Hurricane Threat Index Taking Advantage of the Public's Acceptance of the Category 1 through 5 Threat

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The Saffir-Simpson Hurricane Scale was developed in 1971 by National Hurricane Center Director, Dr. Robert Simpson and structural engineer Herbert Saffir to be used to classify the damage caused by United States landfalling hurricanes. It was then adopted in 1974 by Dr. Neil Frank, Director of the National Hurricane Center as a tool to warn the public of the impact from an approaching hurricane. In an interview with Dr. Simpson in 1991 by Debi Iacovelli, Tropical Weather Specialist, Cape Coral, Florida:

> DI: Dr. Simpson, why don't you give us a bit of background on the development of the Saffir/Simpson hurricane scale?
>
> RS: The problem of evacuating people and getting warnings out that are understood and which will evoke a response in the people who need to move has always been a difficult one. When I first came down to the Hurricane Center in 1967, I tried to come to grips with how we could do a better job of communicating. And that's very difficult; scientists communicate with each other very easily, but a scientist trying to communicate with a person who is a non-scientist on a technical problem is very difficult at times.
> https://novalynx.com/store/pc/Simpson-Interview-d53.htm

The original Saffir-Simpson Hurricane Damage Scale included classifications of the one-minute sustained wind as well as the central pressure and the storm surge threat. (See Table 1). The scale also included the type of damage that could be expected from the hurricane in each category. Historical landfalling hurricanes were classified using this scale. This allowed the public a way to perceive the threat to their area when a hurricane was approaching.

In 2009, National Hurricane Center made the decision to change the original scale to the Saffir-Simpson Hurricane Wind Scale. This was done since the storm surge and central pressure did not always correlate with the maximum sustained wind. The idea was to get the public to focus on the impact of the hurricane and not the category based just on the maximum sustained wind. The problem arises when the categories of past hurricanes are the measure by which the public seems to judge the threat. Recent landfalling hurricanes have shown that the maximum sustained winds are not always a good indication of the impact of a hurricane

After Hurricane Ivan in 2004, Hurricanes Katrina and Rita in 2005, Hurricane Ike in 2008 and Hurricane Sandy in 2012, the importance of the size of the hurricane wind field has become apparent. The impact of waves and storm surges which seems to depend on the size of the hurricane wind field is just as impactful than the maximum sustained

wind. In 2008, the author developed the Freeman/Hasling Hurricane Damage Potential Scale to describe the impact of the waves on offshore structures. The purpose of this scale was to show how “Size Matters”. The Freeman/Hasling Hurricane Damage Potential Scale takes the size of the hurricane wind field into account to classify the damage potential of a hurricane.

Hurricane Sandy in 2012 and Hurricane Florence in 2018 led the author to the development of the **H**urricane **T**hreat **I**ndex [HTI] which combines all of the parameters that contribute to the damage potential of a particular cyclone. Since the categories are already perceived as a guide in the public’s mind to decide the threat to them, it should be enhanced to allow the National Hurricane Center to convey the threat. The new index, HTI, appears in Table 2. The description of the damage caused by the categories that appears in Table 1, the original Saffir-Simpson Scale should be used for the categories that appear in the Hurricane Threat Index.

To use the Hurricane Threat Index, one enters the information from the National Hurricane Center’s Advisory. The maximum sustained wind in knots, the minimum central pressure, forward speed and then the highest radius of hurricane force winds. Each of these parameters are then classified into Categories. The highest category is used for the HTI. The threats are wind, storm surge classified by central pressure and the radius of hurricane force winds. The forward speed is used to give an indication of the threat of flooding from rainfall.

The Hurricane Threat Index [HTI] was applied to Hurricanes Katrina and Rita in 2005, Hurricane Ike in 2008, Hurricane Sandy in 2012, Hurricane Harvey 2017 and Hurricane Florence in 2018, using the parameters of the Hurricane Advisory of the Hurricane as it was offshore just prior to landfall. These results appear in Table 3. All of these hurricanes were large storms which would cause significant storm surge along the coast line. An important feature for rainfall is the forward speed of the hurricane. If the cyclone is moving very slowly or stalls it can cause extreme rainfall flooding. For example, Harvey in 2017 and Florence in 2018.

The results of using the HTI shown in Table 2 resulted in the highest Category to describe each hurricane prior to landfall are given in Table 3. The maximum sustained wind in knots, the central pressure, the forward speed and the highest radius to 64 knot winds were entered into Table 2. On the last row, the highest Category for any of the parameters is entered. This number them uses the description of the damage in Table 1 to indicate the damage potential of the hurricane.

During Hurricane Katrina in 2005, the maximum sustained winds had weakened prior to landfall to a Saffir-Simpson Category 3. The HTI Category would have been a 5 due to the size of the hurricane wind field. The damage caused along the Mississippi coast would indicate that Category 5 was a better description of the damage.

Hurricane Rita in 2005 had also weakened prior to landfall on the upper Texas coast and was a Category 3 hurricane on the Saffir-Simpson Scale. Using the HTI, Rita would have been classified as a Category 4 hurricane.

Hurricane Ike in 2008 was a Category 2 hurricane based on the Saffir-Simpson Scale with maximum sustained winds of 95 knots. Using the HTI, the Category would have been a Category 5 based on the size of the hurricane wind field. This category better describes the damage seen along the upper Texas Coast.

Hurricane Sandy in 2012 was a very large storm and headed to one of the most populated areas along the US east coast. Sandy's maximum sustained winds indicated that Sandy was barely a hurricane when it made landfall. If you look at the central pressure Sandy would have been a Category 4. Based on its size it was a Category 5 on the HTI. The damage resulting from Sandy would be better classified as at Category 4 or 5.

Hurricane Harvey in 2017 was a Category 3 hurricane at landfall based on the Saffir-Simpson Scale. The minimum central pressure and its size using the HTI would have classified the storm as a Category 4. The next advisory had Harvey moving very slowly and stalling which would have made it a Category 5 on the HTI for rainfall. The upper Texas Coast experienced over 60 inches of rain.

Hurricane Florence in 2018 had weakened to a Category 1 on the Saffir-Simpson Scale prior to landfall. The central pressure and the size of Hurricane Florence would have classified it as a Category 4 on the HTI. By the next advisory Florence was slowing down and would most likely cause extreme flooding. Using the HTI on that advisory would have indicated a Category 5 for rainfall and extreme flooding.

In order to save lives, the most important issue to communicate to the public is the threat of the hurricane to them. The public has accepted the idea of Category 1 to 5 system for the past 44 years. So instead of trying the remove this system, it might be a good idea to change how the definition of the classifications to better emphasize the threat at landfall. Using just the wind to describe the impact is not the answer. The Hurricane Threat Index should be used as a warning system and could be tweaked to indicate which Category best describes the type of damage expected with each unique hurricane.

Table 4 shows how the Hurricane Threat Index works on a real-time hurricane, such as Hurricane Michael. This table shows that Michael made it to a Category 5 hurricane or and extreme hurricane when the central pressure dropped to 919 mbs.

TABLE 1 – Original Saffir-Simpson Hurricane Scale

The Saffir-Simpson Hurricane Scale is a 1-5 rating based on the hurricane's present intensity. This is used to give an estimate of the potential property damage and flooding expected along the coast from a hurricane landfall. Wind speed is the determining factor in the scale, as storm surge values are highly dependent on the slope of the continental shelf in the landfall region. Note that all winds are using the U.S. 1-minute average.

Category One Hurricane
Winds 74-95 mph (64-82 kt or 119-153 km/hr). Storm surge generally 4-5 ft above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage. Irene of 1999, Katrina of 2005, and several others were Category One hurricanes at landfall in South Florida.

Category Two Hurricane
Winds 96-110 mph (83-95 kt or 154-177 km/hr). Storm surge generally 6-8 feet above normal. Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings. Frances of 2004 was a Category Two when it hit just north of Palm Beach County, along with at least 10 other hurricanes which have struck South Florida since 1894.

Category Three Hurricane
Winds 111-130 mph (96-113 kt or 178-209 km/hr). Storm surge generally 9-12 ft above normal. Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the center of the hurricane. Flooding near the coast destroys smaller structures with larger structures damaged by battering from floating debris. Terrain continuously lower than 5 ft above mean sea level may be flooded inland 8 miles (13 km) or more. Evacuation of low-lying residences with several blocks of the shoreline may be required. Unnamed hurricanes of 1909, 1910, 1929, 1933, 1945, and 1949 were all Category 3 storms when they struck South Florida, as were King of 1950, Betsy of 1965, and Jeanne of 2004.

Category Four Hurricane
Winds 131-155 mph (114-135 kt or 210-249 km/hr). Storm surge generally 13-18 ft above normal. More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of structures near the shore. Terrain lower than 10 ft above sea level may be flooded requiring massive evacuation of residential areas as far inland as 6 miles (10 km). The 1888, 1900, 1919, 1926 Great Miami, 1928 Lake Okeechobee/Palm Beach, 1947, Donna of 1960 made landfall in South Florida as Category Four hurricanes.

Category Five Hurricane
Winds greater than 155 mph (135 kt or 249 km/hr). Storm surge generally greater than 18 ft above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of all structures located less than 15 ft above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5-10 miles (8-16 km) of the shoreline may be required. The Keys Hurricane of 1935 and Andrew of 1992 made landfall in South Florida as Category Five hurricanes.

https://www.weather.gov/mfl/saffirsimpson

TABLE 2 - HURRICANE THREAT INDEX

CATEGORY	Maximum Sustained Wind [1-minute]	Central Pressure (mbs)	Rain [Forward Speed] - USE ONLY AT LANDFALL	Size [Radius of 64 kt winds] vs max sustained wind <60 nm	>=60 <80 nm	>-=80 nm
1	64 – 82 kts (74-95 mph)	980	>15	1	4	5
2	83 – 95 kts (96-110 mph)	965-979	15	2	5	5
3	95 -113 kts (111-130 mph)	945-964	10	3	5	5
4	114-135 kts (131-155 mph)	920-944	5	4	5	5
5	>= 135 kts (>=155 mph)	<920	0	5	5	5

Cyclone Name	From NHC Advisory #					
Enter Current Hurricane Information						
Category						
Highest						

Enter the parameters from the National Hurricane Center's Forecast Advisory. Then classify by Category the wind speed, pressure, forward speed for rainfall and the size of the Hurricane. Then enter the highest Category to determine the damage potential. Use the description by Category that appears in Table 1.

TABLE 3: HURRICANE THREAT INDEX ON PAST STORMS

Hurricane	Maximum Sustained Wind [1-minute]	Central Pressure (mbs)	Rain [Forward Speed] - USE ONLY AT LANDFALL	Size [Radius of 64 kt win] in nm
Katrina	**2005**			
Advisory Information	**110**	927	14	110
Category	**3**	4	4	5
Highest				**5**
RITA	2005			
Advisory Information	**105**	931	10	75
Category	**3**	4	3	5
Highest				**5**
IKE	2008			
Advisory Information	**95**	954	11	110
CATEGORY	**2**	3	3	5
Highest				**5**
SANDY	**2012**			
Advisory Information	**80**	940	24	150
Category	**1**	4	1	5
HIGHEST				**5**
HARVEY	**2017**			
Advisory Information	**115**	938	6	75
Category	**4**	4	4	5
Highest				**5**
FLORENCE	**2018**			
Advisory Information	**80**	958	5	70
Category	**1**	3	4	4
HIGHEST				**4**

TABLE 4: CLASSIFICATION OF HURRICANE MICHAEL 2018

Current Hurricane Information	**120**	943	11	40		
Category	**4**	4	3	4		
Highest				**4**		
Michael	**Adv 12**	1000 CDT				
Current Hurricane Information	**95**	965	10	30		
Category	**3**	2	3	3		
Highest				**3**		
Michael	**Adv 13**	1600 CDT				
Current Hurricane Information	**105**	957	10	40		
Category	**3**	3	3	3		
Highest				**3**		
Michael	**Adv 14**	2200 CDT				
Current Hurricane Information	**110**	947	10	40		
Category	**3**	3	3	3		
Highest				**3**		
Michael	**Adv 15**	0300 CDT				
Current Hurricane Information	**120**	943	11	40		
Category	**4**	4	3	4		
Highest				**4**		
Michael	**Adv 16**	1000 CDT				
Current Hurricane Information	**125**	928	12	40		
Category	**4**	4	3	4		
Highest				**4**		

Michael	**Update**	1030 CDT				
Current Hurricane Information	**150 mph**	923	14 mph	40		
Category	**4**	4	3	4		
Highest				**4**		
Michael	**Update**	1100 CDT				
Current Hurricane Information	**150 mph**	923	14 mph	40		
Category	**4**	4	3	4		
Highest				**4**		
Michael	**Update**	1200 CDT				
Current Hurricane Information	**150 mph**	919	14 mph	40		
Category	**4**	5	3	4		
Highest				**5**		
Michael	**16A**	1300 CDT				
Current Hurricane Information	**155 mph**	919	14 mph	40		
Category	**5**	5	3	5		
Highest				**5**		
Michael	**16A**	1400 CDT				
Current Hurricane Information	**150 mph**	922	15 mph	40		
category	**4**	4	3	4		
Highest				**4**		
Michael	**Update**	1500 CDT				
Current Hurricane Information	**140 mph**	927	15 mph	40	Moving Inland	
Category	**4**	4	3	4		
Highest				**4**		
Michael	**Adv 17**	1600 CDT				
Current Hurricane Information	**110**	932	14	35		
Category	**3**	4	3	3		
Highest				**4**		

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