The Economist Intelligence Unit

FLOOD ECONOMICS

FLOOD ECONOMICS: A SOCIO-ECONOMIC ANALYSIS

METHODOLOGY

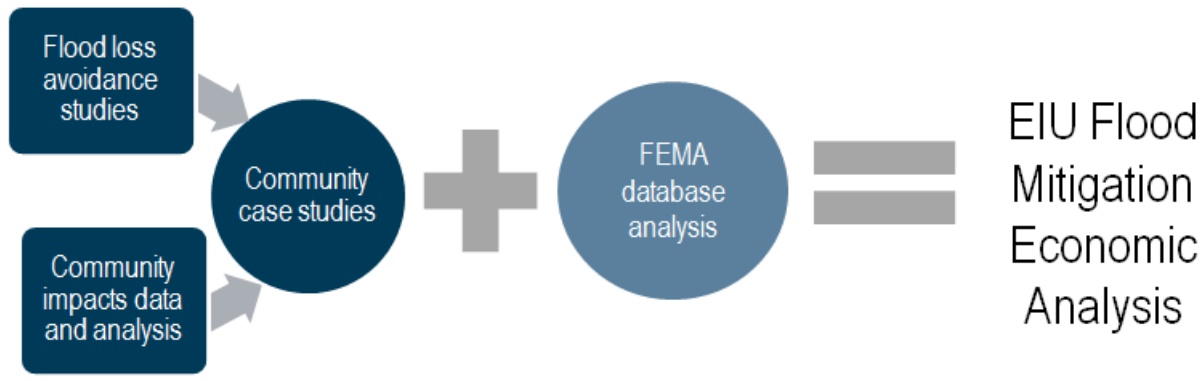
The Economist Intelligence Unit

Table of Contents

I. Summary

To gain a better understanding of the economic and financial imperatives for investment in flood mitigation, Resilience Action Partners (RAP) commissioned the Economist Intelligence Unit (EIU) to undertake a research program to identify the business case for flood mitigation investment. The result is an interactive, online tool that highlights the benefits of flood mitigation investment in the US. The target audience for this tool is a decision-maker at the community level, namely those who are involved in flood mitigation action and investment.

To address the need for an objective approach to understanding the benefits of flood mitigation actions, the EIU utilized data from existing sources and layered additional quantitative and qualitative insights. The core of the research program is the community case studies. These case studies are comprised of insights from existing flood loss avoidance studies and additional community impacts data and analysis. In addition to the community case studies, the EIU undertook a broad analysis of projects and benefits data in the US from 1990 to 2015. The analysis covers a database of flood mitigation projects provided by the Federal Emergency Management Agency (FEMA) of 21,411 flood-specific projects, spanning all 50 states (plus Puerto Rico).



This document details the EIU's project framework and methodology. The research results are embedded in a website (https://www.floodeconomics.com).

While every effort has been made to verify the accuracy of this information, neither The Economist Intelligence Unit Ltd nor the sponsors of this report can accept any responsibility or liability for reliance by any person on this report or any other information, opinions or conclusions set out herein.

II. Defining a methodological approach

As a first step to develop the research framework for the Flood Mitigation Economic Analysis (FMEA), the EIU engaged respected experts in the field. In addition, the EIU undertook a detailed literature review to establish credible methodologies for the data analysis and research approach.

Expert Working Group

In developing the FMEA, the EIU and RAP convened highly respected disaster mitigation experts. This group included experts with a broad range of expertise. The panel advised RAP and the EIU on the research framework and outputs. Specifically, the EIU garnered feedback on methodological approaches to assessing the return on investment for mitigation efforts related to flooding. Input from the panel helped to ensure that the research outputs effectively demonstrate the imperative for mitigation.

Panel members do not undertake the research or analysis. Instead, they play an advisory role in their personal or professional capacities. Participation in the panel does not imply endorsement of every aspect of the research program or its findings.

Mr. Chad Berginnis
Executive Director, Association of State Floodplain Managers (ASFPM)

Kevin Bush
Resilience Team Lead, U.S. Department of Housing and Urban Development (HUD)

Joseph Cordes
Professor, Economics, Public Policy and Public Administration, The George Washington University
Associate Director, Trachtenberg School of Public Policy, The George Washington University

Dr. Jawhar Bouabid
Manager, Catastrophe Modelling and Exposures, The Hartford

Susan Gilson
Executive Director, National Association of Flood & Stormwater Management Agencies (NAFSMA)

Paul Huang
Division Director, FIMA Risk Analysis Division, FEMA

Brenden Jongman
Disaster Risk Management Specialist, Global Facility for Disaster Reduction and Recovery (GFDRR), The World Bank

Dr. Erwann Michel-Kerjan
Executive Director, Risk Management and Decision Processes Center, University of Pennsylvania – The Wharton School

Adam Rose
Research Professor, University of Southern California (USC) Price School of Public Policy
Coordinator for Economics, Center for Risk and Economic Analysis of Terrorism Events (CREATE) at USC

Philip Schneider
Executive Director, Building Seismic Safety Council
Director, Multihazard Mitigation Council (MMC) at the National Institute of Building Sciences

Laura J. Steinberg
Professor and Former Dean of L.C. Smith College of Engineering and Computer Science, Syracuse University

Howard Stronach
Regulation and Policy Branch Chief, Public Assistance Division, FEMA

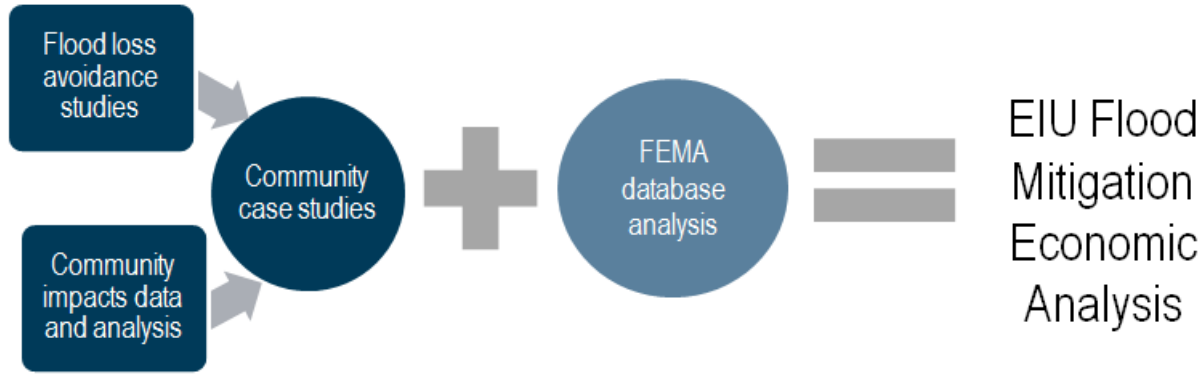
Gregory P. Wilson
Program Specialist, Building Science Division, FEMA

Literature review

The EIU conducted a review of the mitigation literature to understand the available data and common approaches to quantifying the payoffs from mitigation investments. There is an expansive literature investigating natural hazard risk and mitigation. The focus of the literature review was on mitigation research. In the past two decades there has been an increase in the research and analysis that quantifies hazard mitigation benefits and costs. This increase in the research has been underpinned by advances in computing and modeling, as well as an increased focus on efficient resource allocation (particularly in the public sphere). The sophisticated engineering-economic models allow for detailed estimations of a wide array of future potential benefits, to be weighed against immediate costs of these mitigation projects. The literature review covered the approaches to economic quantification of these benefits and costs that have been pursued, highlighting the commonalities and points of contention that are evident in the literature.

III. Methodology framework

The EIU's approach to Flood Mitigation Economic Analysis



Community case studies

The community case studies examine both project-specific data (from flood loss avoidance studies), such as the costs of a project and the estimated benefits attributable to the project, alongside broader data pertaining to the community (i.e. community impacts data and analysis). The latter includes the level of economic development, insurance coverage and premiums, as well as key investment success factors and how communities dealt with mitigation project challenges. By developing a holistic and tangible view of the impact mitigation investment had on the community, the community case studies allow decision-makers to understand the numerous and varied benefits associated with flood mitigation investment.

There are several key elements to developing the community case studies:

1. Flood loss avoidance study selection
2. Quantitative data
3. Qualitative analysis

Community impacts data and analysis is both quantitative and qualitative.

1. Flood loss avoidance study selection

The EIU carefully selected each loss avoidance study to ensure that the final set offers distinct types of mitigation examples. The set of studies was selected to be representative of, for example:

- Different types of flood risk faced (e.g. riverine, coastal, storm surge);
- Different mitigation projects (e.g. acquisition, elevation, flood proofing, building codes);
- Type of funding (e.g. federal, state, local);

The list of selected loss avoidance studies can be found in the *Select bibliography*.

2. Quantitative data[1]

Quantitative data and metrics are the foundation of building the economic and financial imperative for mitigation investment through the community case studies. The EIU presents a range of quantitative metrics in each community case study.

The loss avoidance studies provide project-specific data, such as direct costs and benefits, return on investment (ROI), cost benefit ratios, property damage avoided, lives saved, and project funding details. To complement these data points, we also collated non-project specific data, such as relevant demographic and socioeconomic data reflecting the community's position pre- and post-mitigation investment. These broader community data points help to contextualize the project and build a broader understanding of mitigation investment benefits.

The EIU approach to sourcing the data to develop these community case studies had two prongs: First, we utilized the loss avoidance studies for existing project-specific data and information, complemented with additional research to fill in any data gaps. Second, we examined a broad range of local, regional and national sources for broader community data. See the *Data collection and sources* section for more detail.

The next sections provide more detail on the project-specific data and the broader community impact data that forms the basis of the quantitative portion of the community case studies.

Project-specific data

The community case studies showcase key metrics related to a project.

a. Costs

EIU compiled data on the cost of mitigation investment from each loss avoidance study. The focus was on direct costs of mitigation action (i.e. direct project expenditure). We also included, where available, information on indirect costs of mitigation investment.

b. Direct benefits

Direct benefits of a mitigation investment are future losses and damages that are prevented by the mitigation project. An example is property damage that would have been realized in a flood event, which did not occur because a levee prevented the floodwaters from reaching the building.

The loss avoidance studies present key benefits (e.g., losses avoided) attributable to the mitigation project. The benefits data presented include the aggregate monetary benefits (monetized net present value of the expected future losses avoided), as well as total direct benefits broken down by type, such as economic benefits, environmental benefits, and social benefits (where available).

Where possible the EIU also collected data on other direct benefits. These include social benefits, such as value of social interruption avoided (displacement of residents, emotional hardship), environmental benefits, such as conserved land, and other economic benefits like reduced direct insurance costs.

c. Indirect benefits and co-benefits

Indirect benefits and co-benefits are the positive side-effects of mitigation investment: that is, benefits that arise out of a mitigation investment that are not directly related to losses avoided in the event of a flood. For example, a levee

[1] The EIU conducted open-form interviews with potential end-users and community-level decision-makers to better understand the metrics and analysis that they find most impactful. The results of that research are reflected in the quantitative data points and qualitative analysis the EIU utilized in the community case studies.

reduces the risk faced by businesses operating in a flood-prone area, and might encourage additional investment and attract more businesses to the area.

Such benefits include:

- Encouraging households to save and build assets;
- Promoting entrepreneurship;
- Stimulating firms to innovate;
- Encouraging long-term investment;
- Employment opportunities generated by the investment;
- Other co-benefits which are not dependent on disaster events.

These indirect benefits and co-benefits are important to complete the picture of the payoffs from a mitigation investment. In fact, communities can reap benefits from mitigation investment even in the absence of a flood event. Given a general lack of quantitative data on indirect benefits, the EIU has utilized qualitative insights and analysis to communicate these benefits in the community case studies.

d. Community impacts data and analysis

The EIU also examined the community environment before and after the mitigation investment was undertaken. We assessed how the community's economic, socio-economic and demographic, and other key characteristics, looked pre- and post-mitigation investment. Metrics we analyzed include economic growth and development, employment, average incomes, home prices, education levels, flood insurance coverage, and insurance premiums. It is important to note that the EIU does not draw causal linkages between mitigation efforts and economic or social outcomes, such as economic growth.

Showcasing broader community data strengthens the business case for mitigation. First, it gives decision-makers a more comprehensive view of mitigation investment effects, from a holistic community perspective, providing a broader view than project-specific financial outcomes. Second, it further builds out the indirect benefits and co-benefits argument. For example, a mitigation project might increase community awareness of flood risk and encourage better take-up of flood insurance cover by businesses and homeowners. While the EIU was not able to measure the additional flood insurance take-up that is directly attributable to the flood mitigation project, we could measure insurance penetration pre- and post-mitigation investment, and provide qualitative insights into the potential relationship.

To develop the broader community data points, EIU utilized a varied set of data sources. These included data from nationally comparable, centralized sources like the Bureau of Economic Analysis, Bureau of Labor Statistics and the US Census. In addition, the EIU also layered qualitative insights on the community and the mitigation investment. See the *Qualitative analysis* section for more information.

3. Qualitative analysis[2]

The community case studies blend the quantitative metrics with qualitative community impacts analysis in order to build the narrative and contextualize the mitigation investment. Qualitative analysis provides color to the quantitative data, capturing important elements that are not well-reflected in a pure numeric figure, and dive into other practical realities of mitigation, such as community cooperation, positive externalities, and technological developments.

The key metrics and information that the EIU sought to analyze for each case study were:

- **Project background**. How did the investment idea come about? Was it after a disaster? Was it driven by the private or public sector? Were other mitigation projects already in place or underway? Was there a key pillar, such as elderly populations, water security issues, schools, utility security, that drove particular attention to the issue?
- **Decision-making process**. What did the process to decide to invest in mitigation look like? Was there a committed local partner or mitigation champion? Was there a major influencer from the private sector? Were budget and funding discussions contentious, and how were challenges overcome?
- **Project execution**. What was the project timeline? What were the stumbling blocks or other challenges?
- **Project outcomes**. What did the final implementation look like? What was the public response / media reaction? Did the business environment improve? Was the investment followed by another flood event? If so, what differences were there in the community's recovery compared with previous flood events in the absence of the investment?
- **Cooperative action and positive externalities**. For example, were communities upstream/downstream of a riverine mitigation project involved in the decision-making or execution, and how this might have contributed to / challenged the success of the project?
- **Best practices.** EIU analyzed the case studies to identify and highlight best practices and key success factors in mitigation investment.

In order to gather this contextual information, the EIU undertook one-on-one interviews with individuals at the community level who were involved with each flood mitigation action detailed in the loss avoidance study. The individuals provided insights on the above metrics, which allowed the EIU to provide a broader picture of the benefits of mitigation action, key challenges, and best practices (among other information).

[2] Ibid.

State mitigation actions

FEMA grants database analysis

The second key element of the Flood Mitigation Economic Analysis is the investigation of a large database of flood mitigation projects provided by FEMA. The database covers a total of 21,411 flood-specific projects over the period Feb 1990-April 2016, spanning all 50 states (plus Puerto Rico). At a top level, the analysis of the data showcases overall mitigation returns, the investment levels and returns that have been experienced in a specific state, and the investments and returns associated with a particular type of mitigation project. The database analyzed is a FEMA grants database, and as such only covers projects that have FEMA funding.

The high-level takeaways are directionally the same as those detailed in the high-profile "*Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities*" by the Multihazard Mitigation Council[3], which showed that natural hazard mitigation measures save society an average of $4 for every $1 spent. However, the EIU only analyzed flood mitigation measures, and our results differ in magnitude. The key variances lie in the different set of projects analyzed as well as the benefits estimation methodologies. Moreover, the benefit-cost-ratios (BCRs) in the FEMA database that the EIU analyzed should be considered lower bounds of benefits. This is a reflection of the fact that grant applicants do not have an incentive to itemize and estimate benefits once a strong case for a grant has been made (i.e., once the estimated BCR is over 1).

BCRs are calculated using FEMA's BCA toolkit[4] as part of the grant application process. For FEMA to consider funding a grant, the BCR must be 1.0 or higher. FEMA provides some oversight over the submitted BCAs. The BCA toolkit estimates benefits from avoided losses on the basis of flood zone, wave height, building type, and height of the first floor elevation. The BCA toolkit allows users to estimate benefits for traditional benefits categories (building damage, contents damage, displacement and loss of function) as well as some non-traditional benefits (e.g. damage to vehicles, agricultural equipment or landscaping equipment)[5]. It does not, however, provide a platform for users to estimate other non-traditional benefits, like increased home values from wetlands creation, recreational utility from parks, avoided mental anxiety from flood events, and so on. Further, interviews with FEMA personnel highlight that the BCRs from this process should be considered lower bounds. Oftentimes, the grant applicant will stop itemizing and calculating benefits once the BCR is higher than 1 or 2.

Some of the projects in this FEMA database have multiple project type classifications. For example, the project may include acquisition of riverine property, acquisition of coastal property, and management costs. Since there is no accurate method for segmenting the cost and benefit data amongst the multiple project types, these projects have been excluded from the project-specific analysis.

The FEMA database also had missing data points. While the cost data is complete across the projects, data on benefits is incomplete. Based on advice from FEMA experts, we exclude any project with a benefit-cost ratio that is 0 or absent altogether. We also exclude any projects with a benefit-cost ratio greater than 5, again based on expert input.

[3] Available http://www.floods.org/PDF/MMC_Volume1_FindingsConclusionsRecommendations.pdf
[4] Available http://www.fema.gov/media-library/assets/documents/92923
[5] FEMA. (2011). "Supplement to the Benefit-Cost Analysis Reference Guide".

III. Select bibliography of case studies

The EIU built upon existing loss avoidance studies found in the mitigation literature. Specifically, the EIU utilized FEMA's Flood Loss Avoidance Studies, which examine mitigation projects in detail and outline the associated costs and estimated benefits. EIU also utilized other (non-FEMA) studies of mitigation projects in the literature. A list of the case studies is below.

Dewberry. Drew Valley Flood Mitigation in DeKalb County, Georgia – Risk MAP before its Time.

Federal Emergency Management Agency. (2013). Loss Avoidance Study, Austin, Minnesota, 163 Building Acquisitions Update of March 2001 Study.

Federal Emergency Management Agency. (2012). Mississippi Loss Avoidance Study, Hancock, Harrison and Jackson Counties.

Federal Emergency Management Agency. (2009). Loss Avoidance Study, Wisconsin, Property Acquisition and Structure Demolition.

Federal Emergency Management Agency. (2012). Loss Avoidance Study, Jefferson Parish, Louisiana, Hurricane Isaac.

Federal Emergency Management Agency. (2010). Loss Avoidance Study, Georgia, Building Modification Projects.

Federal Emergency Management Agency. (2010). Loss Avoidance Study, Iowa, Flood Reduction Projects.

Federal Emergency Management Agency. (2007). Loss Avoidance Study, Southern California Flood Control Mitigation.

Kousky, Carolyn and Margaret Walls. "Floodplain Conservation as a Flood Mitigation Strategy: Examining Costs and Benefits." Resources for the Future.

Urban Land Institute: Returns on Resilience: The Business Case. ULI Center for Sustainability. Washington, D.C.: the Urban Land Institute, 2015.

White, Esther. Establishing Long-Term Cost Effectiveness of FEMA Buyouts: A Loss Avoidance Study of the Acquisition/Demolition of 22 Properties in Shepherdsville, Kentucky. University of Kentucky Martin School of Public Policy and Administration, 2011.

IV. Acknowledgements

This research is an Economist Intelligence Unit (EIU) study, commissioned by Resilience Action Partners. Hilary Steiner, Director of Public Policy in North America, and Samantha Grenville, Senior Consultant, were the project managers. Anil Sarda, Consulting Analyst, provided research and analytical support. Leo Abruzzese, Global Director of Public Policy, served as a senior adviser. Shahin Nabavian, Sally Goldman, Paul Jason, and Andres Tinoco designed and constructed the website. We would like to extend thanks to Sarah Fister Gale, researcher, who lent her qualitative interviewing expertise to this project.

For research queries, please contact Hilary Steiner at hilarysteiner@economist.com