



October 09, 2008

## Can we do better than the Saffir-Simpson scale?

One of the most common questions and concerns ([like here, from Patrick](#)) I've heard since Hurricane Ike's landfall has concerned the [Saffir-Simpson hurricane scale](#). Is it adequate? Ike, after all, was *only* a category 2 hurricane and it will go down as the [third-costliest hurricane](#) in U.S. history.

The problem with the Saffir-Simpson scale is that it doesn't account for the size of a hurricane -- how far its damaging winds extend. Size, it turns out, matters a great deal. Larger wind fields produce damage across a much greater area.

Moreover, larger storms increase the risk of long-term exposure to hurricane-force winds, which allows storms with minimal hurricane-force winds to do significant damage. Longevity mattered a great deal during Ike, [local forecasters say](#).

Finally, as we also experienced with Ike, a greater expanse of hurricane-force winds leads to much larger wave generation offshore, and a much larger storm surge. Ike had about double the surge one would anticipate from a category 2 hurricane.

So what are the alternatives if we want to better communicate a storm's destructive potential? One is the Hurricane Severity Index employed by the private forecasting service ImpactWeather. See more about the HSI in this [online presentation](#).

# Not All Storms Are Alike

Highlighted area: 74+ mph winds

<p><b>Hurricane Ivan</b> 105 kts / 120 mph <b>Category 3</b> <b>HSI at landfall: 33</b> <b>Damage: \$15 billion</b></p> <p>ImpactWeather's <b>Hurricane Severity Index</b> is an enhanced hurricane rating system which more accurately defines the strength and destructive capability of a given storm than other scales</p>	<p><b>Hurricane Dennis</b> 105 kts / 120 mph <b>Category 3</b> <b>HSI at landfall: 18</b> <b>Damage: \$2.2 billion</b></p> <p>currently utilized. The Hurricane Severity Index uses comprehensive equations which incorporate <i>not only the intensity of the winds but the size of the area the winds cover.</i></p>
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[impactweather.com/hsi.ppt](http://impactweather.com/hsi.ppt)

The HSI rates storms on a scale from 1 (weakest) to 50 (strongest), accounting for both the intensity of a

storm as well as the size of its wind fields. On this scale Hurricane Katrina rated a 35, Hurricane Rita a 27, both category 3 storms, and Hurricane Charley, a category 4 hurricane, a 23 on the HSI scale. Ike rated a 30 on the HSI scale, just below Katrina.

Another alternative is Integrated Kinetic Energy, a concept developed by Mark Powell and Timothy Reinhold, two scientists who laid out the idea in a recent [BAMS article](#). A storm's IKE (yes, I know that acronym is confusing in light of our recent hurricane) is computed by essentially summing a hurricane's winds across its entire extent to calculate its total energy.

The authors argue that this energy, which ultimately will be dissipated over land, is a much better means of estimating its destructive potential.

Due to its large size Hurricane Ike, at times, had a higher IKE than Katrina.

It will be interesting to see where the debate goes, and it's no doubt Hurricane Ike will be an important driver of the discussions. I do agree that we can and probably should do better than the Saffir-Simpson scale, although that's so ingrained in people's minds it would be difficult to change.

**UPDATE:** Be sure to check the comments below for [additional information](#) from the co-developer of the HSI, Chris Hebert. Good stuff, especially on the inadequacy of the Saffir-Simpson scale to predict storm surges.

Posted by Eric Berger at October 9, 2008 08:23 AM

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#### Comments

Eric,

Thanks for this. I think it answers the question a lot of people have had since Ike, in regards to the discrepancy between Ike's strength and the destruction.

And your presentation makes it very understandable.

My bet is that one of these scales will become the gold standard for storm measurement in the next few years.

Posted by: hunter at October 9, 2008 09:26 AM

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Yes, the Saffir-Simpson scale does need to be expanded. The radius of the damaging wind speed needs to be included. The hurricane can be designated by its SS scale as in Ike's case: 2 and the radius in a simple class: RAT; R=0-5miles, CAT; R=6-25miles, GOAT; R=26-55miles, COW; R=56-105miles, RHINO; R=106-300miles. So you get 2XRHINO for Ike. Rita would have been a 2XGOAT.

Posted by: Jim at October 9, 2008 10:35 AM

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Yes, we can do better. But will it play in Peoria?

The Saffir-Simpson scale is simple: it's one-dimensional and that dimension corresponds to wind speed, which is easily understood by the public.

That makes it a poor tool for estimating potential damage, but a good tool for trying to communicate to the layman some idea of a storm's intensity.

A more accurate tool is needed, and it looks like the HSI fills the bill. Emergency-management professionals

should take to it with glee. But I imagine journalists will still go on using Saffir-Simpson because it's worked well enough for their purposes over many years, and because, for that reason, the public is comfortable with it.

Posted by: [PDQPete](#) at [October 9, 2008 12:40 PM](#)

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I think both alternatives are a good first approximation, but I would add at least one more variable to either one. Speed. How fast is the storm moving. That, along with the size of the wind field, will determine how long a given spot is subjected to hurricane force winds. If the storm is moving at 5 MPH, you'll be exposed to the storm longer than if it were moving 20 MPH. I would also contemplate including the width and height (volume) of the storm surge into the equation since for coastal areas, the height and width of the storm surge will directly determine how much damage is done.

Posted by: [Rorschach](#) at [October 9, 2008 01:36 PM](#)

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Eric,

As one of the co-developers of the Hurricane Severity Index, I can tell you that Ike ranked quite high on the HSI - 30 points out of a possible 50 points. And Ike's size points were 20 of a possible 25 points. For comparison, Alicia in 1983 scored 22 total points - 11 points out of 25 points for intensity (115 mph) and 11 out of 25 for the size of its wind field.

As for the Saffir-Simpson scale, it is only a wind scale, nothing more. Over the years, there have been attempts to attribute a possible storm surge to each category, but those values are practically worthless. Peak sustained wind is not even a factor considered when calculating storm surge. What's more important is the size of the wind field (Radius of Max Winds), the shape of the coastline, and the depth of the water offshore. In most cases, it's far more significant where a hurricane makes landfall than its peak wind at landfall. Some coastal areas just generate a much larger storm surge than others. One of the worst places for a hurricane to hit surge-wise is precisely where Katrina made landfall along the Mississippi coast. Had Ike struck the same point as Katrina, it's surge may have topped 20 feet (Katrina's surge was 28 feet there).

Just out of curiosity, I was calculating some possible storm surges for various sized Saffir-Simpson hurricanes. Here are the ranges I came up with:

Category 1: 2ft to 20ft

Category 2: 4ft to 25ft

Category 3: 5ft to 30ft

Category 4: 6ft to 33ft

Category 5: 8ft to 35ft

As you can see, SS category plays little role in storm surge size. It's completely inappropriate to say that Ike had "a Category 4 surge" as I've heard some people say. Ike had a surge representative of a rather large Category 2 hurricane. And if Ike had moved inland about 30 miles down the coast from where it did, then the surge into Galveston Island may have been 4-5 feet deeper. That's probably as bad as the 1900 storm which was classified as a Cat 4.

Posted by: [Chris Hebert](#) at [October 9, 2008 02:04 PM](#)

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Chris,

Thanks for stopping by, and for providing some excellent background information above.

I'm looking forward to using the HSI as a tool to understanding the potential destructiveness of future hurricanes (although, hopefully, not for those aimed at southeast Texas).

For those who don't know, Chris is one of the region's very best hurricane forecasters.

Eric

Posted by: [Eric Berger](#) at [October 9, 2008 02:12 PM](#)

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I would also add that speed of advance also factors into the rainfall totals as well which is the primary mode of flooding in inland areas.

Posted by: [Rorschach](#) at [October 9, 2008 02:17 PM](#)

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Where is the link to the source blog on this?

Posted by: [Lack of Attribution](#) at [October 9, 2008 02:51 PM](#)

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I believe that this is one of the original articles on the topic:

<http://www.daviddalka.com/createvalue/2008/09/14/hurricane-ike-suggests-need-to-modify-saffir-simpson-scale-hurricane-measurement-metrics/>

[modify-saffir-simpson-scale](#)

Posted by: [Bill Austin](#) at [October 9, 2008 02:58 PM](#)

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You know, I just think that a single number scale doesn't cut it. Under that HSI scale, a small but high intensity hurricane gets the same number as a large but low intensity hurricane. This doesn't describe to the public the specificity of their worries, who needs to be vigilant, and why. A dual number system sounds a lot more useful to me.

Posted by: [JT](#) at [October 9, 2008 03:29 PM](#)

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David and Bill,

If either of you has a concern about the provenance of this blog entry, you're welcome to contact me directly. The fact is I wrote it yesterday after getting some information on ImpactWeather's HSI scale. (Feel free to confirm that with Fred Rogers at ImpactWeather). Sorry, but I've never read David Dalka's blog before. Had I actually read the entry and used it as a kernel for my own writing on the subject, I certainly would have linked it, as is my custom.

If you're contending that the notion that Hurricane Ike exposed the Saffir-Simpson scale as a flawed as a hurricane metric is an original thought, well, good luck with that.

Eric

Posted by: [Eric Berger](#) at [October 9, 2008 04:04 PM](#)

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This is a little off topic, but since we're talking hurricane winds and Chris Hebert is chiming in... There is always discussion about hurricanes spawning damaging tornadoes inland, but how does a tornado stay in one place and dance on those mobile homes when the cross wind is 75+ mph? Wouldn't it just get blown to smithereens?

Posted by: Glenn at [October 9, 2008 04:14 PM](#)

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To answer a couple of questions from some of the comments above:

JT - The HSI is a two-number scale. There's a 25 point intensity scale and a 25 point size scale. Each would have to be considered to assess the potential threat. Like I said, Ike scored 20 of 25 possible points as far as its size, making it an extremely large hurricane.

Glenn - To answer your question about tornadoes in hurricanes, I'm not sure what you're referring to when you're talking about tornadoes staying in one place and impacting mobile homes. Such hurricane-spawned tornadoes do not remain stationary. They're generally embedded in feeder band squalls mostly in the northeast quadrant. As such, they're moving at quite a fast clip, the same speed as the squalls rotating around the center. There's no cross wind, the tornado moves with the wind flow that's carrying the squall.

Posted by: [Chris Hebert](#) at [October 9, 2008 05:06 PM](#)

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Regarding tornadoes embedded in hurricane feeder bands, I've always been curious how these are accounted for in the official archives. In many cases there aren't eyewitnesses, and it would seem that the telling damage to structures during a tornado strike would largely be lost if the same structure is also exposed to prolonged hurricane-force winds. Is most of the tornado data lost in this? For example, how can we say how many tornadoes were present during Ike's landfall with certainty, and how does that affect the official data on the annual number of tornadoes reported in the US?

Posted by: jd at [October 9, 2008 09:57 PM](#)

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I wonder if it really matters how we rate a storm for its damage potential. It seems that those who fear the potential get out of the way. The rest are motivated by any number of reasons to stay. The mind is often unable to understand that the train is coming and you are on the tracks. Ms Ettenger's phone call to her friend is illustrative of this--"I think I really screwed up this time."

The infamous "Hurricane Party" of Camille in 1969 comes to mind for the naivete of those who cannot grasp. I remember as a child of 12 the images played over and over in the news of the slab that stood where a home once was. The people then, as is often the case now, awaited, as drunk on the majesty of the storm as on any liquor in that home, for a storm that ultimately swept them away.

Somehow the infamy of what transpired in that case didn't keep many people in Mississippi from staying right there in their coastal homes for Katrina. As someone who worked on the northern shore of Ponchatrain for 2 months after that storm I remember the story I was told of a man swept inland from his seafront home in Mississippi along Hwy 90. He was swept across the RR tracks inland by a 30 foot wall of water--his mother hadn't been found as of November 2005. Now it is 2008 and more lives were lost by those who wouldn't heed what nature has repeated time and again--pay attention or I may sweep you away.

Posted by: Zorn Jones at [October 9, 2008 10:38 PM](#)

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No doubt the total energy involved in a storm should be the final arbiter of how "strong" a storm is. We can do better but if you get hit by the eye of a small sized storm with cat 5 winds that distinction means little to you.

Posted by: craig at [October 9, 2008 10:43 PM](#)

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Chris,

That's true, sort of. Two numbers are involved, but they're added up to one single number, which is what the weather reporters may well toss up onto the screen when a hurricane approaches.

Posted by: JT at [October 10, 2008 07:13 AM](#)

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Eric/All,

Great Discussion, and a valid point that is also being discussed at high levels of NOAA (if you or others are on the tropical storms list serv, you may have seen one proposal there).

However, before reassessing how threat is communicated for each of the "big four" hurricane-related hazards in the future, the weather enterprise needs to do a full, detailed survey of its end users, ranging from "super" users in the emergency management and media world (those who provide much of the information to the general public and others) down to the general public themselves.

There will likely be "bins" of similar answers, hopefully that divide along a common customer, such that the weather enterprise can serve a variety of data, packaged more specifically for these varied end users. As such, this allows them to "pull" the data they desire.

At the same time, though, beauty is in simplicity, and one of the solutions will need to be a quick method of getting the most understood message out.

I've seen the HSI poster personally at the 2008 AMS Annual Meeting. I really think it has merit. But, I don't see it drilling down to the simple message needed by those in harm's way to take action.

Is the solution, then, another warning type, i.e. Storm Surge Warning? Or, could it be as simple as extricating a storm surge scale (i.e., the "Simpson Scale") to go along with the "Saffir Scale" (wind only)? Or, something altogether different?

Speaking to a few people outside of the weather enterprise (and weather enthusiasts) on each of these, it seemed that splitting the scale had some traction. One even said that "Ike had Category 2 winds with a Category 4 surge". Because the current idea of SSHS is ingrained in most coastal residents, this simple separation may be a way to go - but only a detailed survey would ensure this.

It must be noted that surge impacts vary more widely from coastline to coastline - much more so than wind impacts - but local "tweaking" of the current Simpson contribution to the SSHS may be all that's needed to adjust the impact scale for Orange Co, TX, compared with Sarasota Co, FL.

Posted by: wxdancer at [October 10, 2008 09:21 AM](#)

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wxdancer,

Have you seen James Franklin's (NHC forecaster) white paper on proposed storm surge warnings to go along with tropical storm and hurricane warnings?

He sent it to the tropical storms email group on September 29th.

Our HSI wasn't really meant as a stand-alone tool for the public to use to judge whether to evacuate or not. It is part of a suite of objective hurricane timeline tools to help businesses (like refineries) trigger the various phases of their hurricane plans.

Posted by: [Chris Hebert](#) at [October 10, 2008 09:37 AM](#)

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wxdancer,

Thanks for the (always helpful) insight. I wish I were on Thorson's tropical storms list but the membership is restricted.

In any case I have no doubt that creating a new tool for public warnings will be difficult to implement given the wide acceptance of the Saffir Simpson scale. But at the same time, since the 2004 hurricane season, I think it's safe to say the general public has become much more educated about hurricanes and probably could handle an additional metric to put the threat in perspective.

Personally, I don't see a "storm surge warning" as an end-all and be-all, especially for a community like Houston. Most of the region's population isn't vulnerable to a storm surge, but they certainly are to high winds. So a large wind field is very important, but not because of the surge it builds up.

Eric

Posted by: [Eric Berger](#) at [October 10, 2008 09:47 AM](#)

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wxdancer, maybe I was making an assumption that what I was saying about surge was intuitively obvious, but perhaps it was not. I make that mistake often. What I am suggesting is that since the GoM coastline and seabed geology and topography is fairly well documented, therefore a map of amplification factors (much like that used for tidal wave predictions in the pacific) could be generated. Therefore the surge could be calculated based on the predicted landfall point. Obviously as that prediction moves, the surge would have to be recalculated.

Posted by: [Rorschach](#) at [October 10, 2008 02:17 PM](#)

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Seems to me you are going in the wrong direction on this.

The Saffir-Simpson scale is not too simple. It's too complex.

Not only does the intensity change all the time, the point of landfall and the timing does also. It does not create an immediate sense of danger.

I'll bet a simple "Condition RED", or similar, would have made Bolivar sit up and pay attention. Once you feel you are personally endangered you tend to find out all you need about storm surge and such.

There is perhaps a need for an improved index to facilitate discussions on the relative severity of hurricanes. For public communication though, a classification of the actual danger is more important.

The current system of "warnings" for long stretches of coast line seems a bit lame. The people who actually know how wind field, size, precipitation, surge, coast and everything else interacts would have all the information necessary to assign such a simple "danger" index to different locations. The definition of the highest danger could be something like "Extreme danger of inundation, destruction of... etc." There is no need even to mention wind speed.

Posted by: [Henrik](#) at [October 10, 2008 05:23 PM](#)

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The total energy of the storm occurs over distance all the way to Oklahoma or where ever (That is the Potential). "No doubt the total energy involved in a storm should be the final arbiter of how "strong" a storm

is."

The question if we could control the release of the Potential energy in one locale, would we prefer to do it one hundred miles east of Florida when it is heading to Texas or Louisiana (anywhere USA? If we could.

There will always be a cost, even to diminishing the intensity or potential energy of the hurricane (if we could), for example Georgia may want the rain from the drought that the Hurricane would provide

Regarding storm surge and wind and distance, does the model consider trajectory of the wind and at sea level or in an airplane?

Posted by: xxx at [October 11, 2008 10:19 AM](#)

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Hi all,

Thanks for the comments to my entry. A few responses: Chris...yes, I've read the white paper, which is where my first statement came from. Regarding the HSI...yes indeed, I definitely saw the benefit for more sophisticated users, including myself :)

Eric...my feelings, as well - I'm not sold on the feasibility of another warning, but if there is a significant slice of users that would find one useful, then such a warning would need to be considered.

Henrik...Such color-coding and risk/potential impact information is being provided not only by private entities, but NOAA also ran experimental graphical tropical cyclone hazards information at a number of NWS offices this year. These "impact graphics" include descriptive text that goes along with the color codes. Some of the wording used to elicit a more personalized response (i.e. "certain death") can be found in high to extreme potential impact cases.

<http://www.nws.noaa.gov/os/tropical>

A cool variation was used by Florida offices, which added a text "mouse-over" to the color codes

<http://www.srh.noaa.gov/mfl/ghls>

Posted by: wxdancer at [October 11, 2008 02:02 PM](#)

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