A Framework for Quantifying Social, Economic, and Environmental Sustainability of Hazard Mitigation Policies

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Motivation

• Damage is not the only contributor to social impacts.

• Community resilience approaches should be community-specific.

The framework presented here takes into account damage, functionality, and community-level social dynamics, as well as how that community fits into the surrounding region, to estimate social impacts in a loss estimation framework.
What are social dynamics?

Social Dynamics are the complex social relationships apparent in a community due to the intersection of culture, economy, and governance.

Simplified here into four components:

- **Social vulnerability**
  - the pre-existing conditions and characteristics of a person that make them more or less susceptible to harm and negative outcomes

- **Social capital**
  - the networks of relationships that individuals have within or outside of a community that provide them with access to resources, decision-making, and overall power

- **Social cohesion**
  - the networks of relationships that individuals have within a community that provide trust

- **Social equity**
  - the even, or fair, distribution of resources and access to essential needs across individuals within a community
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How are the other social dynamics measured?

- Race
- Income
- Age
- Education
- Gender
- Tenure
### Social Vulnerability Indicators

\[ M_{SV,1} = \text{percentage of the population identifying with one primary SV indicators} \]
\[ M_{SV,2} = \text{percentage of the population identifying with two primary SV indicators} \]
\[ M_{SV,3} = \text{percentage of the population identifying with three primary SV indicators} \]
\[ M_{SV,4} = \text{percentage of the population identifying with four primary SV indicators} \]
\[ M_{SV,5} = \text{percentage of the population identifying with five or more primary SV indicators} \]

### Social Capital Indicators

\[ M_{SCa,1} = \text{number of religions organizations per 1,000 population members} \]
\[ M_{SCa,2} = \text{number of social advocacy organizations per 1,000 population members} \]
\[ M_{SCa,3} = \text{number of arts, entertainment, and recreation centers per 1,000 population members} \]
\[ M_{SCa,4} = \text{number of civic organizations per 1,000 population members} \]
\[ M_{SCa,5} = \text{number of shared working business hubs per 1,000 population members} \]

Cutter et al 2010

### Social Cohesion Indicators

\[ M_{SCo,1} = \text{number of regular volunteers per 1,000 population members} \]
\[ M_{SCo,2} = 1 - \text{number of nonviolent crimes per year per 1,000 population members} \]
\[ M_{SCo,3} = 1 - \text{number of violent crimes per year per 1,000 population members} \]
\[ M_{SCo,4} = \text{number of the population who were natively born in community per 1,000 population members} \]
\[ M_{SCo,5} = \text{number of children’s play areas per 1,000 population members} \]

Cutter et al 2010

### Social Equity Indicators

\[ M_{SE,1} = \text{ratio of (number of healthcare facilities per 1,000 population members) for different neighborhoods} \]
\[ M_{SE,2} = \text{ratio of (number of grocery stores per 1,000 population members) for different neighborhoods} \]
\[ M_{SE,3} = \text{ratio of (number of parks per 1,000 population members) for different neighborhoods} \]
\[ M_{SE,4} = \text{ratio of (number of children’s play areas per 1,000 population member) for different neighborhoods} \]
\[ M_{SE,5} = \text{ratio of (percentage of minority households per 1,000 population members) for different neighborhoods} \]
\[ M_{SE,6} = \text{ratio of (percent of population within 2 miles of public transportation) for different neighborhoods} \]
\[ M_{SE,7} = \text{ratio of (percent of population within 1 mile of a walking path) for different neighborhoods} \]
\[ M_{SE,8} = \text{ratio of (households whose rent or mortgage is greater than 40% of their income) for different neighborhoods} \]
Social, Economic, and Environmental Sustainability Decision Framework

1. Identify target
   - Building type(s)
   - Performance level(s)
   - Service life

2. Decision alternative 1
   - Evaluate community-level social dynamics
     - Social measures
   - Evaluate building-level SEES measures
     - Economic measures
     - Environmental measures

3. Aggregate SEES measures to Community-Level

4. Compare tradeoffs across SEE sustainability

5. Recommend decision
Step 1. Identify the assessment target

**Target infrastructure(s)**
- Population data
- Building or other infrastructure
- Design level(s) and service life

**Decision alternatives**
- With new policy or action
- Without new policy or action

**Hazard scenario(s)**
- Hazard type(s)
- Hazard level(s)

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**Identify target**

- Building type(s)
- Performance level(s)
- Service life

- Decision alternative 1
- Decision alternative 2

**Evaluate community-level social dynamics**

- Social measures

**Evaluate building-level SEES measures**

- Economic measures
- Environmental measures

**Aggregate SEES measures to Community-Level**

**Compare tradeoffs across SEE sustainability**

**Recommend decision**
Step 2a. Evaluate building-level SEES consequences

Social
- Physical & mental health
- Dislocation

Economic
- Direct costs
- Indirect costs

Environmental
- Global warming potential
- Total primary energy

Identify target

Building type(s)
Performance level(s)
Service life

Decision alternative 1
Decision alternative 2

Evaluate community-level social dynamics
Evaluate building-level SEES measures

Social measures
Economic measures
Environmental measures

Aggregate SEES measures to Community-Level

Compare tradeoffs across SEE sustainability

Recommend decision
Step 2b. Evaluate community-level social dynamics
- Social equity
- Social capital
- Social cohesion
- Social vulnerability

Evaluate building-level SEES measures
- Environmental measures

Evaluate community-level social dynamics
- Social measures
  - Economic measures
  - Environmental measures

Aggregate SEES measures to Community-Level

Compare tradeoffs across SEE sustainability

Recommend decision
Step 2c. Aggregate building-level measures to community-level

- Social (health, dislocation, relocation)
- Economic (direct & indirect costs)
- Environmental (GWP & total primary energy)

Recommend decision
Step 3. Assess decision feasibility

- Target infrastructure
- Decision alternatives
- SEES measures

Recommend decision
THANK YOU!

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<thead>
<tr>
<th>Conclusions</th>
<th>Limitations</th>
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<tbody>
<tr>
<td>- Social dynamics influence - positively or negatively - social impacts in</td>
<td>- Proposed measurement of social dynamics is still a simplification on</td>
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<td>the community, and can lead to higher rates of mental health and permanent</td>
<td>actual complexity.</td>
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<td>relocation/oufmigration.</td>
<td>- Some data required for suggested indicators is difficult to obtain, or</td>
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<td>- Modeling social dynamics helps make the decision framework community-</td>
<td>often not recorded.</td>
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<td>specific in terms of its social system.</td>
<td>- SEES framework needs to be validated.</td>
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