CRSI (Climate Resilience Screening Index) – Development and Application

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RESILIENCE

The capacity to prepare for disruptions, recover from shocks and stresses, and adapt and grow from a disruptive experience.

#RebuildBETTER
The Climate Resilience Screening Index (CRSI) is a composite measure developed to characterize the resilience of socio-ecological systems in the context of governance and risk to natural hazard events.

- Comprised of five domains (Risk, Governance, Society, Built Environment, and Natural Environment)
- Represented by 20 indicators
- Calculated from 117 metrics

**Intended Use:** Help communities target potential areas for resources to increase relative resilience given specific hazard profiles.
## CRSI Domains and Indicators

<table>
<thead>
<tr>
<th>Domain Description</th>
<th>Indicator Description (# of metrics)</th>
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<tbody>
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<td>The Risk domain represents the characteristics of a place that contribute to a level of exposure or loss resulting from specific hazards.</td>
<td>Exposure</td>
<td>The Natural Environment domain describes resilience of natural and managed ecosystems through measures of extent and condition.</td>
<td>Extent</td>
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Domain Overviews

- **Risk Domain**: Characteristics of a place that contribute to level of exposure or loss resulting from specific hazards
  - **Exposure**: Probability of hazard occurrence over full spectrum of natural hazards (13) and technological hazards (5)
  - **Loss**: Historical loss of life and property (3)

- **Governance Domain**: Collaboration of government agencies and NGOs and private citizens towards joint objectives with a system of rules and regs for increasing community resilience
  - **Community Preparedness**: County and community resilience strengthening and structure hazard mitigation (2)
  - **Personal Preparedness**: Individual or household activities that help protect personal property for acute climate events (2)
  - **Natural Resource Conservation**: Protection of natural resources (1)
What is CRSI?

- The Climate Resilience Screening Index (CRSI) is a composite measure developed to characterize the resilience of socio-ecological systems in the context of governance and risk to natural hazard events.
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Domain Overviews

• Society Environment Domain: All human aspects of a community except built environment (include economic, demographic and social interactions)
  – Demographics: General vulnerability attributes of a community’s population (5)
  – Economic Diversity: Factors associated with economic stability and ability to monetarily respond and recover (2)
  – Health Characteristics: Factors associated with healthcare access, special health vulnerability populations, and specific health problems (9)
  – Trace and Labor Services: Appropriate construction skills needed to provided for accelerated recovery (8)
  – Safety and Security: Emergency and civil services (4)
  – Social Cohesion: Social bonds and willingness of society members to cooperate (4)
  – Social Services: Critical services for recovery unrelated to labor/trade, safety/security and civil control (15)
  – Socio-Economics: Employment opportunities and issues associated with personal economics (2)
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Intended Use: Help communities target potential areas for resources to increase relative resilience given specific hazard profiles.
Domain Overviews

- **Built Environment Domain:** Man-made surroundings that support human activities and reflect structural vulnerability and critical functions for recovery
  - Communications Infrastructure: Communications Continuity (7)
  - Utilities Infrastructure: Relative availability of drinking water, sewer and power services (3)
  - Transportation Infrastructure: Transportation flow continuity (6)
  - Housing Characteristics: Home overcrowding, housing density, type of housing and structural condition of housing (5)
  - Vacant Structures: Number of vacant buildings (3)

- **Natural Environment Domain:** Resilience of natural and managed ecosystems
  - Extent: Proportion of land that is undeveloped and acreage in each ecosystem type (9)
  - Condition: Ecological condition of each ecosystem type (9)
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<td>The Risk domain represents the characteristics of a place that contribute to a level of exposure or loss resulting from specific hazards.</td>
<td>- Exposure: The probability of hazard occurrence across a full spectrum of natural hazard events as well as additional technological hazards that may coincide with, or be exacerbated by such events (18)</td>
<td>The Natural Environment domain describes resilience of natural and managed ecosystems through measures of extent and condition.</td>
<td>- Extent: the proportion of land that is undeveloped and includes the spatial extent or acreage of each ecosystem type (9 metrics)</td>
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<td>The Governance domain describes the collaboration of government agencies and Non-Governmental Organization (NGOs) or private citizens towards joint objectives within a system of rules and regulations in context of increasing community resilience.</td>
<td>- Loss: Characteristics of vulnerability represented through historical loss of life and property (including crops) associated with specific hazard events (3)</td>
<td>- Community Preparedness: County and community resilience strengthening and structure hazard mitigation (2 metrics)</td>
<td>- Condition: Condition-represents the ecological condition of the ecosystems identified in the extent indicator (9 metrics)</td>
</tr>
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<td>The Built Environment domain describes the man-made surroundings that support human activities and reflects structural vulnerability and critical functions needed for recovery from hazard events.</td>
<td>- Natural Resource Conservation: Protection of natural resources from anthropogenic activities (1 metric)</td>
<td>- Personal Preparedness: Individual or household activities that help protect personal property from acute climate events (2 metrics)</td>
<td>- Demographics: Demographics-measures that reflect general vulnerability attributes of a community’s general population (5 metrics)</td>
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<td>- Communication Infrastructure: communications continuity (7 metrics)</td>
<td>- Utilities Infrastructure: Measures of the relative availability of drinking water, sewer and power services based on number and location (3 metrics)</td>
<td>- Economic Diversity: Diversity-represents factors associated with economic stability and ability to monetarily respond and recover from hazard events (2 metrics)</td>
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<td>- Housing Characteristics: addresses issues of home overcrowding, housing density, type of housing and structural condition (5 metrics)</td>
<td>- Vacant Structures: measures of the number of vacant business structures residences and other vacant buildings (3 metrics)</td>
<td>- Health Characteristics: factors associated with healthcare access, special health vulnerability populations, and specific health problems (5 metrics)</td>
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<td>- Transportation Infrastructure: represents transportation flow continuity described with related measures for bridges, roads and airports (6 metrics)</td>
<td>- Safety and Security: addresses the provisioning of emergency and civil services (4 metrics)</td>
<td>- Trade and Labor Services: represents measures of the appropriate construction skills needed to provide for accelerated recovery (8 metrics)</td>
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<td>- Social Cohesion: Cohesion-represents social bonds and the willingness of members of a society to cooperate with each other in the wake of natural hazard events (4 metrics)</td>
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<td>- Social Services: Services-characterizes services critical for recovery and includes the availability of services unrelated to laborforce, emergency services and civil control (15 metrics)</td>
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<td>- Socio-economics: Socio-economics-relates to employment opportunity and issues associated with personal economics, primarily level of income (2 metrics)</td>
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</table>
Calculating Basic Resilience

- Ratio of Governance and Risk Domains (G/R)
- Basic Resilience scores were calculated for each county as follows:

  Basic Resilience = Gov/Risk

![Graph showing distribution of Basic Resilience scores with frequency and cumulative percent of counties]
Hazard Exposure Score vs. Governance Score – All Counties

Using All County-Level Domain Scores
Calculating CRSI

- Society, Natural Environment and Built Environment domain scores for each county were first adjusted to become factors in the county level CRSI calculation as follows:

\[
\text{Adj. County Domain Score} = \frac{(\text{County Domain Score} - \text{Median Domain Score for all counties})}{\text{(Median Domain Score for all counties)}}
\]

- CRSI scores were then calculated for each county as follows:

\[
\text{CRSI} = \text{Gov} + (\text{Gov} \times \text{Adj Society}) + (\text{Gov} \times \text{Adj Built}) + (\text{Gov} \times \text{Adj Natural})
\]
## National CRSI Scores

<table>
<thead>
<tr>
<th>National Average</th>
<th>Risk</th>
<th>Governance</th>
<th>Built Environment</th>
<th>Natural Environment</th>
<th>Society</th>
<th>CRSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Including Alaska</td>
<td>0.29590</td>
<td>0.59674</td>
<td>0.39320</td>
<td>0.41333</td>
<td>0.51561</td>
<td>2.71349</td>
</tr>
<tr>
<td>Excluding Alaska</td>
<td>0.29758</td>
<td>0.59575</td>
<td>0.39262</td>
<td>0.41182</td>
<td>0.51587</td>
<td>2.37534</td>
</tr>
</tbody>
</table>
EPA Region 8

CRSI and Domain Scores – Region 8

EPA Region 8

Risk

Governance

Society

Built Environment

Natural Environment

CRSI 6.09

Domain Score (lighter shade bar)/Median Adjusted Score(darker shade bar)
Maps of Region 8 CRSI and Domain Scores

Region 8
Risk Statistics – Region 8

Three Primary Exposures:
1. Drought
2. Extreme Temps – Highs
3. Extreme Temps – Lows

Risk Range:
High – Meade, SD – 4.14
Low – Daniels, MT – 1.42
Mean – 2.54

Natural Exposures:
- Drought: 37%
- Extreme High Temps: 18%
- Extreme Low Temps: 16%
- Landslide: 9%
- Hail: 5%
- Wildfire: 1%
- Earthquake: 4%
- Inland Flood: 6%
- High Wind: 4%

Technological Exposures:
- TRI: 37%
- Superfund: 62%
- RCRA: 1%
- Natural Exposure: 99%

Losses:
- Natural Loss: 45%
- Dual-Benefit Loss: 48%
- Developed Loss: 7%
Climate Resilience Screening Index: Future Applications

- Adaptation of CRSI to Superfund sites
- Retrospective Analyses of Hurricanes of 2017
- Cases Studies for CRSI at Community Level
- Working with Regions to Assess Research Needs to Support Improvement of Resilience
- Evaluation of Relationship between Well-Being and Resilience
SUMMARY

- National assessments are needed to address widespread socio-ecological impacts of natural hazard events from a policy perspective.
- Assessments for geographically specific areas are useful in identifying potential strengths and weaknesses in resilience aspects given similar hazard profiles and governance structures (counties).
- As constructed, CRSI allows for a drill down not only in scale, but also at the indicator level which could be useful for targeting resources to increase resilience.
- CRSI provides a “starting point” for resilience assessments. Locally held data should be used to supplement CRSI characterizations.
Available Manuscripts and Reports


THANK YOU

CHALLENGES AHEAD