Washout from high intensity / short duration storm

Redefining Extreme Rainfall Events to Avoid Public Confusion Moving from a Rarity Based Rating to a Severity Based Scale

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Widespread flooding from long duration storm

Abstract

The public does not understand how the 100-year storm can happen 5 times in 25 years when we call them 100-year storms. They don't understand that 100-year storms can have different intensities and total rainfall over different durations.

Why do we label these events based on their recurrence interval? Other natural disasters are rated in other ways. Earthquakes use the Richter scale, tornadoes use the Fujita scale, and hurricanes use the Saffir-Simpson scale. They use a simple scale to rate the event's severity, not it's rarity.

The public understands the ratings for these weather events. We need to change how we communicate with the public about these major rain events. I propose the industry adopt a new standard of identifying and classifying rainstorms from a recurrence interval to one that the public can understand.

Probabilities and statistics

The problem with using recurrence intervals is they are based on probability and statistics, and the public does not understand this.

The chance of the 100-year event occurring once in 100 years is:
1-(1-p)100 = 1-(0.99)100 = 1-0.366 = 63.4%
But the public thinks it should occur once every 100 years

The odds of the 100-year event occurring 5 times in 25 years are:
n!*pY*(1-p)(*n*-Y) / (Y!)*(*n*-Y)! = 25!*0.015*(0.99)20 / 5!*20!
= 1 in 4.4 million

Seems pretty rare; so the public asks, "How could this occur?"

Why do we define rain events based on their rarity? Wouldn't it be better to define them based on their severity?

Recent history of flooding in Brookfield

August 6, 1986 – 6.8" in 24 hours
June 20 - 21, 1997 – 6" in 26 hours
August 6, 1998 – 11.35" in 8 hours
June 7 - 8, 2008 – 5.8" in 24 hours
June 19, 2009 – 4.8+" in 3 hours

Five 100-year storms or larger in 25 years!

How can they all be 100-year storms

Public does not understand this because:
Everyone of the storms was different
They each had different effects on flooding
They occurred more than once every 100 years

There must be a better way
Think, think, think – Inspiration!

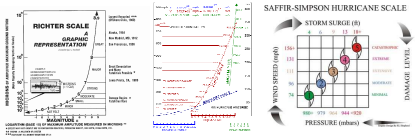
Rainfall - duration table for SE Wisconsin

Storm Duration	2 - year	5 - year	10 - year	25 - year	50 - year	100 - year
1 hour	1.31	1.60	1.84	2.20	2.50	2.82
2 hour	1.54	1.93	2.23	2.73	3.16	3.64
3 hour	1.68	2.07	2.40	2.93	3.39	3.89
6 hour	1.95	2.40	2.79	3.44	4.03	4.70
12 hour	2.24	2.74	3.17	3.89	4.53	5.25
24 hour	2.57	3.14	3.62	4.41	5.11	5.88
2 day	3.04	3.71	4.20	4.94	5.53	6.13
3 day	3.29	3.94	4.40	5.09	5.63	6.17
5 day	3.77	4.42	4.84	5.43	5.86	6.26
10 day	4.68	5.42	5.89	6.55	7.03	7.46

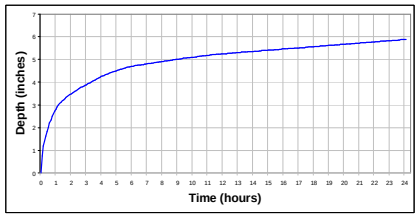
Rainfall data is based on Milwaukee rainfall data for the 108-year period of 1891 to 1998. Source: Rodgers, Potter, and SEWRPC

Earthquakes, tornadoes and hurricanes

Each of these natural disasters use a scale to rate the severity of the storm, not the rarity. The public understands this. The bigger the number the bigger the storm. They have no expectation that two major storms could not happen in a row like they do with large rain events (100-year storms).



100-Year storm shown graphically



This graph is based on probability of the storm occurring. There can be hundreds of 100-year storms that all look very different from each other, causing confusion with the public.

A new rating system (scale) proposed

Develop a formula to convert recurrence intervals to a scale that the public understands.

$$RI = 2^{(G-1)}$$

Where: RI = Recurrence Interval of the rain event
G = the Category of storm

Example: For the 100-year storm: $100 = 2^{(G-1)}$
Solve for G, G = 7.64
100-year storm is reported as a G-7.64 storm

A new communication tool using a rating system based on severity, not rarity

Recurrence Interval

Storm Duration	2 - year	5 - year	10 - year	25 - year	50 - year	100 - year
1 hour	2.00	3.32	4.32	5.64	6.64	7.64
2 hour	2.00	3.32	4.32	5.64	6.64	7.64
3 hour	2.00	3.32	4.32	5.64	6.64	7.64
6 hour	2.00	3.32	4.32	5.64	6.64	7.64
12 hour	2.00	3.32	4.32	5.64	6.64	7.64
24 hour	2.00	3.32	4.32	5.64	6.64	7.64
2 day	2.00	3.32	4.32	5.64	6.64	7.64
3 day	2.00	3.32	4.32	5.64	6.64	7.64
5 day	2.00	3.32	4.32	5.64	6.64	7.64
10 day	2.00	3.32	4.32	5.64	6.64	7.64

Not all storms within a recurrence interval are the same. Need to adjust ratings to reflect duration and intensity of rain events

$$G_{ADJ} = G \times (DAF) \times (IAF)$$

Where:

G = the Category of storm

DAF = Duration adjustment factor:
$$\frac{\text{Total rain for X duration storm}}{\text{Total rain for 24 duration storm}}$$

IAF = Intensity adjustment factor:
$$\frac{\text{Total rainfall per X-year storm}}{\text{Total rainfall for 100-year storm}}$$

Fully adjusted G-scale ratings (rounded for ease in reporting)

Recurrence Interval

Storm Duration	2 - year	5 - year	10 - year	25 - year	50 - year	100 - year
1 hour	0	1	1	2	3	4
2 hour	1	1	2	3	4	5
3 hour	1	1	2	3	4	5
6 hour	1	1	2	3	4	6
12 hour	1	2	2	4	5	7
24 hour	1	2	3	4	6	8
2 day	1	2	3	5	6	8
3 day	1	3	4	5	7	8
5 day	2	3	4	6	7	8
10 day	2	4	6	7	9	10

Recent history of flooding in Brookfield

August 6, 1986: 6.8" in 24 hours = **G-8+**
June 20 - 21, 1997: 6" in 26 hours = **G-8**
August 6, 1998: 11.35" in 8 hours = **>G-10**
June 7 - 8, 2008: 5.8" in 24 hours = **G-8**
June 19, 2009: 4.8+" in 3 hours = **G-6**

Advantages of this new scale

No implication of rarity
Public understands these ratings
The bigger the number the bigger the storm
Preserves and builds upon existing science and data
Avoids confusion by the public regarding 100-year storm and 100-year floodplain and their relationships
Provides a more appropriate scaling factor