Breaking the Disaster Cycle: 
Future Directions in Natural Hazard Mitigation

Measuring Hazard Mitigation Success; 
Issues in Measuring Mitigation Success

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Measuring Hazard Mitigation Success; Issues in Measuring Mitigation Success

Objectives:

15.1 Understand the issues and background of attempts to measure the success of hazard mitigation, both before and after a disaster.

15.2 Identify indicators of success.

15.3 Describe quantitative measurement approaches, such as benefit cost analysis.
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Objectives:

15.4 Describe qualitative measurement approaches, such as case studies.

15.5 Assess the political, social, and economic aspects of measuring mitigation success.

15.6 Participate in a structured discussion about the credibility and validity of methods for measuring mitigation success.
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Objective 15.1

- Understand the issues and background of attempts to measure the success of hazard mitigation, both before and after a disaster:
  - Community impact analysis
  - Benefit cost analysis
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- Figure 15.1 Measuring Success in Hazard Mitigation

- Two main types of analytical methods:

  - 1) *community impact analysis* ("success stories")
    - success = impact of mitigation on community sustainability & reduction in vulnerability to natural hazards as measured through losses avoided as a result of mitigation

  - 2) *benefit cost analysis* (economic analyses)
    - success = benefits of mitigation (net change in direct and indirect future losses) exceed costs (expenditures on mitigation projects & processes)
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Figure 15.2 Benefit Cost Analysis Terms

- Benefits = losses avoided through mitigation of:
  - direct losses: e.g., building damage caused by physical impact of hazard, such as flood water
  - indirect losses: e.g., loss of production from an industry that is flooded

- Discount rate = interest rate used to calculate present value of expected future yearly benefits and costs
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- Critiques of benefit cost analysis
  - Narrow (fails to capture all benefits)
  - Mechanistic (reduces all values to dollars)
  - Formula driven (analysis only seeks ratio of 1+ & overvalues present vs future)
  - Monetizing inappropriate for many non-economic values (life, health, environmental quality, social community, etc.)

- Critiques of community impact analysis
  - Too broad
  - Imprecise
  - Outputs not comparable
  - Results not generalizable
  - Community impact analysis should not ignore failures
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Objective 15.2

- Identify indicators of success:
  - Benefit cost approach
  - Community impact analysis approach
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- Figure 15.4 Indicators of Success: A Sustainability Approach

- Goals:
  - Reducing losses from disasters
  - Creating sustainable communities
  - Building mitigation capacity
  - Analysis questions:
    - How effective are mitigation tools—acquisition and relocation of hazard prone properties and in-place elevations—in reducing losses?
    - How can communities utilize indicators to measure progress in reducing actual or potential disaster losses?
    - How can communities gauge their progress toward institutionalization of mitigation?

(Source: Hazard Mitigation in North Carolina)
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- **Figure 15.4 Indicators of Success: A Sustainability Approach - 2**

- Sustainable *housing* indicators:
  - households living in unsafe areas
  - households living in unsafe structures
  - repetitively damaged houses
  - households that carry flood insurance.

- Sustainable *business* indicators:
  - businesses in unsafe areas
  - businesses in unsafe structures
  - businesses with adequate hazard insurance
  - businesses with business impact analysis & business risk reduction plan

(Source: *Hazard Mitigation in North Carolina*)
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- Report: Hazard Mitigation Successes in the State of North Carolina (Source: Department of Crime Control and Public Safety Emergency Management Division)
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- Figure 15.4 Indicators of Success: A Sustainability Approach - 3

- Sustainable *infrastructure & critical facilities* indicators:
  - critical facilities (hospitals, emergency operations centers, police and fire stations, schools) in hazard-prone areas
  - repetitively damaged critical facilities
  - infrastructure elements (water supply, roads, bridges, sewerage, telecommunications, port facilities) in hazard-prone areas
  - repetitively damaged infrastructure elements
  - infrastructure elements with design & construction techniques that strengthen individual components against hazard forces
  - increase or decrease in functionality of critical facilities & infrastructure systems following major disaster.

(Source: *Hazard Mitigation in North Carolina*)
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- Figure 15.4 Indicators of Success: A Sustainability Approach - 4

- Sustainable *environmental* indicators:
  - unsafe land uses in 100-year floodplain or environmentally sensitive areas
  - commercial or industrial facilities in 100-year floodplain or environmentally sensitive areas mitigating against release or spill of hazardous materials
  - activities to reduce flood water storage capacity, including stream channelization, wetland drainage & ditching, filling of floodplains

(Source: Hazard Mitigation in North Carolina)
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Downtown Mullens, WV after floods of 2001. (Source: FEMA)
Objective 15.3

- Describe quantitative measurement approaches, such as benefit cost analysis:
  - Required of all FEMA-funded projects
  - Benefits definition:
    ✓ avoided future damages and losses as a result of the mitigation project
  - Analysis must include:
    ✓ building type
    ✓ building size
    ✓ replacement value
    ✓ contents value
    ✓ data about use and function
    ✓ hazard risk (probability of future events).
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Figure 15.5 Benefit Cost Analysis Methodology
Source: FEMA Full-Data Flood BC Analysis Module

The expected net present value, NPV, is defined as:

$$NPV = \frac{B_1}{1+i} + \frac{B_2}{(1+i)^2} + \ldots + \frac{B_t}{(1+i)^t} + \ldots + \frac{B_T}{(1+i)^T} - INV$$

where:

- $NPV$ is the expected Net Present Value of the hazard mitigation project;
- $B$ is the expected annual net Benefit of the hazard mitigation project for year $t$;
- $i$ is the annual discount rate;
- $T$ is the length of the planning horizon (useful life or Time of the hazard mitigation project); and
- $INV$ is the initial investment (the cost of the project).
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#### Figure 15.6 Expected Damages and Benefits

Building type: 2 story / Project useful life: 30 years

<table>
<thead>
<tr>
<th></th>
<th>Expected annual damages before mitigation</th>
<th>Expected annual damages after mitigation</th>
<th>Expected annual benefits</th>
<th>Present value of annual benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building damages</strong></td>
<td>$1,052</td>
<td>$9</td>
<td>$1,042</td>
<td>$12,935</td>
</tr>
<tr>
<td><strong>Contents damages</strong></td>
<td>525</td>
<td>5</td>
<td>521</td>
<td>8,468</td>
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<tr>
<td><strong>Displacement costs</strong></td>
<td>142</td>
<td>1</td>
<td>140</td>
<td>1,741</td>
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<tr>
<td><strong>Business income lost</strong></td>
<td>35</td>
<td>0</td>
<td>35</td>
<td>431</td>
</tr>
<tr>
<td><strong>Rental income lost</strong></td>
<td>21</td>
<td>0</td>
<td>21</td>
<td>255</td>
</tr>
<tr>
<td><strong>Public services lost</strong></td>
<td>745</td>
<td>7</td>
<td>730</td>
<td>9,165</td>
</tr>
<tr>
<td><strong>Total losses &amp; benefits</strong></td>
<td><strong>$2,521</strong></td>
<td><strong>$23</strong></td>
<td><strong>$2,496</strong></td>
<td><strong>$30,999</strong></td>
</tr>
</tbody>
</table>

Source: FEMA Full-Data Flood BC Analysis Module
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Objective 15.4

- Describe qualitative measurement approaches, such as case studies:
  
  - Contains data on:
    - Mitigation projects
    - Mitigation processes
  
  - Systematic methodology
  - Research design
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Figure 15.7 Case Study Methodology

- Case study:
  - empirical inquiry that investigates a contemporary phenomenon (e.g., hazard mitigation) within its real life context (e.g., a community)
  - when boundaries between phenomenon and context are not clearly evident (e.g., how does the community itself affect & influence mitigation)
  - in which multiple sources of evidence are used (e.g., records, data bases, interviews, documents)
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- Question: impact of mitigation program on sustainable housing?
- Proposition: relocation strategies must identify safe and feasible locations for relocatees within the community in order to foster sustainability
- Unit of analysis: relocation program
- Criteria:
  - Primary program benefits: number of housing units related in safe & feasible locations within the community, as compared with number of units dispersed to other locations
  - Primary program costs: governmental expenditures on acquisition of units, moving costs, staff costs
  - Secondary program benefits: restoration of original ecosystem in cleared area, such as a wetland or stream buffer
  - Secondary program costs: un-reimbursed moving expenses incurred by relocatees, social disruptions faced by relocatees in new neighborhoods
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- Objective 15.5

- Assess the political, social, and economic aspects of measuring mitigation success:
  - Value laden activity
  - Pleasing stakeholders vs. accurate report
  - Honest, objective analysis is most beneficial in the long run
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- Figure 15.9 Politics of Mitigation Analysis
  - Stakeholders
    - Government decision makers
    - Relocated households
    - Taxpayer groups
    - Public safety providers
    - Analyst
    - Be honest and objective
    - Provide community learning
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Objective 15.6

- Participate in a structured discussion about the credibility and validity of methods for measuring mitigation success:

  - Benefit cost analysis vs. community impact analysis
    - Advantages
    - Critique
    - Examples