

BUILDING RESILIENCE OF BUILDING SYSTEMS: LOW-INCOME MULTIFAMILY WEATHERIZATION

November 6, 2020



RESILIENCE

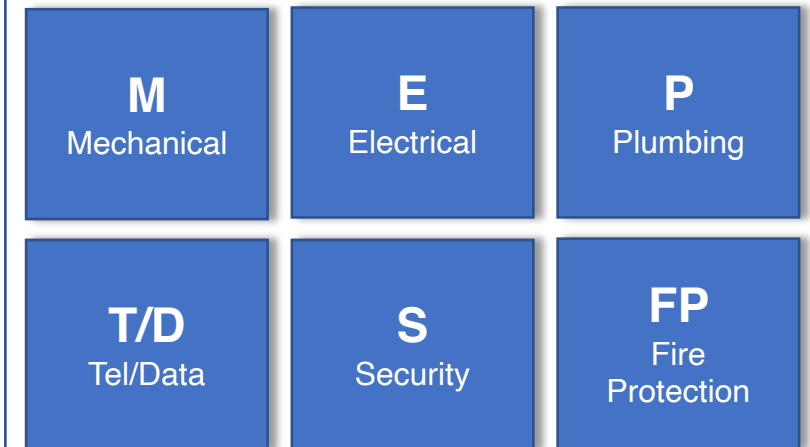
Resilience is the response of systems – economic, social, and environmental – to both extreme disturbances and persistent stress.

- Interventions are often a response to disruption.
- Much of resilience remains rooted in preparedness.

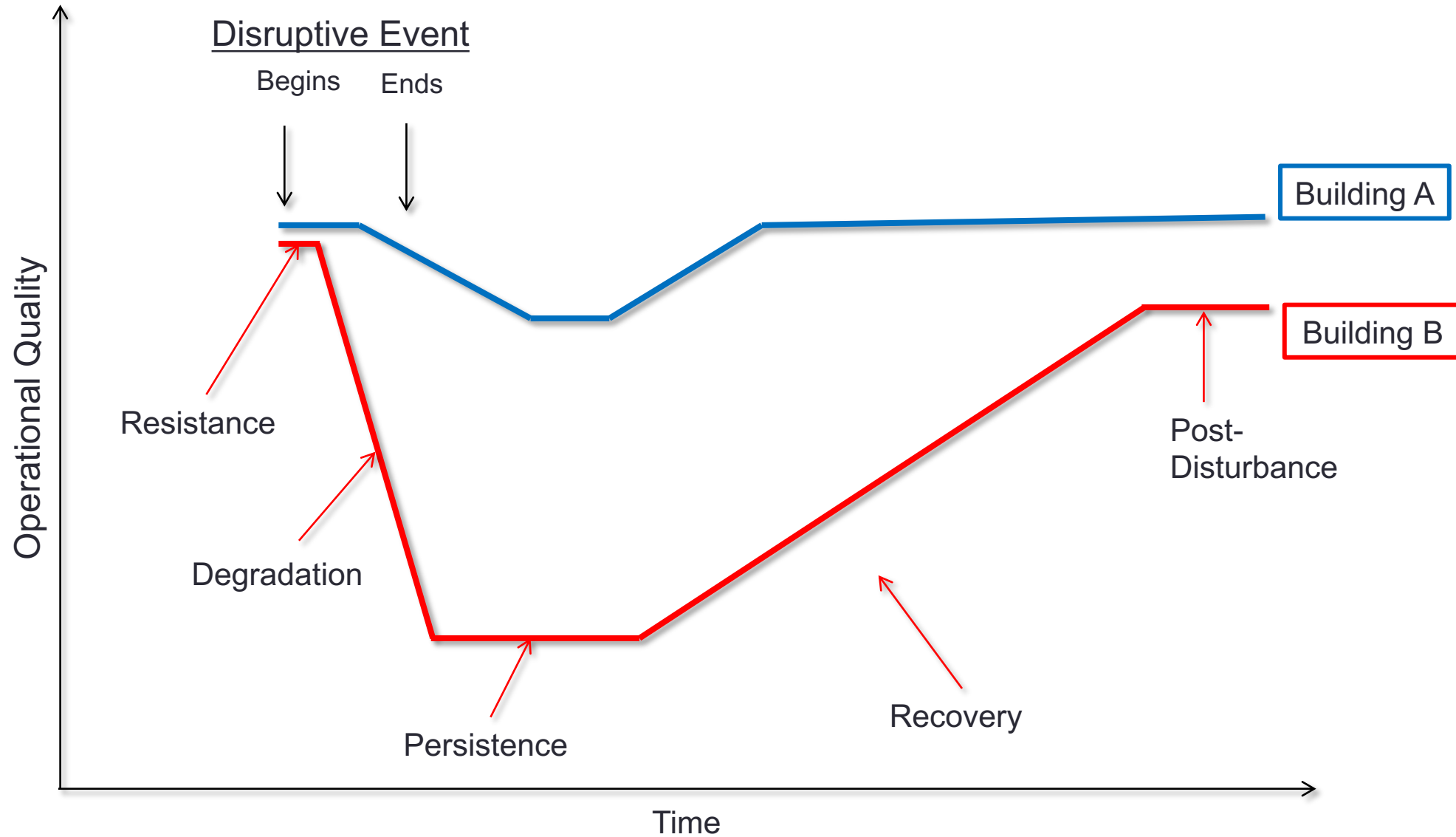
Building Systems Resilience

- Buildings are also a system of systems, providing services to its end users.
- Most building systems are interdependent – vulnerabilities of each system include its vulnerability to each interconnected system.
- Vulnerability is indirectly proportional to resilience.

Critical Building Systems



CONCEPTUALIZING RESILIENCE



DEFINING DISTURBANCES

“Pulse”
Disturbance

Discrete event in time
Lower frequency
Higher severity



Image borrowed from: Andy Padian; PadianNYC

Risk Continuum*

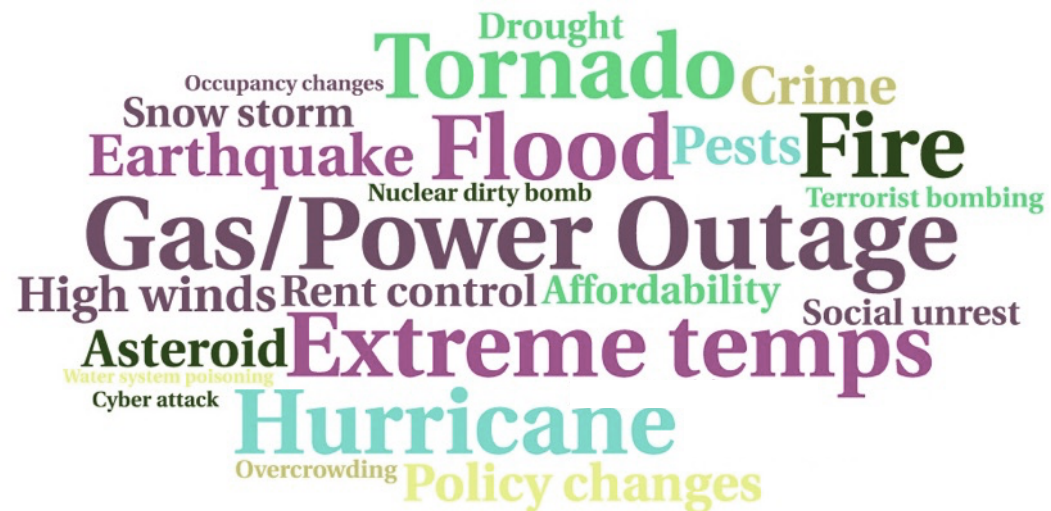
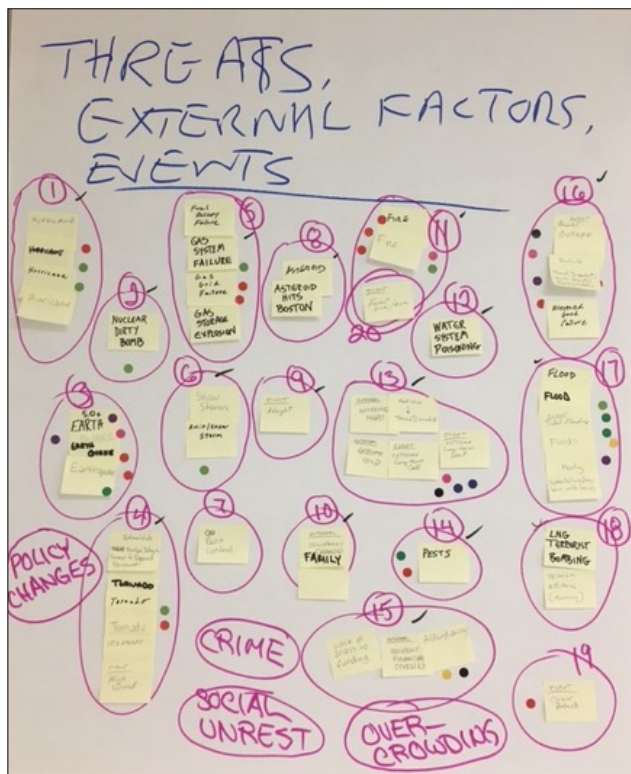
“Press”
Disturbance

Cumulative pressures
Higher frequency
Lower severity

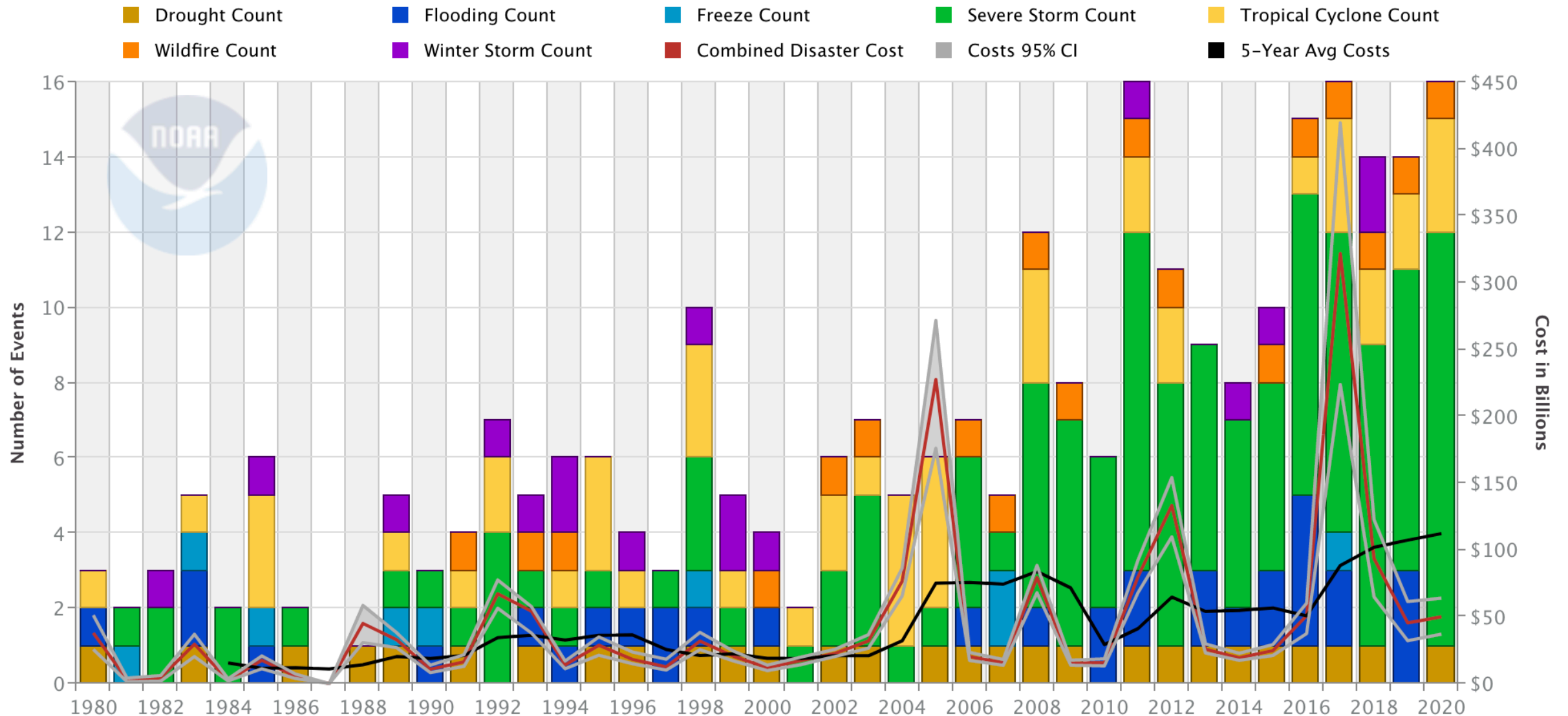


*McGregor et al. (2013). Two Degrees: The Built Environment and Our Changing Climate.

IDENTIFYING DISTURBANCES (Brainstorming Exercise)



U.S. BILLION-DOLLAR DISASTER EVENTS (1980-2020)



Updated: October 7, 2020

Source: NOAA National Centers for Environmental Information (NCEI) (2020). <https://www.ncdc.noaa.gov/billions/>

EXTREME HEAT AND AT-HOME MORTALITIES

By 2040, an annual average of 14,000 heat-related fatalities is projected*.

- Heat vulnerability risk factors**:
 - MF housing residents;
 - live in “intra-urban” heat islands;
 - low-socio-economic status;
 - non-Hispanic persons of color;
 - women;
 - children under 5 and seniors over 65
 - pre-existing medical conditions.

Resident Survey Question	Treatment		Diff.
	Pre-Wx	Post-Wx	
Unsafe or unhealthy indoor temperatures (almost every month or some months)	40%	29%	-11%**
”Hot or very hot” indoor temperatures during the summer (over last 12 months)	50.0%	6.9%	-43.1%***

Many of these vulnerability risk factors characterize our affordable MF population.

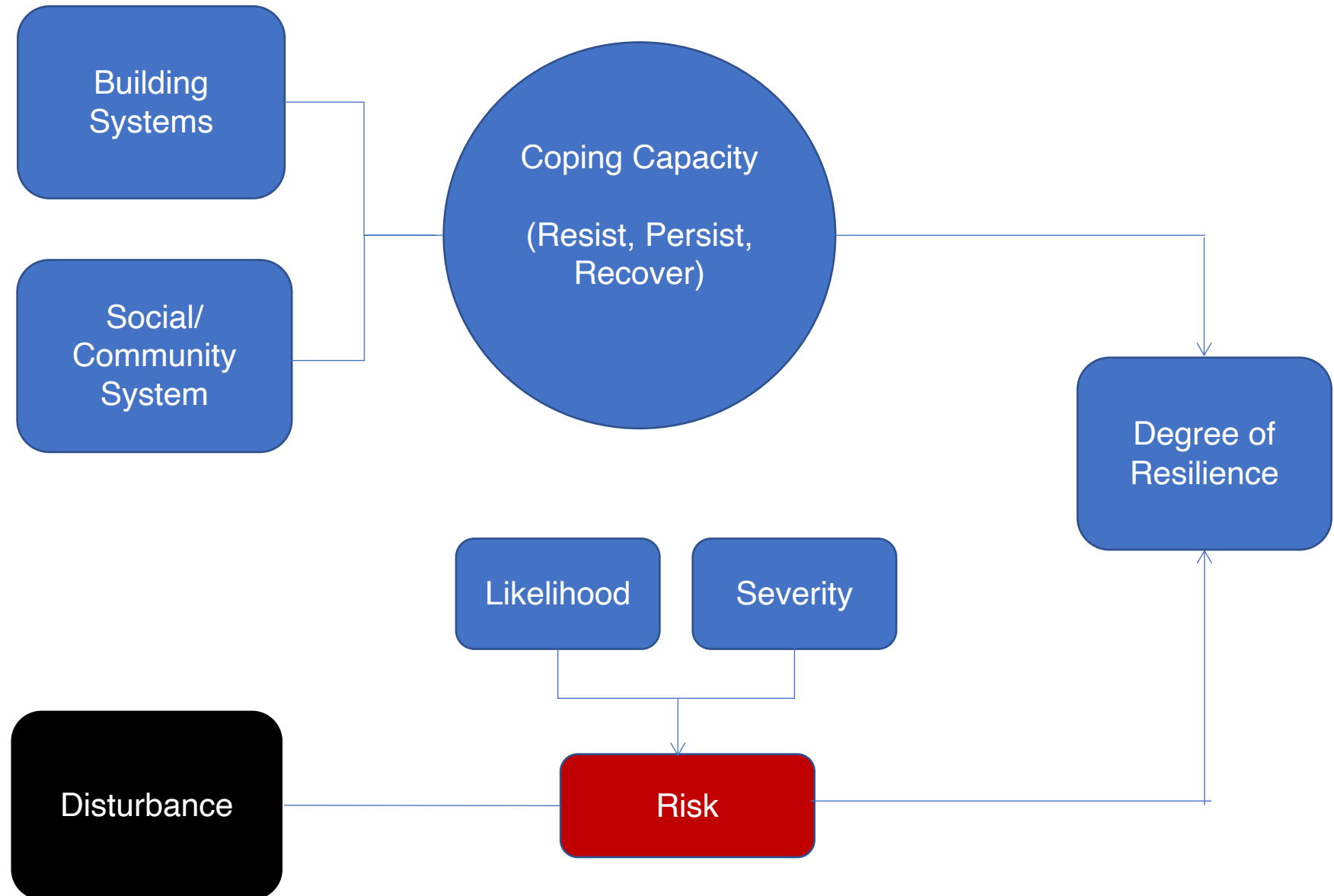
*Natural Resources Defense Council: <https://www.nrdc.org/sites/default/files/killer-summer-heat-paris-agreement-compliance-ib.pdf>

** Williams, et al. (2020). “The Role of Individual and Small-Area Social and Environmental Factors on Heat Vulnerability to Mortality Within and Outside of the Home in Boston, MA.” Climate 2020, 8, 29.

POWER OUTAGES AND HEALTH

Resident Survey Question	Full Sample
<i>Do you or anyone else in your household currently take prescription medicines that need to be kept in the refrigerator? (Yes)</i>	16.2% (n=1,836)
<i>If Yes, would it be life threatening if the medicines were not refrigerated for an extended period of time because of a power outage? (Yes)</i>	46.0% (n=235)
<i>Do you or does anyone else in your household currently rely on medical equipment that would stop working if the power goes out? (Yes)</i>	14.0% (n=1,771)
<i>If Yes, would it be life threatening if your electric medical equipment was unable to be powered for an extended period of time? (Yes)</i>	63.0% (n=219)

ELEMENTS OF RESILIENCE



RESEARCH APPROACH AND SAMPLE

Property Manager Survey

- Electronically administered by in-field staff
- Questions focused on building systems resilience
- Survey programmed into data collection software program (FileMaker Pro)
- \$25 gift card incentive
- 70% response rate

Challenge

- Phase 2

	Weatherized (CwT)	Unweatherized (T)	Unweatherized (C)	TOTAL
IL	14	16	4	34
WI	17	7	16	40
MA	19	11	11	41
NY	8	3	10	21
PA	2	2	0	4
RI	4	2	4	10
VT	9	1	4	14
Total	73	42	49	164

LIKELIHOOD OF OCCURRENCE

In the past 12 months, how many times have any of these events occurred in the area where your property is located? (%)

Property Manager Survey Question					
Type of Disturbance (n=164)	0	1	2	3	4 or more
Extreme hot temperatures* (%)	23	12	15	14	35
Extreme cold temperatures* (%)	9	19	11	15	46
Very high winds (%)	22	27	13	21	18
Heavy snow (%)	15	16	13	19	37
Heavy Rain (%)	11	20	18	23	28
Flooding (%)	72	14	2	7	5
Drought (%)	92	4	4	0	0
Wildfire (%)	99	1	0	0	0
Earthquake (%)	97	1	2	0	0
Power Outage* (%)	53	18	18	2	9

*Lasting 3 or more days

Due to rounding totals may not equal 100%

SEVERITY OF OCCURRENCE

Thinking about the events you reported in the previous question, did any of them result in the following situations? (% Yes)

Property Manager Survey Question	
	Full Sample
Heating or cooling system shut down	27.2%
Residents could not use oxygen machine	12.4%
Residents could not refrigerate medications	11.2%
Residents could not use phone	11.6%
No safe drinking water	7.0%
Residents could not cook meals	18.9%
Resident's food spoiled	12.0%
Units dangerously cold	20.8%
Units dangerously hot	24.2%
Raw sewage smell	8.3%
Residents extremely concerned about welfare	21.4%

BUILDING SYSTEMS RESILIENCE

*For each event below, which system on this property would be **MOST** critical?
(%)*

Property Manager Survey Question					
Type of Disturbance (n=164)	Building Envelope	Plumbing System	Electrical System	Mechanical System	Does not apply
Extreme hot temperatures* (%)	5	4	16	68	8
Extreme cold temperatures* (%)	6	28	6	60	2
Very high winds (%)	61	0.2	25	4	11
Heavy snow (%)	51	15	11	14	10
Heavy Rain (%)	50	69	8	10	17
Flooding (%)	33	31	2	12	21
Drought (%)	16	1	0.4	17	65
Wildfire (%)	29	0	3	4	65
Earthquake (%)	38	0.2	0.7	4	57
Power Outage* (%)	7	1	56	28	9

*Lasting 3 or more days

BUILDING SYSTEMS RESILIENCE

In your opinion, how has weatherization affected this property's ability to withstand extreme events? (%)

Property Manager Survey Question							
Type of Disturbance (n=164)	Greatly Improved	Improved	No Change	Decreased	Greatly Decreased	Don't know	Doesn't Apply
Extreme hot temperatures* (%)	27	49	15	0	0	3	6
Extreme cold temperatures* (%)	36	48	10	1	0	3	3
Very high winds (%)	10	36	36	1	0	7	11
Heavy snow (%)	6	32	48	0	0	7	8
Heavy Rain (%)	4	32	44	4	0	7	10
Flooding (%)	1	8	59	0	0	10	22
Drought (%)	3	1	48	0	0	10	38
Wildfire (%)	3	1	41	0	0	8	47
Earthquake (%)	3	1	41	0	0	12	43
Power Outage* (%)	4	16	49	0	0	8	22

*Lasting 3 or more days

BUILDING SYSTEMS RESILIENCE

Comparing Costs of Vulnerability – Preventative or Reactive Maintenance

Preventative and Reactive Maintenance Costs (mean cost per unit)	Weatherized (CwT)	Unweatherized (T + C)	Diff.
<i>Could you please estimate the <u>preventative</u> maintenance costs spent on this property over the last 12 months?</i>	\$462	\$709	-\$247
<i>Over the last 12 months, could you please estimate any <u>reactive</u> maintenance costs spent on this property <u>due to equipment failure</u>?</i>	\$660	\$771	-\$111



CONCLUDING THOUGHTS

- Our health impact data shows that weatherization is quite effective at the mitigation of adverse impacts of exposure to extreme temperatures.
- Data from the property managers show that standard weatherization as a standalone may not be enough to increase resilience to additional disturbances.
- Multi-component interventions that adequately address a rapidly changing climate or a sudden break from the "normal" past should be seriously considered.

How might we fulfill our obligations to current and future generations and ensure that our more disadvantaged populations have adequate housing?

RESEARCH CONTINUES

- Monetization challenges:
 - Identifying costs related to a systems' IN-ability to cope in the face of each disturbance.
 - Placing a value on coping capacity in order to value the benefits of higher resilience.
 - Identifying property insurance costs attributable to building system improvements.
 - Collecting costs to insurers for reported basement flooding, water damage, and roof damage.
 - Collecting actual maintenance cost data (as opposed to self-reported)

THANK YOU!!

Questions?

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