RESILIENCY:
Designing for the next 50 years

Sarah Hong
Agenda

- Impacts of climate change in the US over the next 50 years
- Vulnerabilities in today’s buildings
- Design solutions
- Incentivizing resilience
“Resilience is the capacity of a community, business or natural environment to prevent, withstand, respond to and recover from a disruption.”

US-Climate Resilience Toolkit
Impacts of Climate Change

- **Drought**: 25-50% increase in water withdrawal over next 50 years
- **Flooding**: Flash flooding expected to triple over the next 100 years in Rocky Mountain range
- **Extreme Heat**: Ave temperature expected to rise 2-5 degrees F in next 50 years
- **Severe Winter Storms**: Severe storms can cause power outages and closures of streets, schools, and businesses
- **Hail Storms**: More than $5 billion in damage in CO in past decade
- **Wildfire**: Fire frequency and intensity increases with rising greenhouse gas emissions
Frequency of $Billion+ Extreme Weather Events and Associated Losses
Average temperature is likely to increase by 2-5 °F by 2050

Vulnerable Populations

Extreme heat episodes in much of the region disproportionately threaten the health and well-being of individuals and populations who are especially vulnerable... Communicable diseases, ground-level ozone air pollution, dust storms, and allergens can combine with temperature and precipitation extremes to generate multiple disease burdens.

US Fourth National Climate Assessment – 2018

Mortality rates expected to increase to annual average of 13,000 by 2050. – Natural Resources Defense Council
Heat is one of the biggest climate-related public health threats, according to the CDC.
US Water Demand in 2050

Projected Changes in Water Withdrawals

(a) Without Climate Change

(b) With Climate Change

% change

- < 0
- 0 to 10
- 10 to 25
- 25 to 50
- >50
Effects of Drought on the Built Environment

- Water scarcity
- Sinking and shifting of land
- Expanding and shrinking soil
- Flash floods
Wildfires are increasing and wildfire season is getting longer in the Western U.S.

Average number of large wildfires per year

- 1980-1989: ~140
- 1990-1999: ~160
- 2000-2012: ~250

Smoke Wave Days
Wildfire Air Pollution

Days per year
- 0
- 0-2
- 2-5
- 5-10
- 10-20
- 20+

Source: Climate Central
FEMA Flood Maps

- FEMA flood maps based on historical data only
- Takes 2-3 years to update a region
- Study shows actual risk is 3x higher than what is shown in FEMA flood maps

17% of homes hit by the 2013 floods were outside of the mapped floodplain.
70% of Major Power Outages Caused by Severe Storms

Extreme Weather is Causing More Major Power Outages
(major = at least 50,000 customers affected)

- storms and severe weather
- cold weather and ice storms
- hurricanes and tropical storms
- tornadoes
- extreme heat and wildfires

Number of outages


CLIMATE CENTRAL
How vulnerable are our buildings today?
International Building Code Requirements

1/3 of US communities have not adopted or do not fully enforce International Codes

Flood
- Elevate 1+ foot above BFE
- Wet floodproofing
- Dry floodproofing (commercial)

Fire
- Land use planning
- Defensible spaces
- Retrofits for fire mitigation

Landscaping
- Light or green roof (Denver)

Air quality
- Ventilation requirements

Water efficiency
- 1.6 gpf toilets / 2.5 gpm shower
- 2.2 gpm sinks

Envelope Design
- Insulation requirements by climate
- Air-tightness requirements

-- National Institute of Building Science
IECC Code Adoption in the US

Residential Buildings
- No statewide code
- Less efficient than 2009 IECC
- 2009 IECC

Commercial Buildings
- Between 2009 and 2012/15 IECC
- 2012/15 IECC
- More efficient than 2012/15 IECC
Climate-Resilient Design Strategies
Resiliency Principles

- Redundancy and diversity
- Simple, passive, flexible
- Durability
- Locally available, renewable, and reclaimed
- Social equity and community
Passive Building Design

1. Solar Orientation
2. High Insulation
3. High Performance Windows
4. Airtight Enclosure
5. Balanced Ventilation and Energy Efficient Mechanical Systems

Renewables
Reducing Heat Island Effect

- Install cool and green roofs that is Energy Star Certified or made of highly reflective materials
- Standard grey concrete for pavement instead of asphalt
- Plant trees or vegetation to provide shade - evapotranspiration cools the air around trees.
Drought Mitigation: Water Efficiency

1. Reduce indoor water consumption
2. Greywater reuse
3. Rainwater harvesting & on-site water storage

Install low-flow equipment
- Low flow faucets & showers
- Low flow or composting toilets
- Waterless urinals
- Water efficient appliances
Site Water Management

- Permeable paving allows precipitation to replenish ground water supply instead of being funneled into storm sewer.
- Providing shade, especially for riparian areas, helps reduce the rate of evapotranspiration. Use water-efficient, native species of trees.
- Install bioswales to collect and filter stormwater from impervious areas and gutters, allowing stormwater to recharge the groundwater supply.

4. Green infrastructure to allow stormwater to replenish ground water

5. Xeriscape to reduce need for watering landscape

6. Plant drought-tolerant native plants and trees to provide shade
Primary determinants of a home’s ability to survive a fire are *roofing material* and surrounding *defensible space*.

- Break up continuity of horizontal and vertical fuel sources
- Replace wood shingled roofs with non-combustible material
- Prescribed fire control (burns)

Homes with 30’ defensible space and non-combustible roofs have a 85% survival rate in the event of a wildfire.
Indoor Air Quality

- Check filters for dust and debris buildup at least every month during heavy smoke seasons

- Mechanical Supply or Balanced Ventilation with minimum MERV 8 filters

- Educate occupants about when to use natural ventilation in emergency situations – run AC with fresh air intake closed off, keep windows and doors closed, close fireplace dampers
Flood Mitigation

Dry floodproofing:
Seals buildings to keep water out

Wet floodproofing:
Allows unoccupied portions of building to be flooded
Elevate mechanical equipment
Boilers, furnaces, water heaters, fuel storage tanks, elevator machine rooms, ductwork, electrical systems.
If not on roof, on raised platform.

Floodwater vents
Allow water to flood lower levels

Elevate living spaces
Reserve sub-DFE for parking, storage, entryways

Stormwater management
Permeable paving, green roofs and bioswales infiltrate excess stormwater
Low-cost Retrofit Floodproofing Measures

**Sump pumps**
Remove water that accumulates at lowest point in building

**Backwater valves**
Prevent sewage backflow

**Protect mechanical equipment**
Build barrier around critical systems if it can’t be elevated
Flood risk measures = lower insurance premiums

DID YOU KNOW?

Community Rating System (CRS) is a voluntary incentive program that recognizes communities for implementing floodplain management practices that exceed the Federal minimum requirements of the National Flood Insurance Program (NFIP). Policyholders in communities that participate in the CRS program can receive reduced flood insurance premiums for their buildings within the community.

When your community participates in CRS, you can qualify for an insurance premium discount of up to 45% if you live in a high-risk area and up to 10% in moderate- to low-risk areas.
3 Strategies to address winter storm occurrences:

1. Backup power + disaster preparedness plan
   - Fuel-fired backup generators, solar with battery storage, micro-grid
   - Snow removal plan for building ingress/egress

2. High performance building enclosure in case of power outage
   - Passive solar strategies (orientation, thermal mass, high SHGC windows)
   - Tighter, higher performance envelopes

3. Provide access to potable water
   - Rooftop storage, gravity-fed
Incentivizing Resilient Building Design
Real Estate Risk Factors

• **Catastrophes**
  - Increased Insurance Premiums
  - Capital Expenditures
  - Higher Operating Costs
  - Decrease in liquidity and value of buildings

• **Transitional Risks**
  - Locational decrease in value
  - Obsolescence of assets

“Investors acknowledge that using insurance as the main protection for asset value is not an effective solution to mitigate the risk of devaluation, because premiums currently are **largely based on historical analysis and are not likely to consider future climate risk.**”

– ULI, *Climate Risk and Real Estate Investment Decision-Making*
### Stakeholder Incentives to Invest in Resilience Measures

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Incentives</th>
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<tbody>
<tr>
<td><strong>Home / Building Owner:</strong></td>
<td>Reduced insurance premium, tax reduction, later building owners may pay more for resilient buildings. Reduced repair costs, accelerated recovery, reduced chance of mortgage default</td>
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<tr>
<td><strong>Occupant:</strong></td>
<td>Enhanced safety</td>
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<tr>
<td><strong>Builder:</strong></td>
<td>Increased market value of building</td>
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<tr>
<td><strong>Insurer:</strong></td>
<td>Reduced portfolio risk</td>
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<tr>
<td><strong>Loan Provider / Financer:</strong></td>
<td>Increased loan security, increased financing opportunities, asset risk reduction</td>
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<tr>
<td>Natural Benefit-Cost Ratio Per Peril</td>
<td>Exceed common code requirements</td>
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<td>---------------------------------</td>
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<tr>
<td>Overall Hazard Benefit-Cost Ratio</td>
<td>4:1</td>
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<tr>
<td>Riverine Flood</td>
<td>5:1</td>
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<tr>
<td>Hurricane Surge</td>
<td>7:1</td>
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<tr>
<td>Wind</td>
<td>5:1</td>
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<tr>
<td>Earthquake</td>
<td>4:1</td>
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<tr>
<td>Wildland-Urban Interface Fire</td>
<td>4:1</td>
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Description:
A multifamily building located in the AE flood zone in New Jersey installed 9 flood vents as a wet floodproofing strategy after suffering heavy damage from Superstorm Sandy. The owner also raised the flood to ground level by adding 9 inches of gravel and concrete fill.

**CASE STUDY**

**COST SAVINGS**

Individual insulated flood vent = $200-250 each  
Total Cost of renovation = $25,000

After retrofit, building experienced **83% reduction** in flood insurance cost policy.

BEFORE: Paid $12,000 for $300,000 coverage  
AFTER RETROFIT: Paying $2,000 for $820,000 coverage  
ROI = 2.5 years

Due to reduced insurance premiums, flood mitigation efforts have a 5:1 financial payback (Source: National Institute of Building Sciences)
Resilience starts with strong, regularly updated, and properly implemented building codes.
- International Code Council (ICC)
AND THEY SAID
I WAS CRAZY
Thank you!

Stay in touch!
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Group 14

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