

Prioritization of Hazard Mitigation Projects in the State of Illinois

Mia Leigh Renna¹

¹University of Maryland, College Park



20
24

NHERI Computational Symposium

February 1-2
Los Angeles, California

How can the State of Illinois maximize the impact of hazard mitigation funds through strategically executing mitigation projects?

Motivation

- Illinois Emergency Management Agency (IEMA) receives applications from across the entire state requesting funding for hazard mitigation projects
 - Applications range in types of hazards targeted, scale of project, and anticipated mitigation approach
- IEMA must choose which hazard mitigation projects should be awarded funding based on published prioritization criteria
 - Projects must be prioritized considering project benefits and costs^{i-iv}
 - IEMA previously recommended mitigation applications using a first come first served basis, without considering the benefit to cost ratio
- I developed a new prioritization methodology for IEMA to meet all regulations and standards set by the federal government and Illinois governor^{iii-vii}
 - The new prioritization methodology is published in the 2023 Illinois Natural Hazard Mitigation Plan (INHMP)

Project Overview

- I utilized a Multi-Criteria Decision Analysis (MCDA) approach to measure the benefits of the proposed hazard mitigation projects
- MCDA is a comparative analysis for options that have conflicting criteria and objectives
 - Ranked list of desired mitigation action outcomes shaped the benefit value equation
 - The order of importance of targeted outcomes of mitigation actions was collaboratively created by IEMA and stakeholders across Illinois^{vii}
 - The ability to quantify benefits with MCDA allowed me to prioritize hazard mitigation projects based on the required benefit and cost considerations^{viii}

Prioritization Methodology

1. Receive all proposal hazard mitigation applications

2. Review the applications for funding eligibility

3. Measure the applications' benefits based on the developed benefit value equation

Targeted outcomes of mitigation actions by order of importance:

1. Mitigation actions executed by the project are listed in an approved mitigation plan or in a developing mitigation plan
2. Projects that mitigate against the loss of human life
3. The project decreases the probability of future hazardous events to include reducing the negative impacts of climate change
4. The project reduces repetitive loss properties
5. The project reduces significant damage that leads to over 50% of property value loss
6. The project uplifts underserved communities and protects socially vulnerable populations
7. The project targets the most severe hazards
8. The project uses or promotes nature-based solutions
9. The project goals and direct impacts are (in order of importance):
 - i. Natural resource protection
 - ii. Critical facility protection
 - iii. Conducting structural projects
 - iv. Retrofitting critical facilities
 - v. Providing leadership or planning/technical assistance for hazard mitigation planning
 - vi. Projects regarding alert systems for hazard announcements, warning, and evacuation mitigation strategies
 - vii. Providing public education and awareness of personal mitigation strategies
 - viii. Providing public education and awareness of hazard risk
10. The project maximizes benefit-cost analysis (BCA) calculated by FEMA standards
11. Projects with the quickest completion of target goal

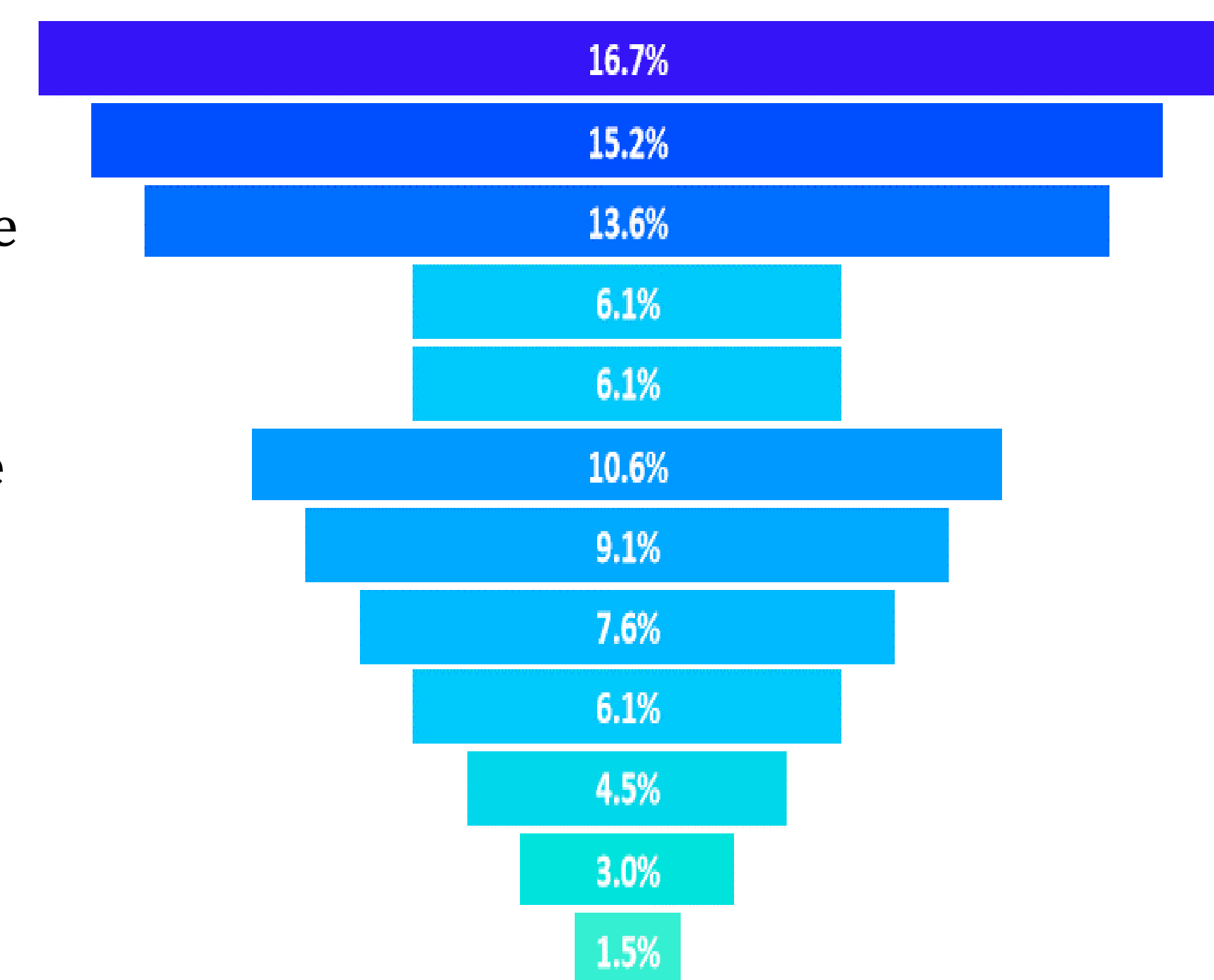


$$\text{Benefit Value} = A + L + H + P_R + P_L + C + V + R + N + G + B + T$$

Where the variables listed are:

- A = Approved Project Variable
- L = Loss of Life Variable
- H = Probability of Hazard Occurance Variable
- P_R = Repeat Loss Variable
- P_L = Property Value Loss Variable
- C = Climate Change Consideration Variable
- V = Vulnerable Populations Variable
- R = Hazard Rating
- N = NatureBased Solutions Variable
- G = Project Goal Variable
- B = Benefit Cost Analysis Variable
- T = Time Variable

Impact (or weight) each variable has on total Benefit Value:



4. Calculate the total cost of the proposed hazard mitigation project

5. Use the developed optimization formula for all non-discarded applications by funding source to select applications to advance for funding consideration

$$\max_K f(K) = \sum_{i=0}^n x_i * K_i$$

Where: K = Benefit Value of the project; n = total number of projects; x = decision variable for each project

Subject to: $\sum_{i=0}^n x_i * m_i < M$ and $x_i \in \{0, 1\}$

Where: M = total value of the financial resource available; m = cost of the project

Barriers to Execution

- Disagreements among Illinois disaster management stakeholders regarding mitigation action rankings
 - Should projects addressing repetitive loss take priority over those addressing significant loss?
- Understanding and buy-in of Illinois disaster management stakeholders about the inclusion of climate change and social vulnerability
- Technological training and understanding of Microsoft Excel add-ins and macros of IEMA employees

Future Work and Recommendations

- Conduct further evaluation of IEMA and other Illinois disaster management stakeholders to understand "how much more important" mitigation actions are from one another
- Have more collaboration in the benefit value equation development between IEMA and stakeholders
- Develop a clean, simple interface for hosting the methodology that IEMA employees can access, edit, and utilize with ease
- Compare the results from the methodology with previously submitted hazard mitigation applications for an expired grant
 - Did our methodology choose different applications to recommend than what was chosen previously? If different,
 - Does IEMA agree or disagree with the methodology's results?
 - What could be the cause of the discrepancy?

References

- i. Clinton Gore Administration, "Regulatory Planning and Review," Executive Orders, September 30, 1993, <https://www.archives.gov/files/federal-register/executive-orders/pdf/12866.pdf>.
- ii. Obama Biden Administration, "Improving Regulation and Regulatory Review," Executive Order, January 18, 2011, <https://obamawhitehouse.archives.gov/the-press-office/2011/01/18/executive-order-13563-improving-regulation-and-regulatory-review>.
- iii. Federal Emergency Management Agency Released, "State Mitigation Planning Policy Guide" (Washington, DC: Government Printing Office, April 19, 2022), https://www.fema.gov/sites/default/files/documents/fema_state-mitigation-planning-policy-guide_042022.pdf.
- iv. "Mitigation Planning." In Title 44 Code of Federal Regulation Part 201. Washington DC: Government Printing Office, 2021, updated. <https://www.govinfo.gov/app/details/CFR-2022-title44-vol1/CFR-2022-title44-vol1-part201>.
- v. "Robert T. Stafford Disaster Relief and Emergency Assistance Act," Public Law, May 22, 1974, <https://www.govinfo.gov/content/pkg/COMPS-2977/pdf/COMPS-2977.pdf>.
- vi. Disaster Mitigation Act of 2000," Public Law, October 30, 2000, https://www.fema.gov/sites/default/files/2020-11/fema_disaster-mitigation-act-of-2000_10-30-2000.pdf.
- vii. Program, Emergency Management Accreditation. Emergency Management Standard. Standard, Falls Church, Virginia: Emergency Management Accreditation Program, 2022. <https://emap.org/wp-content/uploads/2023/04/EMAP-EMS-5-2022-Emergency-Management-Standard.pdf>.
- viii. Mouter, Niek, Marco Dean, Carl Koopmans, and José Manuel Vassallo. "Comparing Cost-Benefit Analysis and Multi-Criteria Analysis." In Advances in Transport Policy and Planning, 6:225-54. Elsevier, 2020. <https://doi.org/10.1016/bs.atpp.2020.07.009>.

Acknowledgements

I extend my sincere appreciation to the exceptional team at Illinois Extension, under the exemplary leadership of Carrie McKillip, Zach Kennedy, Russell Medley, and Anne Silvis. A special acknowledgment goes to the Illinois Emergency Management Agency for granting me the invaluable opportunity to contribute to and collaborate on this project. Furthermore, I would like to express my gratitude to the Illinois State Water Survey for their significant contributions by providing the hazard rating calculations for this project.