

Hurricane Sandy and Climate Change: Are We Being Taken For a Ride?

Allan Frei

Professor and Chair, Department of Geography, Hunter College

Deputy Directory, City University of New York Institute for Sustainable Cities

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The inundated remnants of a roller coaster in Seaside Heights, NJ, three days after Hurricane Sandy.

<http://www.thedailybeast.com/galleries/2012/10/26/sandy-s-deadly-path-photos.html#47937aa9-bfbb-4784-b2af-5096ef00ebdd>

Writing this from my apartment in Brooklyn less than a week after Hurricane Sandy struck the Northeastern coast of the United States, it occurred to me that my original intent in writing this may not be the most compelling aspect of the story. My first thought was that, because everyone was already tuned in to the storm's impacts, I could provide students and faculty in my department with some links to, and context for, thoughts related to the relationship between this Hurricane and climate change, a relationship that has been disputed in the media. However, as I was reading through various articles it occurred to me that these discussions are emblematic of the political divide in our country, and the differing narratives that accompany each side. While the two sides are not equally represented in my non-scientific sample of mainstream media articles that I have read (more about this later), it seems instructive to consider these world views. In the rest of this message I summarize the main ideas presented in the articles that I have read over the last day or two. For those who prefer to skip my musings, scroll down to the bottom to see links to many of the articles that I have seen.

The Physical Argument

The argument supporting the moniker “Frankenstorm,” which implies that the storm is partly of our own creation and not solely a natural (or divinely inspired) event, is based on the physics of the climate system. Hurricanes are fueled by energy present in warm ocean surface waters, which is why these storms weaken after landfall when they are cut off from their energy source, and can sometimes strengthen again if they track back out over warm ocean waters. Water temperatures in the Atlantic Ocean underlying Sandy’s storm track were five degrees Fahrenheit above average.

Also, a warmer atmosphere can “hold” more water vapor. (I put quotes here because the atmosphere does not actually “hold” water vapor: the relationship between water vapor and temperatures is true even in the absence of other air molecules, but that is a story for *Weather and Climate*101). Thus, in a warmer atmosphere, water that evaporates from the ocean surface provides more energy to the hurricane when it re-condenses to form clouds, and provides more water available for rainfall.

Storm surge, which was the main culprit behind the severe flooding along coastal New Jersey, New York City, and Long Island, was particularly high in this storm due to the confluence of several events. First, globally averaged sea level has been rising, so the height of ocean waters today are higher than in the past. Second, at high tide and with a full moon the force of gravity pulls more ocean waters to our side of the world, raising sea level even more. Third, with Sandy’s winds blowing from the east in northern New Jersey and southern New York State (north of the center of the storm), water is funneled by the shape of the coasts of New Jersey and Long Island into a gradually narrowing area, so that by the time the rising waters reach New York City the water is piled even higher. Three of these factors (ocean water temperatures, atmospheric temperatures, and sea level) have been increasing in recent decades, trends that are believed by the majority of scientists who study these sorts of things to be at least partly related to human activity. Furthermore, these trends are expected to continue, making such phenomena more likely.

Finally, Sandy’s track was unusual, turning sharply to the west--towards the coast--rather than spinning out into the ocean. This behavior was due to a blocking high pressure pattern near Greenland and the lower pressure frontal system approaching the east coast, which is associated with a southward dip in the jet stream (upper level winds). Because air is forced from regions of higher pressure to regions of lower pressure, Sandy was directed back towards the coast. Perhaps surprisingly to some people, the presence of this pattern may also be the product of human impacts. Warming in the Arctic region, which, as predicted decades ago has been greater than the global average warming, has resulted in significantly reduced summer/autumn sea ice coverage (sea ice disappearance has occurred much faster than even the direst predictions) which accelerates Arctic warming. There is evidence to suggest that Arctic warming contributes to a more meandering jet stream and the blocking high patterns that pushed Sandy toward our shores.

Despite all these connections, there are scientists who have written that it is too soon to know for sure whether these seemingly related incidents mean that Sandy was really climate change related, or just part of natural variability. It is too soon for any studies to have been made on Sandy, so we should wait for a more complete understanding before jumping to conclusions. The

response to that is often stated in a sports analogy. Imagine a famous baseball slugger or bicycle racer on steroids (I am not naming names). Can one definitively attribute any particular home run, or any particular winning race, to steroids? No, but one can say that the competitor is pumped so that, on average, balls will be hit farther and pedals pushed faster, producing a pattern of more homeruns and faster times as a result of steroid use. Analogously, an atmosphere pumped with greenhouse gases will result in warmer ocean and atmospheric temperatures near the earth's surface, which will, according to our physical model, result in more extreme events.

Sandy as part of a pattern of extreme events

But, is the prediction of more extreme events due to the priming of the atmosphere with greenhouse gases consistent with observations? One can list a number of large-scale extreme events of recent years: the European heat wave of 2003, the Russian heat wave of 2010, and the 2012 record breaking central US drought and temperatures; disproportionate warming of the Arctic region and disappearing Arctic sea ice; Hurricane Irene, Tropical Storm Lee, and now Hurricane Sandy hitting eastern North America. These and other extreme events are consistent with predictions by models, based on atmospheric physics, that are used to estimate the potential impacts of human-induced climate change. Thus, many climate scientists and others believe that these observed patterns fit the predictions and constitute strong evidence of human impact on climate.

Two sides

The discussions in the press appear to me to reflect the conflicting discourses of two camps. While one side sees Sandy as the event that should finally convince everyone of the urgency of battling climate change, the other side see Sandy as an excuse for liberals to expand government. One side sees the inefficiencies of the Federal Emergency Management Agency (FEMA), while the other side notes that only the federal government is capable of managing such large scale emergencies. Indeed, the gracious behavior between New Jersey Governor Chris Christie and President Obama is seen by some as a welcome respite from politics, by others as a cynical necessity. One side notes the total absence of climate change in the recent presidential debates as a major omission, blaming both candidates for political calculations. The other side does not seem to mind the lack of addressing this issue at all.

One side says that we cannot afford to wean ourselves off fossil fuels, while the other side says that the costs of these extreme events will be even greater than tackling climate change, with Hurricane Sandy impacts estimated (as of this writing) at \$50 billion, and the total insured value of property along the Gulf and Atlantic US coasts approaching \$9 trillion. Several writers cite as a sobering manifestation of climate change recent changes in the insurance industry. The release just a few weeks ago of a report titled *Severe Weather in North America* by a German reinsurance company noting the rise of extreme events across the globe, and particularly in North America. This report notes a large increase in weather-related insurance claims, and specifically blame at least part of this trend on human activity.

Some in our region have perceived an increase in the frequency of extreme storms, and this "anecdotal evidence" is borne out by peer reviewed publications and some recent analyses that I have been working on. Conversely, one periodical known to publish "skeptics" had an op-ed piece by a well respected scientist noting that the frequency of Atlantic hurricanes has not been rising in recent years at all, and therefore Sandy is an unusual event associated with natural

climate variability, not an indicator of climate change. Other experts point out that due to ocean warming related to human induced climate change the hurricane season is longer than it used to be (we are getting more late season storms), and more generally large storms are getting more common, exactly as predicted and as perceived by many in this region.

I mention above that the two sides are not equally represented in my selection of articles. The authors I found overwhelmingly perceive Sandy as a likely harbinger of our future under a changing climate. Although I restrict my discussion to mainstream media, including a variety of publications from across the country, admittedly these results may be biased by my choice of sources. However, even this uneven coverage will likely be interpreted differently by each side: one side will see this as liberal bias in the media and academia, and one side will see it as sober reasoning by the majority and deluded self interest by the minority..

Taking us for a ride?

So, which side is taking us for a ride? Is one side skewing the truth in order to further their own agenda while putting others at risk, while the other side is attempting to steer our country on a course towards our mutual well being? I will not answer these questions, but will end by pointing out that there seems to be some meeting of the minds around the question of infrastructure: an emerging consensus around the need to update our infrastructure and streamline our bureaucracy to more effectively deal with potential hazards.

For example, no one can reasonably deny that forecasters performed well with Hurricane Sandy. Yet, most people are unaware that the European forecast model outperformed the US model in predicting Sandy. Furthermore, just one month before Sandy made landfall the satellite used for tracking weather over the east coast of the US, which provides vital input to weather prediction models, went offline for over a month. There was a backup system that provided most but not all of the normal capabilities, but this came on the heels of an independent review sponsored by the National Oceanographic and Atmospheric Administration (NOAA) that is critical of the agency's oversight of its weather satellite programs. How might proposed federal budget cuts affect our ability to provide adequate forecasts for future hurricanes?

With specific regard to hurricanes and New York City, infrastructure discussions revolve around concepts such as protecting the subways from flooding, protecting land owners and possibly modifying zoning regulations in flood zones, and even to the establishment of storm surge barriers in the New York Harbor and the Long Island Sound. It seems that the costs of keeping and improving our forecasting capabilities and our infrastructure are well worth the insurance they provide against the potential costs of being unprepared for disasters. I hope that the two sides can come together on at least this one issue.

LINKS TO ARTICLES

Sandy: how much natural and how much anthropogenic?

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<http://www.project-syndicate.org/commentary/hurricane-sandy-and-climate-change-by-j--m--shepherd-and-john-knox>

<http://www.the-scientist.com/?articles.view/articleNo/33084/title/Opinion--Super-Storm-Sandy/>

<http://www.thedailybeast.com/articles/2012/11/01/hurricane-sandy-the-last-straw-on-climate-change.html>

<http://www.guardian.co.uk/commentisfree/2012/oct/31/sandy-climate-change-us-election>

<http://www.newyorker.com/online/blogs/newsdesk/2012/10/watching-hurricane-sandy-ignoring-climate-change.html>

<http://www.latimes.com/news/opinion/editorials/la-ed-sandy-climate-change-20121101,0,4601297.story>

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<http://www.businessweek.com/printer/articles/79420-its-global-warming-stupid>

http://www.washingtonpost.com/opinions/eugene-robinson-will-hurricane-sandy-be-our-wake-up-call/2012/11/01/eb50acd6-2447-11e2-ac85-e669876c6a24_story.html

http://www.washingtonpost.com/politics/decision2012/sandy-puts-climate-change-back-in-the-conversation/2012/11/01/685da046-2487-11e2-9313-3c7f59038d93_story.html

<http://www.npr.org/2012/10/31/164043372/sandy-raises-questions-about-climate-and-the-future>

infrastructure

<http://www.latimes.com/news/opinion/commentary/la-oe-linden-sandy-climate-change-20121102,0,2994914.story>

<http://www.npr.org/2012/11/01/164080621/protecting-new-york-from-future-flooding>

<http://transportationnation.org/2012/11/01/subway-flooding-predictable-eerily-matches-climate-change-model/>

<http://www.nytimes.com/2012/09/11/nyregion/new-york-faces-rising-seas-and-slow-city-action.html>

Budget and management of weather satellites

http://www.nytimes.com/2012/11/02/opinion/satellite-tracking-of-hurricanes-in-peril.html?_r=1&

<http://earthsky.org/earth/goes-13-satellite-returns>

<http://www.climatecentral.org/news/key-weather-satellite-goes-offline-may-limit-forecast-accuracy-15038>

http://www.aviationweek.com/Article.aspx?id=/article-xml/asd_09_24_2012_p03-01-498907.xml

http://science.house.gov/sites/republicans.science.house.gov/files/documents/NESDIS_IRT_Final_Report.pdf

<http://www.usatoday.com/story/opinion/2012/10/30/sandy-forecasting-ecmwf-gfs/1670035/>

insurance

<http://bostonglobe.com/opinion/2012/10/31/frankenstorm-and-creating-monsters/KI6a9sWQZ60sHuPS1MF2PJ/story.html>

wall street journal

http://online.wsj.com/article/SB10001424052970204840504578089413659452702.html?mod=googlenews_wsj

<http://online.wsj.com/article/SB10001424052970203880704578088832078561060.html>

sandy in contrast to social problems – attitudes of US and Europe

http://www.washingtonpost.com/opinions/matt-miller-sandys-closing-argument/2012/10/31/555f0214-238d-11e2-ac85-e669876c6a24_story.html