FEMA'S BENEFIT COST-ANALYSIS TOOL FOR ELEVATION PROJECTS

General Guidance

The purpose of this document is to provide potential subapplicants with general guidance on FEMA's Hazard Mitigation Assistance (HMA) benefit-cost analysis (BCA) tool. The BCA is a required subapplication component. This guidance is not intended to provide complete information, but rather to outline basic requirements and considerations as subapplicants begin the analysis process. Cal OES is available to answer technical questions about BCAs and can be contacted by e-mailing HMA@caloes.ca.gov.

Flood Benefit-Cost Analysis for Elevation Projects

Elevation mitigation projects are those that protect by physically elevating a structure to a pre-determined height, in order to greatly reduce the probability of the structure being flooded again.

BCA Software and Methodology

FEMA requires the use of its BCA software (version 6 for all BCAs). Subapplicants can get the software by visiting FEMA's Benefit-Cost Analysis Guidance and Tools website: https://www.fema.gov/media-library/assets/documents/179903.

There are two BCA methodologies for flood projects: the "full flood" approach, and the "damage-frequency assessment" (DFA) approach. The full flood methodology uses a specific range of information to determine existing flood risks and the benefits of mitigating them. The full flood methodology has the advantage of incorporating certain default data, which can make it easier on the analyst to complete the BCA. However, the software is not flexible in terms of the data that is required, and in many cases, this is simply not available. Read the subsection immediately below, and if this data is not available and cannot be obtained, then analysts should use the DFA methodology for this work.

The DFA approach is the one most commonly used, because it is flexible, allowing analysts to use a wide range of data. Such analyses may be based on historical hazard data, or projected future hazard data, or a combination of these. The basis of a DFA analysis is establishing a series of points of known correspondence between the frequencies of flood events and the damage

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they have caused, or may cause in the future. It is important to understand that because the methodology can be based on a range of different data (and sources of data), all the inputs and the ways that they are derived must be fully explained and documented in the materials submitted to Cal OES as part of the subapplication package. See the notes below regarding documentation and a technical report.

Data used in the Analysis

This subsection is intended as a general summary of data requirements for the two types of BCAs, not a comprehensive explanation of how to complete an analysis.

A **Full Flood BCA** requires the following data, at a minimum:

1. The "use" of whatever structures may be protected by the project, i.e. residential, public building, or critical facilities. For public facilities there are several related data that are required, depending on the specific situation. These include the budget of the facility, the numbers of people served by the critical facility, and the distance to the nearest analogous facility (in the case of fire/police/EMS).
2. Finished floor elevations and square footages of any structures that are protected (mitigated) by the proposed project. This data is critical to the analysis, and must come from a valid, documented source.
3. The building replacement value.
4. Flood hazard data, including a full series of probability/water surface elevation relationships. These will typically come from a FEMA Flood Insurance Study, but other legitimate sources are acceptable if documented.
5. Stream bottom elevation of the flood source.
6. The design performance of the proposed project, i.e. provides flood mitigation to a specific flood elevation or probability. For an elevation project, this value is determined by local codes and FEMA requirements.
7. Project cost and project maintenance cost.

Full Flood BCAs are generally used only in the case of overbank flooding from rivers and streams. Please note again that this is not intended as a detailed or comprehensive list of data that may be appropriate to a BCA.

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A **Damage-Frequency Assessment BCA** requires the following data.

1. A series of at least two relationships between the frequency of flood events and the damages associated with them.
2. The frequencies of such events may be determined in several ways, depending on what resources and data are available. For example, if flood damages are related to extreme rainfall events, it is usually possible to use rainfall records and NOAA probability tables to derive event frequencies; in such a case it is necessary to know the date(s) of flood events, and their locations. It is also possible in some cases where there are numerous historical floods to simply divide the period of record by the number of events, although doing so requires an understanding of statistics so that unequal events are not combined. As noted, such methodologies are sometimes combined in a single analysis when no individual approach is sufficient.
3. Damages may be observed and documented historical damages or "expected" damages, i.e. determined using one of several established methods. It is outside the scope of this general document to describe every possible approach to such a determination, as this can vary considerably based on the specific flood risk. For example, developing data for a floodprone residential structure may involve estimating flood depths using GIS technology and FEMA damage function (statistical depth-to-damage relationships that are based on large-scale studies, and are related to specific structure types). Note that damages include not only physical damages, but in many cases are in fact predominated by loss of function, which the value of a service that is interrupted by a flood. Examples include police/fire/EMS, and any other public service. These are valued differently depending on the service. FEMA guidance includes these values. Loss of function calculations must always include the durations of such service interruptions.
4. The design performance of the proposed project, i.e. provides flood mitigation to a specific flood elevation or probability.
5. Project cost and project maintenance cost.

Benefits

Benefits of flood mitigation projects are the damages and losses of function that are avoided because a project is implemented. Flood damages are usually limited to direct damages and losses of function, although in some rare cases

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deaths and injuries may be prevented via flood mitigation activities. The **full flood approach** calculates these benefits automatically based on the various user inputs. The **damage-frequency approach** requires the user to understand the full range of potential benefits, and how to go about calculating them (except that the software includes separate paths for assigning values to public services, so that it can calculate the value of lost function.

FEMA also allows the use of *stress and anxiety* benefits that apply specific values to avoiding these forms of damage. These are based on the numbers of people in the project area, and apply only when the underlying benefit-cost ratio for the project is 0.75 or greater.

Project Useful Life and Project Effectiveness

Project useful life is simply the period over which a project is effective. FEMA's 2009 BCA guidance (Appendix D) provides specific values for useful life, and can be found by visiting [FEMA's Benefit-Cost Analysis Guidance and Tools website](https://www.fema.gov/media-library/assets/documents/179903): https://www.fema.gov/media-library/assets/documents/179903. Project effectiveness is the extent to which a mitigation activity reduces future damages. In the full flood methodology, the software requires the analyst to enter information to calculate this value – generally an elevation to which a structure is being raised or protected via floodproofing. In the DFA approach, the analyst must provide information about the frequency to which a proposed measure is effective (this is usually related to a specific flood elevation, and is often dictated by local building codes or engineering standards).

Documentation

Cal OES and FEMA require subapplicants to provide documentation for all data that is used in a BCA. This must be included with the materials that are submitted as part of the application package. The documentation required for flood mitigation BCAs varies considerably, depending on the basic methodology (full flood vs. DFA) and the approaches used to derive information. The latter refers mostly to analyses conducted using the DFA approach, i.e. frequencies, damages, and the effectiveness of the proposed project.

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Best Practices

Cal OES strongly recommends that each subapplicant BCA be supplemented by a brief technical report that summarizes the approach to the analysis, the data that was used, the sources of the data, and the results of the analysis.

Subapplicants should provide electronic copies of any data sources that are used in a BCA, including such things as Flood Insurance Studies (applicable sections and tables), rainfall records, engineering/hydrology reports, information about the design performance of the project, building valuations, etc. Ideally, every data point entered into the software will be explained in a technical report and backed up with written documentation.

Pre-Calculated Benefits

Elevation BCAs can utilize pre-calculated benefits to determine cost effectiveness of elevations in the Special Flood Hazard Areas (SFHA). The average benefit for this project type is $175,000 per structure. FEMA has determined that the elevation of a structure located in the 100-year floodplain as delineated on the Flood Insurance Rate Map (FIRM) or based on best available data, that costs less than or equal to the amount of benefits listed above is considered cost effective. For projects that contain multiple structures, the average cost of all structures in the project must meet the stated criterion.

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