Methodology Guide:

# COST-EFFECTIVENESS ANALYSIS

## Overview

Cost-effectiveness analysis is an economic method used to compare the costs associated with multiple projects that provide similar benefits. In this method, only the costs are monetized, and an analyst can determine the project with the largest "bang for the buck." Cost-effectiveness analysis is a helpful tool to inform deciding between projects when there are multiple possible ways to achieve the same benefit, project objective, or level of results.

## When to Consider

Here are some instances where you may want to conduct a cost-effectiveness analysis:

- You want to know the least-cost strategy for a particular benefit.
- Costs for project alternatives are straightforward to calculate.
- The project goal or benefit you hope to achieve is straightforward and similar across possible project alternatives.
- It is impossible, impractical, or just not necessary to monetize the benefits because of time or resource constraints. However, you need to be able to describe the benefits in other ways.

## Important Results

Typically, the result from a cost-effectiveness analysis is expressed in terms of a ratio that shows the cost per unit of some measurement of benefit. Here are some examples of results that can be used to evaluate project alternatives:

- "Bioretention ponds provide a lower cost per acre managed than porous pavers."
- "Green roofs provide the highest cost per acre of impervious area managed compared to other natural infrastructure strategies."
- "A case study shows that porous pavers cost approximately $1,400 per acre managed less than green roofs on an annual basis."

## Strengths

- A cost-effectiveness analysis is useful for comparing alternative projects with similar benefits or outcomes by finding the least costly way of achieving a benefit or outcome without the need to monetize benefits.

- Since a cost-effectiveness analysis does not require monetization of benefits, it can be used when the analyst has less time availability compared to a benefit-cost analysis.

## Challenges

- This analytical method does not help you determine whether a specific project's benefits outweigh its costs.
- The results might be limiting in that they underrepresent the benefits a project could provide. Two projects rarely have the exact same set of benefits. For example, you might be selecting between building dunes and coastal armoring, both of which would protect against 6 feet of flooding. You could perform a cost-effectiveness analysis to compare the costs to provide this level of protection, but the results might be inconclusive if dunes are deemed less cost-effective, yet also offer additional benefits that coastal armoring may not.

## Key Suggestions, Interpreting Results, and Potential Mistakes

### Key Suggestions

- The quality of a cost-effectiveness analysis study will largely depend on the confidence you have in the accuracy of projects' implementation and maintenance costs.
- As with a benefit-cost analysis, it is necessary to identify an appropriate discount rate and discount all future costs that are anticipated to occur over the life of the project into present value. Converting all expected costs through the expected end of the project into today's currency will allow for an "apples-to-apples" comparison between proposed project alternatives.
- If possible, work with an economist to conduct a comprehensive cost-effectiveness analysis. This guidance document does not provide an exhaustive set of the steps and information needed to do a complete analysis.

### Interpreting Results

- Remember to include maintenance costs as part of your potential projects' overall costs. These may increase over time.
- Consider uncertainty in your estimate. For example, choose varying discount rates and see how it changes your outcomes.
- Define the relevant population for whom you are calculating the costs.
- Select the geographic region you are considering for the analysis.
- State and qualitatively describe the factors, such as benefits, that your cost-effectiveness analysis does not address.
- See additional explanation presented in the benefits-cost analysis guide.

- As with a benefit-cost analysis, the results from a cost-effectiveness analysis provide only one input to the decision-making process. If you use the cost-effectiveness analysis metric alone, you may make a less than ideal decision. You should consider other aspects such as feasibility, timeliness, cultural preference, equity, and distribution of costs and co-benefits to ensure that you ultimately choose a project that is the best fit for your region or community.

**Potential Mistakes**

- The outcome from a cost-effectiveness analysis is a ratio. Care must be taken to compare projects with similar benefits. For example, if we compare two coastal protection projects, we may find that a small-scale project that protects 10 homes has a larger cost-effectiveness ratio than one that protects 1,000 homes. These two projects are not really comparable due to their scale.

## Key Steps

This section outlines some of the key tasks to help you perform a cost-effectiveness analysis.

1. **Identify a common, desired outcome**

   Identify a common objective that a project's benefits will provide and a metric to measure the benefit that you will use to compare projects. For example, an objective might be to provide flood protection. One way in which you can measure, and ultimately compare, the benefit between the different project alternatives is by identifying the height at which flood storage capacity is provided. Another measure of flood protection is through the number of acres of impervious surface managed.

2. **Monetize the costs over time for each proposed project**

   Monetize the costs of each proposed project for the anticipated time horizon of the projects. The time horizon is the period of time, or life of the project, over which an analyst calculates benefits or costs.

3. **Choose a discount rate**

   Apply the discount rate to costs over your project's time horizon or project options. Discounting is the process of calculating the present value (in today's dollars) of a cost anticipated to be incurred in the future. See the Choosing a Discount Rate Quick Reference guide.

4. **Compare projects**

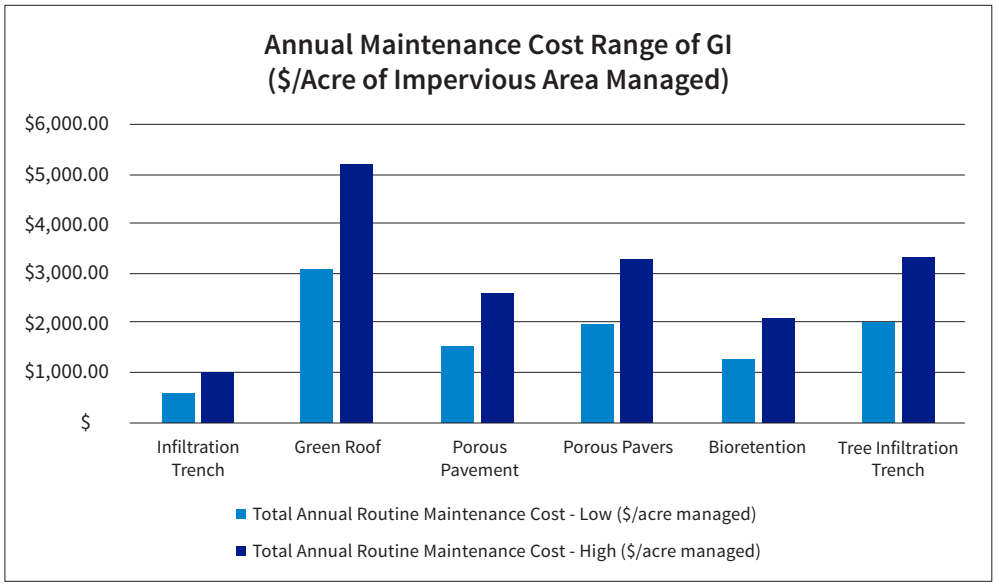
   Compare projects by developing a ratio of the common benefit to the cost. Because the common benefit or desired objective will be the same across all the project alternatives, it is likely that ultimately you will be looking for the least costly option.

### 5. Consider other important factors

Consider other factors influencing your decision-making process. Are there additional benefits or drawbacks to consider qualitatively outside your primary outcome? For example, you might be considering dunes and a sea wall. Both provide flood storage capacity, or wave attenuation up to x, but the dune vegetation also provides bird habitat. Using a cost-effectiveness analysis, you don't necessarily have to quantify or monetize the bird habitat benefits provided by the dune vegetation. Instead, you can consider them in addition to the cost ratio output results for each project. Also, consider any equity concerns in how the costs might be distributed across the community or distributional factors that might assist in the decision-making. Remember, any economic analysis should inform decision-making but not be the only determining factor.

## Interpreting Results Example

In the cost-effectiveness analysis example below, the decision-maker first identified the various methods to achieve the ultimate goal. In the example, the goal was to manage stormwater. The decision-maker aligned the options on the cost-per-acre-managed metric. The chart below presents a low to high range of maintenance cost per acre managed for six natural infrastructure methods to manage stormwater.[1] The case study found infiltration trenches and bioretention are the two most cost-effective options. It is important to note that this particular example only considers ongoing maintenance costs and does not address large upfront costs, or what economists call capital costs. However, this example provides a clear visualization of how to evaluate results from a cost-effectiveness analysis for natural infrastructure. A full, or more holistic, cost-effectiveness analysis would need to consider capital as well as maintenance costs.




[1] Water Environment Federation. 2015. "The Real Cost of Green Infrastructure." Graph by CH²M. *https://stormwater.wef.org/2015/12/real-cost-green-infrastructure/*.

## Resources to Dive Deeper

**Getting Help**

- Reach out to our team (*econguidance@noaa.gov*) for specific questions or to brainstorm how to start your cost-effectiveness analysis.
- Hire a private consultant or request support from academic partners. Researchers, graduate students, and academic scholars may be able to provide guidance or work directly on your cost-effectiveness analysis.

**Cost Data**

- Nature-Based Solutions: Benefits, Costs, and Economic Assessments. This quick reference guide outlines common expected construction maintenance costs when building natural infrastructure.

**Additional Resources**

- For flood reduction, NOAA developed a broad step-by-step economic framework, "What Will Adaptation Cost" for performing a benefits-cost analysis for adaptation strategies for coastal flood prevention.
- A similar guide specific to green infrastructure, "A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction."
- NOAA also published a companion piece with two natural infrastructure benefit-cost case studies in the Great Lakes region, "Economic Assessment of Green Infrastructure Strategies for Climate Change Adaptation."