Sell The Beach House, Buy North Dakota Real Estate

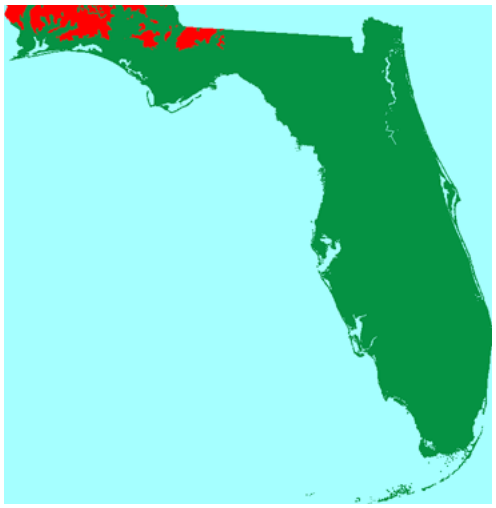
A gentleman once approached me at a holiday party and asked, in all seriousness, how many years could he hope to live in his beach house before rising sea levels would force him out of it? Then he told me that the house was perched on a bluff over forty feet above the ocean! I told him that only folks living so close to the shoreline that they had to sweep water out of the living room every time a wicked 2-mph breeze kicked up had anything to worry about. I said he probably had 300 years to plan on moving day.

On the one hand, he was relieved. On the other hand he was also surprised, because he was under the impression that sea levels were rising much faster than this.

It isn't hard to see how he might get that impression. There is a lot of loose talk in the media about rising sea levels. The knowledge that global warming could flood hundreds of thousands of square miles and displace 20% of the world's population is nothing new, but it certainly received new life and long legs when Al Gore discussed it in his documentary on Inconvenient Truths. That documentary featured some ominous graphics which showed the entire state of Florida going underwater – if all the ice on Earth were to melt.

That last is a very big if, of course. More importantly, it is a very big when. There is little doubt that global flooding will occur, if we continue down the road we're on, but when it might happen is another matter. Fortunately, no matter what political decisions we make, the time it might take for Maximum Florida Flood Day (MFF Day) to arrive is something we can estimate, given a few basic assumptions.

Let us start by assuming that the current amount of greenhouse warming will continue without change. Now, the world's consumption of fossil fuels has been relentlessly moving upward for decades, and the pace is *accelerating* as I write this in 2012. Contrary to the impression that the media often gives, with their well-intentioned stories on Boy Scouts heating their clubhouses with solar energy, this is a great time to be the owner of a coal mine. No leading economist believes that the demand for coal and oil will even level off, never mind start to drop, within the next 20 years. So, the assumption of no change is as spectacularly rosy-cheeked and optimistic as you can imagine.

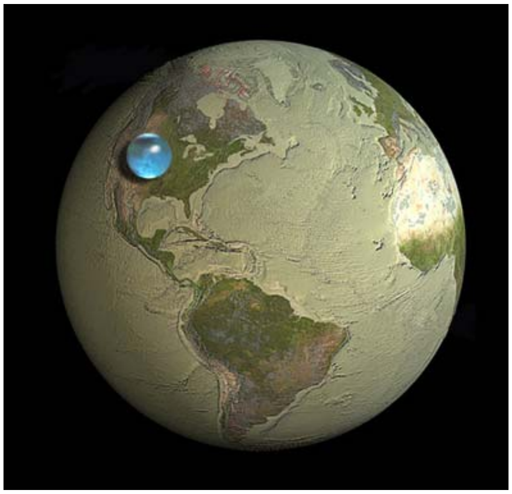


But let's use it anyway, just to see where it gets us. The total volume of ice and snow on planet Earth is about 40 million cubic kilometers, as calculated from satellite images and radar data on the depth of the ice at the poles. If all this were to melt, it would indeed raise sea level by about 77.5 meters, or 255 feet. (The highest point in Florida is at 345 feet altitude, so in fact some of the state would escape. But not much. Florida is pretty flat. The graphic at left shows what would be left of Florida if the oceans were to rise to their maximum level. That little part in red is it.) 40 million cubic kilometers of ice translates into 4×10^{19} kilograms. The energy needed to melt a kg of ice is 334 kilojoules, so the energy needed to melt all of Earth's ice is $(4 \times 10^{19}$ kg$) \times (334$ kJ/kg$) = 1.34 \times 10^{25}$ J.

The degree to which the greenhouse warming created by human activity has increased the amount of solar heating (as compared to Earth in the year 1750) was calculated in an exhaustive, authoritative, 106-page report issued by the United Nations in 2007. This number, which is known as the degree of ***greenhouse radiation forcing***, turns out to be 1.6 J/m^2, according to the best data available.[1] The Earth has a radius of

[1] P. Forster, V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D.W. Fahey, J. Haywood, J. Lean, D.C. Lowe, G. Myhre, J. Nganga, R. Prinn, G. Raga, M. Schulz and R. Van Dorland, 2007: Changes in Atmospheric Constituents and in Radiative Forcing. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

6370 km, so at any given time it has $\pi r^2 = (3.14159)(6{,}370 \text{ km})^2 = 1.27 \times 10^{14} \text{ m}^2$ of surface area facing the Sun. The total excess energy being absorbed by the Earth due to greenhouse warming is thus $(1.6 \text{ J/m}^2) \times (1.27 \times 10^{14} \text{ m}^2) = 2.04 \times 10^{14}$ joules per second, or 6.44×10^{21} joules per year. So, if we simply divide the energy needed to melt the polar ice caps by the current warming rate we get $(1.34 \times 10^{25}) / (6.44 \times 10^{21}) =$ 2080 years to melt all the ice on Earth.



However, there are other things on Earth that are absorbing greenhouse heat besides the ice caps, and by far the main one among those is the ocean. The oceans of the Earth are quite cold once one gets beyond the range into which sunlight can penetrate, which is only a few hundred feet. The deep ocean in fact has an average temperature near the freezing point of fresh water, because the oceans consist of salt water and salt water freezes at a lower temperature than fresh water. (This is why they spread salt on snowy winter roads.)

The Earth's surface contains 1,386 million cubic kilometers of water, which is a huge amount, but maybe not quite as huge as you think. The very amusing illustration at right[2] shows what all the water on the Earth would look like if you could gather it into a single ball. The ball would only be about 860 miles across, which as you can see isn't all that huge when compared to planet Earth! Even the oceans cannot cool us forever.

But, back to our estimate. 80% of the ocean consists of cold, deep-sea water. To warm this water from near-freezing (4 ˚C) to the typical ocean surface temperature (about 20 ˚C) would take an amount of heat $\Delta Q = mc\,\Delta T$, where $m = (0.8)(1.386 \times 10^9 \text{ km}^3)(10^5 \text{ cm/km})^3(1 \text{ g/cm}^3) = 1.18 \times 10^{24}$ g, $c = 4.186$ J / g ˚C, and $\Delta T = 16$°C. If we make a fairly generic estimate that maybe half of the oceans' mass can be heated like this before the Earth's overall temperature reaches equilibrium, then we have an estimate of 3.72×10^{25} J needed to heat the oceans. Using the 6.44×10^{21} joules per year of excess greenhouse heat that we previously calculated, the time needed to warm the oceans is then $(3.72 \times 10^{25} \text{ J}) / (6.44 \times 10^{21} \text{ J/ yr}) = 5770$ years. Adding in another 2080 years to melt the ice gives us 7850 years until MFF Day.

What does this estimate tell us, and what does it not tell us? It does *not* tell us that we have until exactly 9862 AD to twiddle our thumbs while we wait for the ice caps to melt. It tells us, in essence, that about 7850 years is the absolute maximum time until MFF Day, because we obtained this estimate by assuming nothing will change in the next 7850 years. Unfortunately, almost anything you can think of is likely to make global warming worse and therefore reduce the time to MFF Day. The amount of fossil fuel that we are burning is rising. There are vast amounts of methane gas (a strong greenhouse gas) buried in the northern permafrost and at the bottom of the ocean, and that might well be released as the Earth warms. The white snow of the polar caps helps reflect sunlight and cool the Earth, but that effect will diminish as the caps shrink. The burning of coal and wood and other fuels that produce "black soot" helps the Earth to absorb heat and make it hotter. And on it goes. We can melt the polar ice caps in far less than 7850 years, no question.

On the other hand, our estimate tells us that MFF Day won't come in the next 50 years, or 100 years, or 150 years. There is just too much water and ice to be warmed first. Estimates have their place, even very rough estimates like this one, which is why I was able to reassure the gentleman at the holiday party that he has nothing to worry about regarding his beach house, no matter what the human race does or doesn't do within my lifetime.

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[2] Jack Cook, Woods Hole Oceanographic Institution, taken from "Water in Crisis: A Guide to the World's Fresh Water Resources", Peter H. Gleick (editor), 1993, Oxford University Press, New York.

We can sharpen our estimate somewhat if we realize that most of the excess carbon dioxide in the Earth's atmosphere has been put there in just the past 50 years. The world has maybe 100 years of fossil fuel left, so if we assume that humanity will burn ALL of it before we get serious about alternative energy sources (and sadly, my friends, that is one assumption I am willing to take to the bank), then we will roughly double the rate of warming. This brings the time for MFF Day down to 7850/ 2 = 3925 years. Still a long way off.

One could well argue that you don't need to flood Florida 255 feet deep for rising sea levels to be a big problem. True enough, and 20 feet is plenty to devastate coastlines everywhere from New Orleans to New York to London. However, our estimate puts even this deadline (20/255)(3925) = 300 years away. Call me a cheerful fool, but I think our civilization can easily deal with an advancing sea level that is this slow, partly because we won't have any choice, but mostly because 300 years is a lot of years by the standards of modern human civilization.

So, now that I have disposed of rising sea levels as a real threat (or at least an immediate real threat), what then is the real threat? And the answer is: complexity.

You see, the Earth is a complex system, in the physics sense. I can define what I mean by "complex in the physics sense" by giving you an example. If you put a rock and a sleeping puppy on a table and poke them both, it is very easy to predict what the rock will do. It will slide 1.5 centimeters. The rock is not a complex system. The puppy, on the other hand, is quite complex. It might wake up and wag its tail. It might whine piteously and run away. It might bite your finger. It is very hard to tell.

The Earth may be made of rocks and air, but when it comes to how its climate and its ecosystem behave and react to each other, it is much closer to being a puppy than it is to being a rock. And the simple fact is, our forced global warming is poking the Earth, and poking it, and poking it. It is extremely difficult to predict exactly what the final result of all this will be, but it is even more extremely naïve to imagine that the final result will be nothing. Well-intentioned newscasters often ask scientists "what the chances are" that all of Alaska's permafrost will melt, or that some other specific scenario will come to pass. The short answer is, we don't know – as far as any given one of those consequences are concerned. But now ask me "what the chances are" that ***some*** consequence will happen, somewhere, to someone, sometime soon, and I'll tell you what they are: 100%. If you poke a sleeping puppy then something will happen. You might not know exactly what, but you do know the puppy won't behave like it is made of plaster of Paris.

So it is with planet Earth. The Earth is simply too complex to do nothing as we continue to poke its climate harder and harder as the years roll by. This is the real reason we need to fear global warming. That is, the real danger lies in subtle shifts in atmospheric circulation that suddenly create devastating droughts here, or torrential flooding there. The small fact that we cannot predict exactly when or where this might happen is as irrelevant as the fact that we cannot exactly predict next month's weather. Dramatic scenarios such as Florida disappearing under 255 feet of water are way cool, and eco-liberals love to talk about them, but they aren't the real danger. The real danger is a subtle shift of wind here, a gentle hic-up in the jet stream over there, a bit too much humidity someplace else, and then dramatically – and unpredictably – the weather in some part of the world changes severely and makes life almost untenable for the people living there.

We may be seeing some of this already, in the form of the severe droughts that have hit the American Southeast over the past few years. The resulting water shortages have goaded the states of Georgia, Alabama, and Florida into spending dismaying amounts of money suing each other over the water in the Chattahoochee River basin. I freely admit that these "water wars" have been going on for years, and this essay is certainly ***not*** the place to discuss the in and outs of every federal court decision concerning water usage in the Southeast.

However, this is the place to note that many global warming models predict significantly less rainfall for the southern parts of the U.S., and the metropolitan Atlanta area is not excepted. Any water decisions in this area of the nation which ignore the fact that the average rainfall has a real probability of going down, way down, and staying down for decades if not centuries, is just whistling in the dark. Building more reservoirs and the like only works if there is rain to fill the reservoirs. Were they wise, the politicians in Georgia, Alabama, Florida, and Washington, DC, would even now be considering new water laws for the Southeast that would allow for the fact that Atlanta may soon have a climate more like southern Texas than the Old South Of Magnolia Blossoms.

But of course they aren't wise, and they won't consider anything of the sort. Which is exactly the ***real*** threat that global warming poses. The real threats will not dramatically flood Florida until it disappears; the real threats will slip up on us, heavily disguised as mere weather trends, and won't make the full impact of their disastrous arrival known until after many years have passed. The real threats are doubled and redoubled by the fact that we have "leaders" who were once presented with irrefutable, point-blank scientific evidence that the sea walls around New Orleans would ***not*** protect it in the event of a severe hurricane – Scientific American magazine reviewed this prediction at least two years before Katrina hit – and they did nothing but whine that strengthening the walls would be "too expensive".

In the end, the biggest threat from global warming is ourselves, because too many of us simply will not pay attention to the best information that science has to offer.

P.S. – The title of this essay, by the way, comes from the fact that global warming will certainly not be a negative thing for everyone. The Earth will have winners as well as losers. Any place that is now well inland and has a generally cold, dry climate will almost surely benefit from global warming. I don't expect North Dakota to become the new California, but it might well become the new Kansas.