# 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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- **Figure 15.3 Critiques of Analytical Methods**

  - 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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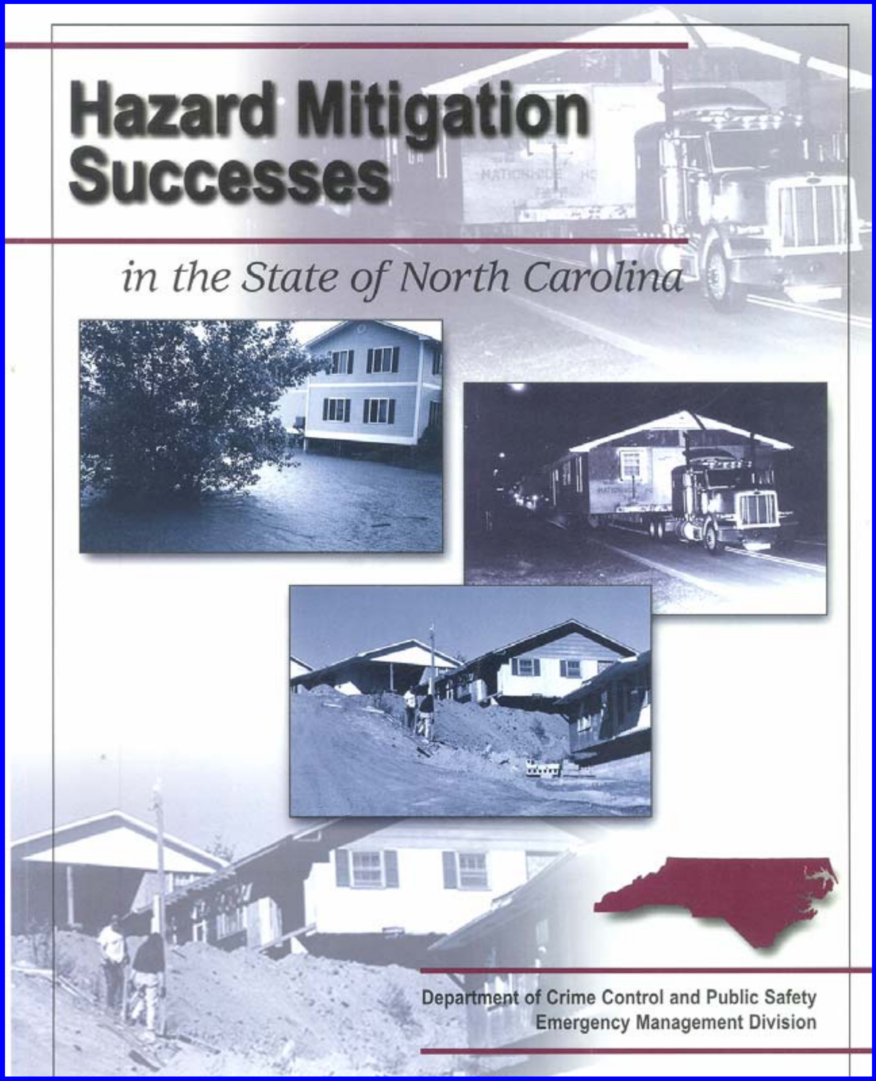
- Report: Hazard Mitigation Successes in the State of North Carolina (Source: Department of Crime Control and Public Safety Emergency Management Division)



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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)

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- **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

| | Expected annual damages before mitigation | Expected annual damages after mitigation | Expected annual benefits | Present value of annual benefits |
|---|---|---|---|---|
| **Building damages** | $1,052 | $9 | $1,042 | $12,935 |
| **Contents damages** | 525 | 5 | 521 | 8,468 |
| **Displacement costs** | 142 | 1 | 140 | 1,741 |
| **Business income lost** | 35 | 0 | 35 | 431 |
| **Rental income lost** | 21 | 0 | 21 | 255 |
| **Public services lost** | 745 | 7 | 730 | 9,165 |
| **Total losses & benefits** | **$2,521** | **$23** | **$2,496** | **$30,999** |

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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- **Figure 15.8 Case Study Example**
  - 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