modern levels, which stabilized by about 4,000 B.C. Then, with the industrial revolution, about 1860, they began to rise again, and haven't stopped since.

In between, rising seas and slowing rivers provided optimum conditions for humans. Early on, small groups of hunter-gatherers found abundant fish, game, fowl and edible plants in the marshy estuaries and wetlands along rivers. The seas surely attacked, sometimes violently, but small mobile groups adapted by moving temporarily to higher ground.

Then, with the advent of farming and the first cities, when people were wed to the land, sea surges – caused by tsunamis, cyclones, hurricanes – began routinely taking thousands of lives. Most recently was the 2011 tsunami that overwhelmed northern Japan, compromised the Fukushima nuclear plant, and killed 300,000 people. Or, closer to home if less lethal, costly Hurricane Katrina, in 2005, or Sandy in 2012.

The seas are no more deadly now than they were, only there are many more of us in the way. Tens of millions of us live on alluvial plains, and 200 million more along seacoasts, a few meters above sea level or even below it.

And these many humans have contributed substantially to the seas' threat. We've replaced protective marshes and mangrove swamps with real estate or shrimp farms, our dams cause rivers to deposit silt not near shore, where it can build natural defenses, but far out at sea, where it contributes to sea level rise.

Overdrawing aquifers and beach development cause land subsidence, and hence greater risk of surge damage. Political frontiers prevent swift movement of threatened populations, and failure to create international policies will leave displaced people stranded or worse.

Our only long term defenses – savvy from generations of dealing with sea surges, and mobile populations – vulnerable coastal dwellers no longer have.

Who's most immediately at risk? Worldwide -- Bangladesh, Arctic and Pacific islands, the Bahamas, Vietnam, the Philippines, Shanghai, the Low Countries, the south Baltic coast, eastern England, the Nile delta and Venice; in the U.S. -- Miami, New Orleans, Tampa, Virginia Beach and San Francisco Bay; plus anyone living near the sea at or below sea level.

How about standing water over the San Francisco and Oakland airports? Over freeways? The Pacific wouldn't have far to rise, pushed by a big storm.

We need, Fagan says, to start building massive infrastructure to protect coastal cities now, though its completion may stretch far into the future. We need better satellite coverage, better grid technology, a workable federal emergency response. We need to start thinking about people living in low places, especially poor people, who have no high ground to flee to.

And we need to stop putting high rises in those low places – “a stunning act of delusional hubris.”