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Field Notes:
Extreme Weather and Community Resilience

COLLAPSE OF THWAITES GLACIER IN ANTARCTICA: A WAKE-UP CALL FOR U.S.

Steven Steinhour June 10, 2014

WHAT HAPPENED?

On May 14, 2014 a team of scientists from the University of Washington confirmed that the 70.3 square-mile Thwaites Glacier has begun a slow collapse into the waters of the stormy Southern Ocean that encircles Antarctica. The glacier serves as the lynchpin holding the entire West Antarctic Ice Sheet in place. The Thwaites collapse raises the uneasy question of whether this may be just the first atmospheric-heating tipping point. The collapse appears to be irreversible, long-term and capable of disrupting the U.S. society, its economy and much more.

The Antarctic Ice Sheet (AIS) covers the entire south polar continent. It is a solid cap of ice extending over 5.4 million square miles. That is roughly the area of the U.S. and Mexico combined. The vast West Antarctic Ice Sheet (WAIS) represents slightly less than one-half of that area and has, in places, solid ice up to 1.2 miles thick. Thwaites Glacier occupies only a fraction of the coastal edge of the WAIS, but it is located in a critical position that blocks seaward movement of the WAIS.

Sea Face of Thwaites Glacier-Photo NASA

How glaciers collapse and melt into the sea
Photo Credit Beforeitsnews

For thousands of years, the Southern Ocean edge of Thwaites Glacier has been locked in place by resting on a grounding line, which is a submerged rocky ridge extending up from the ocean floor. On its landward side, the glacier blocks the rest of the WAIS from sliding into the ocean. The glacier has, in recent years, been moving seaward at an increasing pace. But now, the warming ocean has melted its submerged edge, decaying that critical point of stability on the underwater grounding line. The glacier is now beginning to break up and melt more quickly into the ocean. Once the glacier melts entirely free and begins floating, it will collapse at a much faster rate. When it can no longer provide a barrier to the West Antarctic Ice Sheet, nearly half of the Antarctic continental ice sheet may begin to slide into the Southern Ocean.

AND, THIS WOULD MEAN?

The physical collapse of the Thwaites Glacier into the sea means that over the next 200 to 500 years it will largely or entirely disappear. It could even vanish more quickly if hotter air and warmer ocean water melt it faster. Over the course of the next several centuries, freshwater from this single melting glacier could raise oceanic sea levels by an extra 2 to 4 feet above sea level rise from other sources. Glaciologist Dr. Richard Alley, of Pennsylvania State University and not involved in the study, put the now-certainty of that additional sea-level rise into perspective: "Very crudely, we are now committed to global sea level rise equivalent to a permanent Hurricane Sandy storm surge."

CURRENT FORECASTS OF SEA LEVEL

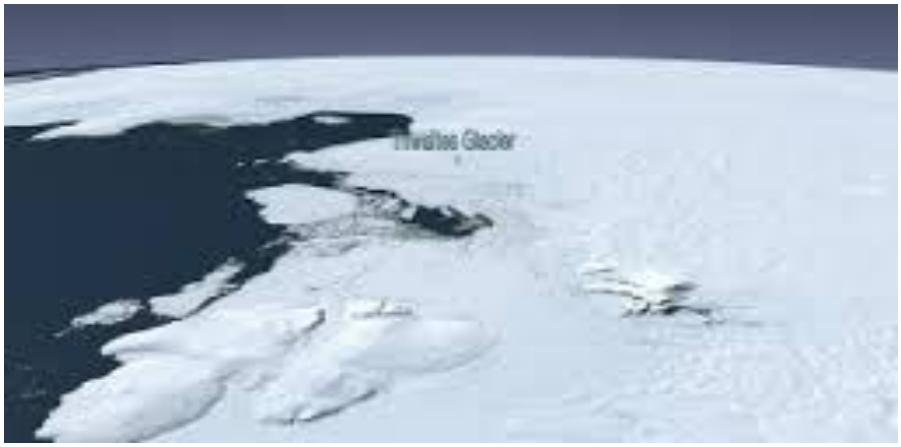
The recently published U.S. National Climate Assessment (NCA) states: "The oceans are absorbing over 90% of the increased atmospheric heat associated with emissions from human activity…water expands as it warms up…causing sea levels to rise. Melting of glaciers and ice sheets is also contributing to sea level rise at increasing rates."

The NCA forecasts average sea-level rise of 1-4 feet by 2100 based largely on thermal expansion of the warming ocean and previously-known smaller glaciers. Adding in the melting of Thwaites Glacier, the NCA raised the upper range of that estimate to 6.6 feet by 2100. If atmospheric and oceanic heating are not reversed, sea level will continue to rise by that amount, or more, for century after century.

As a point of reference for relative scale, Florida has 4,730 square miles of area that is lower than 5 feet above current sea level. Miami and other cities are within that low-elevation zone.

RISK OF LOSING THE ENTIRE WEST ANTARCTIC ICE SHEET

If humans push atmospheric and oceanic heating to even higher temperatures, the entire West Antarctic Ice Sheet could, over many more centuries, slide into the ocean and melt.



Thwaites Glacier relative to West Antarctic Ice Sheet-Photo NASA

Were that to happen the melting WAIS could raise average global sea-level by an additional 10 to 16 feet. Potential melting of the West Antarctic Ice Sheet is a worst-case outcome. Because of its massive size, it has the capability to fundamentally disrupt and potentially both force abandonment of cities and damage economies in every coastal nation of the world. We are facing centuries of this risk according to England's Royal Society in a study that analyzed

outcomes under a scenario of reducing CO2 emissions to zero over the next 50 years. The study concluded that it would take another 400 (most optimistic case) to 1,000 (most likely case) years before atmospheric temperatures dropped enough to permit most glaciers and ice sheets to refreeze to their former stability as hard-frozen ice.

WHY SHOULD WE CARE?

One of the great uncertainties in climate research is whether and when we might experience irreversible tipping points due to changes caused by atmospheric heating. Think of tipping points as small events that can cause large permanent changes in natural systems. These changes are governed by the rules of physics, where the change is from one stable condition (e.g., water frozen in a glacier) to another stable condition (e.g., melted water).

Our nation and economy developed during nearly three centuries of relative climatic stability. We built cities, infrastructure, commerce and living conditions that are adapted to sea levels, oceanic currents and weather that exist largely because the glaciers and ice caps of Greenland and Antarctica were frozen solid. As those huge ice systems melt, enormous disruptive changes will occur. There will be staggering and unavoidable costs in adapting to constantly-rising sea levels and disrupted weather patterns.

The science of tipping point-analysis is extremely complex. Dr. Tony Barnosky, at the University of California, used the analogy of a raw egg to illustrate how a tipping point can change a system from one stable condition to another. The egg in its shell, sitting on a table, is in a stable condition. Left alone, it will stay in that condition. But if a slight push sends the egg over the edge of the table, even that small an action sets off irreversible changes that are governed by the physics of an egg falling and hitting the floor. When it smashes, the new stable condition is “egg splattered”.

The water in Thwaites Glacier is in a stable condition—it is frozen. The small pressure, of warmer seawater that is daily flowing past the submerged ice edge, has destabilized the glacier and is forcing the glacier ice to change to its next stable condition—melted water. The changes have become self-sustaining, governed by the physics of melting ice and glacier dynamics, and hence are unstoppable. Once a glacier begins melting, due to large-scale atmospheric and oceanic heating, nothing can prevent ice from turning into water except, possibly, by removing the heat source. But global-scale heating, and cooling, occurs only over centuries. For Thwaites, it is too late for that option.

We care about tipping points in large-scale systems like glaciers because of their sheer size and the self-sustaining changes that have the potential to cause massive disruptions in our society and economy. Size matters. There is a reason why our popular metaphor is the “900-pound gorilla” not the “13-pound spider monkey”. The threatening aspect of such large scale changes is that, when they pass that threshold of irreversibility, humans can no longer influence the outcomes. We can only adapt where possible and pay the costs of living with the consequences.

CONNECTING THE DOTS

For reasons of obvious necessity, humans around the world built their port facilities, adjacent cities and other coastal communities at current sea level. Already it is very likely that within this century, most of the ports and coastal communities in the world will have to adapt to sea

levels that are rising due primarily to thermal expansion of the oceans. The added melt water from the Thwaites raises the stakes for even higher sea levels. If adaptation is not possible, some communities may have to abandon part or all of their current sites and relocate. How will the U.S. economy be affected by collapse of coastal real estate markets?

In the Netherlands, a nation living partly below sea level, a deliberate and selective adaptation to sea level rise is being implemented as both least-cost and most manageable. The Dutch have rejected the alternative of dithering until decisions are forced upon them by disastrous flooding with loss of life, communities and livelihoods.

We all know that flooding and erosion are constant challenges to the coast. Storm surge rolling in on top of high tide, as occurred in the 2012 Hurricane Sandy, can be, and frequently is, a destructive killer. There is an old saying: "A rising tide floats all boats". The new climatic corollary is that "a rising sea level floats all storm surges", dramatically increasing the risks for people and structures at sea level—ports, commercial buildings, communication and energy networks, roads, railways, airports, residences and public infrastructure. Hurricanes Katrina and Sandy graphically showed that damage-repair costs, even from storms that lasted only a few days, can run into the billions of dollars. The scale of future costs of adaptation to or relocation away from remorseless sea level rise over centuries will be difficult to comprehend.

THE CHALLENGE MAY NOT BE WHETHER WE CAN ADAPT, BUT WHETHER WE CAN AFFORD THE COST TO ADAPT.

In 2012 Hurricane Sandy caused over $65.7 billion (2013 CPI) in damages. Mayor Bloomberg formally estimated the damage to New York City, alone, at $19 billion in direct damage repairs and economic losses. New York City took the brunt of storm-surge waves that roared inland atop a high tide and inundated streets in the heart of lower Manhattan to depths of 4 to 9 feet above ground level. Buildings and infrastructure such as roads, electrical power, water, and sewage were damaged too as floodwaters poured into subway tunnels.

New Orleans, with elevations ranging from 6.5 feet below current sea level to levees 20 feet above, was devastated by flooding during Hurricane Katrina in 2005. Direct storm and flood damage amounted to about $148.8 billion (2013 CPI). The nearby Port of Gulfport, Mississippi was also heavily damaged.

The damage from those two events alone totaled nearly $215 billion. For comparison, in the prospective 2015 U.S. federal budget, it may be a struggle even to secure $302 billion to fix decades of wear and tear to U.S. land-based transportation infrastructure. Education, transportation, public health, the military, agricultural and industrial subsidies, federal flood and crop insurance, and disaster relief are always aggressively competing for funding. There is no obviously free money floating around.

The United States has enormous wealth invested in coastal cities. It is one of the countries in the world at highest risk of damage from storm surges over higher sea levels. If damage from just two storm-surge events can cost billions, the costs of protecting against higher sea level at the ports and cities of New York, Miami, New Orleans, or any of a dozen other major U.S. ports may well soar into the trillions of dollars or more.

If we fail to reverse the rise in atmospheric heating, we commit the entire U.S. economy, and millions of businesses and homeowners, to potentially unlimited demands on public and

private sector funds. Remember the 900-pound gorilla? We must ask the questions. From where will we find the money? What are the appetites of the American public for paying soaring costs of adapting or relocating from increasing coastal flooding? What other priorities must be slashed? Or, will we exhaust our treasury to pay damages, disaster by disaster, until everyday life in these areas becomes impossible?

DAMAGE REPAIR COSTS ARE ONLY PART OF THE PICTURE. LOST-OPPORTUNITY AND OTHER BUSINESS COSTS MAY BE IMMEASURABLE.

One might think that a glacier melting some 10,000 miles away from Midwestern corn and wheat farmers could not be a matter of present concern. So, as a reality check, let's look at a slice of potential impacts on the U.S. economy from melting of the Thwaites Glacier.
A single example will illustrate the point. The Port of New Orleans and the adjacent Port of South Louisiana are the primary trans-shipment ports for 60% of all exported grains and 25% of all imported petroleum products for the U.S.

In those ports, river barges capable of transiting the shallow channels of the Mississippi River transfer their cargoes to deep-water ships that carry exported agricultural products to the entire world. Bulk agricultural commodities, valued in 2011 at nearly $7 billion for corn, soybeans and wheat, were barged down the Mississippi River from the U.S. Midwest and Great Plains.

For farmers in the 31 states of the Mississippi River watershed, sea level rise increasingly threatens their access to export markets, perhaps for indefinite periods. Either or both of those two ports could be damaged or shut down by future hurricanes howling in over the surface of a sea level that might be up 2 feet, 4 feet or even 6.6 feet higher by the end of this century. Electrical power, roads and rail access to port facilities are just as critical to port operations as the piers, cranes and other equipment. They may be even more-vulnerable to storm damage because they are often built at lower coastal elevations than piers for loading and unloading deep water ships.

Port of Gulfport incurred $580 million costs from Katrina damages-Photo Port of Gulfport (Miss.)

Katrina road damage-Photo Pinterest

At this point it is challenging to predict what adaptations will be needed, over what planning horizons, to secure export facilities—assuming that adaptations are possible. Who will pay the costs, and when, for the needed adaptations?

WHAT DOES THE THWAITES GLACIER COLLAPSE HAVE TO DO WITH U.S. COMMUNITY RESILIENCE? AFTER ALL, THE GLACIER IS IN ANTARCTICA.

First, Thwaites illustrates that the varied risks created by atmospheric heating are inter-related. Just because a melting glacier is 10,000 miles away is no guarantee that its ripple effects won't physically or economically damage your community. We live in an economically inter-dependent world. Suppliers and markets are global—whether for food, oil and gas products, or manufactured goods. Every community that relies on an import or export economy will be increasingly vulnerable due to sea level rise.

Second, Thwaites Glacier is a 900-pound gorilla. It is already on the move; slowly at first then more quickly as it floats free. That makes the risk of multi-century collapse of the West Antarctic Ice Sheet a potential game changer. How much? Just imagine how the world's coastal cities and ports would be transformed if an ice sheet extending across the U.S. from the Atlantic Ocean to Colorado, over a mile thick, were to melt into the ocean. Were the WAIS to melt completely over many centuries, it alone could add as much as 10 to 16 feet to sea level rise. But of course, it won't be alone, since the melting Greenland ice cap and glaciers will also be added over time.

Third, the scale of potential physical and economic impacts from a melting Antarctic glacier and ice sheet far exceeds the adaptive resources of individual communities. Because Thwaites hasn't yet disintegrated, we still have some time to reduce damaging outcomes. Communities can assess their vulnerability and forcefully use their political strength to focus state and federal representatives on the human and economic urgency of reducing carbon emissions and initiating adaptations to sea-level rise.

There is no silver bullet for reducing emissions, but there are potential options. A tax on carbon in fuels is the most direct way to reduce atmospheric heating. The tax dollars could be refunded to taxpayers, making it revenue neutral. Or it could be used to pay for adapting our ports and communities to rising seas. The U.S. Environmental Protection Agency's new rules to clean up dirty emissions from coal-fired power plants will also be effective.

Engineers and scientists are working hard to develop technologies to reduce carbon emissions and still maintain economic productivity. Energy conservation measures, from households to cities, are readily available and may even reduce costs. New methods for burying CO2 underground and new ways to use CO2 to make building materials, such as concrete, are being tested. New technologies for capturing CO2 at the natural gas well-head or for converting CO2 chemically to produce fuels, materials and products are in the experimental phase.

The greenhouse gases we have emitted over the past 250 years or so, when added to natural fluctuations in the earth's climate, have destabilized the reliable sea levels we have enjoyed over the last thousand years or more. The potential costs of adapting to this new instability and endlessly rising sea level may prove so great that cutting our greenhouse gas emissions may not only be more effective, but the only solution we can afford.

Fourth, ultimately resilience, at the community, state and federal levels, is what it's all about. We have the option of allowing atmospheric heating to continue, much like a mouse watching a snake before it strikes. But that consigns us to the stunningly high costs of repetitive disaster recovery in one place or another. The better alternative would be to demonstrate least-cost resiliency by avoiding the disasters. The greatest (and least costly) victory is the battle that is won by foresight and prompt actions; and never fought.

Heating of the earth's atmosphere has been an un-intended collateral effect of raising our global standards of living. But today we know how to maintain our economy at the same time as avoiding atmospheric heating. We see one of several potential tipping points from heating becoming real—the Thwaites Glacier collapse and the certainty of up to 6.6 feet of sea-level rise over the balance of this century, and for centuries into the future.

The least-cost solution is to cut back our greenhouse gas emissions that are currently accelerating that heating. Sea-level rise is simply one of a number of hazards, including heat damage to crops, increased extreme weather, drought, and urban heat-spikes, that are made more certain by atmospheric heating. By the single action of reducing our contribution to that heating, we can effectively reduce or avoid, not just one, but a number of those hazards. When it comes to climate, we can't talk about winning. But we can avoid losing high-stakes battles by working together to reduce our greenhouse gases and by avoiding the folly of trying to mitigate those hazards one by one.

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How to Get Involved

RRI would like to hear from you. If you have questions, comments, or concerns, please contact us at:

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