Prioritization of Climate Change Adaptation Options

The Role of Cost-Benefit Analysis

Session 8: Conducting CBA Step 7

Accra (or nearby), Ghana
October 25 to 28, 2016

8 steps

Empowered lives.
Resilient nations.

Step 1: Define the scope of analysis.

Step 2: Identify all potential physical impacts of the project.

Step 3: Quantify the predicted impacts: With and without project

Step 4: Monetize impacts.

Step 5: Discount to find present value of costs and benefits.

Step 6: Calculate net present value.

Step 7: Perform expected value and/or sensitivity analysis.

Step 8: Make recommendations.

8 steps

Step 1: Define the scope of analysis.

Step 2: Identify all potential physical impacts of the project.

Step 3: Quantify the predicted impacts: With and without project

Step 4: Monetize impacts.

Step 5: Discount to find present value of costs and benefits.

Step 6: Calculate net present value.

Step 7: Perform expected value and/or sensitivity analysis.

Step 8: Make recommendations.

Empowered lives.
Resilient nations.

Outline of presentation

1. Overall approach
2. Two approaches to account for risk
3. Approach 1: Sensitivity analysis
4. Approach 2: Expected value analysis

Outline of presentation

Empowered lives.
Resilient nations.

1. Overall approach
2. Two approaches to account for risk
3. Approach 1: Sensitivity analysis
4. Approach 2: Expected value analysis

Overall approach

Empowered lives.
Resilient nations.

When we assess the economic efficiency of a policy, we look into the future and we ask how this future may look like without the policy, and then with the policy.

That future is unknown.

Yet, decisions must be made.

The ultimate objective of accounting for risk is to increase our level of confidence in the nature of the recommendations which will emerge from the economic analysis.

Outline of presentation

1. Overall approach
2. Two approaches to account for risk
3. Approach 1: Sensitivity analysis
4. Approach 2: Expected value analysis

Empowered lives.
Resilient nations.

Outline of presentation

Empowered lives.
Resilient nations.

Approach 1: Sensitivity analysis

Test the sensitivity of the results (NPV) to various possible realizations of the key variables of the analysis.

Should always do sensitivity analysis.

Approach 2: Expected value analysis

Takes into account that the realization of some benefits and/or costs components may depend on occurrence of specific known states of the world.

Should be used when we have (1) reasonably adequate knowledge about possible future states of the world; (2) how these future states may impact parameter values; and (3) reasonably known probability distributions over these states of the world.

Outline of presentation

1. Overall approach
2. Two approaches to account for risk
3. Approach 1: Sensitivity analysis
4. Approach 2: Expected value analysis

Empowered lives.
Resilient nations.

Approach 1: Sensitivity analysis

Empowered lives.
Resilient nations.

Principle:

Test the sensitivity of the results to various possible realizations of the key variables of the analysis.

3 different options to conducting sensitivity analysis:

Option 1: Try out a number of different realizations for key parameters, one at a time or in combination.

Option 2: Calculate switch (or trigger) values.

Option 3: Try out worst-case or best-case scenario.

Approach 1: Sensitivity analysis

Empowered lives.
Resilient nations.

Suppose that NPV is positive (base case scenario).

Questions such as:

- **What happens to NPV if cost x% higher?**
- **What happens to NPV if benefit x% lower?**
- **What happens to NPV if cost x% higher and benefit x% lower?**
- **What's the largest increase in cost (or decrease in benefit) which the policy could experience and still deliver positive NPV? These are switch (or trigger) values.**
- **What's the worst cost scenario? What's the worse benefit scenario? Is NPV still positive?**
- **What happens to NPV if benefits start to be realized x years later than expected? Is NPV**

Approach 1: Sensitivity analysis

Sensitivity analysis appears "unsophisticated". Yet it can be very useful in identifying key cost and/or benefit components of the policy/project which can have a decisive impact on the outcome.

Results from sensitivity analysis may trigger a search for more accurate or reliable information.

Outline of presentation

1. Overall approach
2. Two approaches to account for risk
3. Approach 1: Sensitivity analysis
4. Approach 2: Expected value analysis

Empowered lives.
Resilient nations.

Approach 2: Expected value analysis

Empowered lives.
Resilient nations.

Principle:

An expected value analysis aims to attach probabilities to each possible realization of a variable and to estimate the *expected value* of this variable.

Essentially transforms the treatment of uncertainty as risk.

Approach 2: Expected value analysis

There are two crucial components to an expected value analysis.

Component 1:

Need a set of possible "states of the world".

Component 2:

Need to assign probabilities to each state of the world.

Note: Probabilities must sum up to 1.

Need to assign probabilities to each state of the world.

Approach 2: Expected value analysis

The validity of expected value analysis critically depends on the assigned probabilities: the more empirically based they are, the more valid the exercise.

Possible sources of probabilities:

- **History: Historically observed frequencies**
- **Expert opinions**

Approach 2: Expected value analysis

Example:

Exceedance probability function used in the natural hazards literature.

Frequency	Damages (millions)
1 in 100 year event	10
5 in 100 year event	8
10 in 100 year event	5
20 in 100 year event	2
50 in 100 year event	0.5

Empowered lives.
Resilient nations.

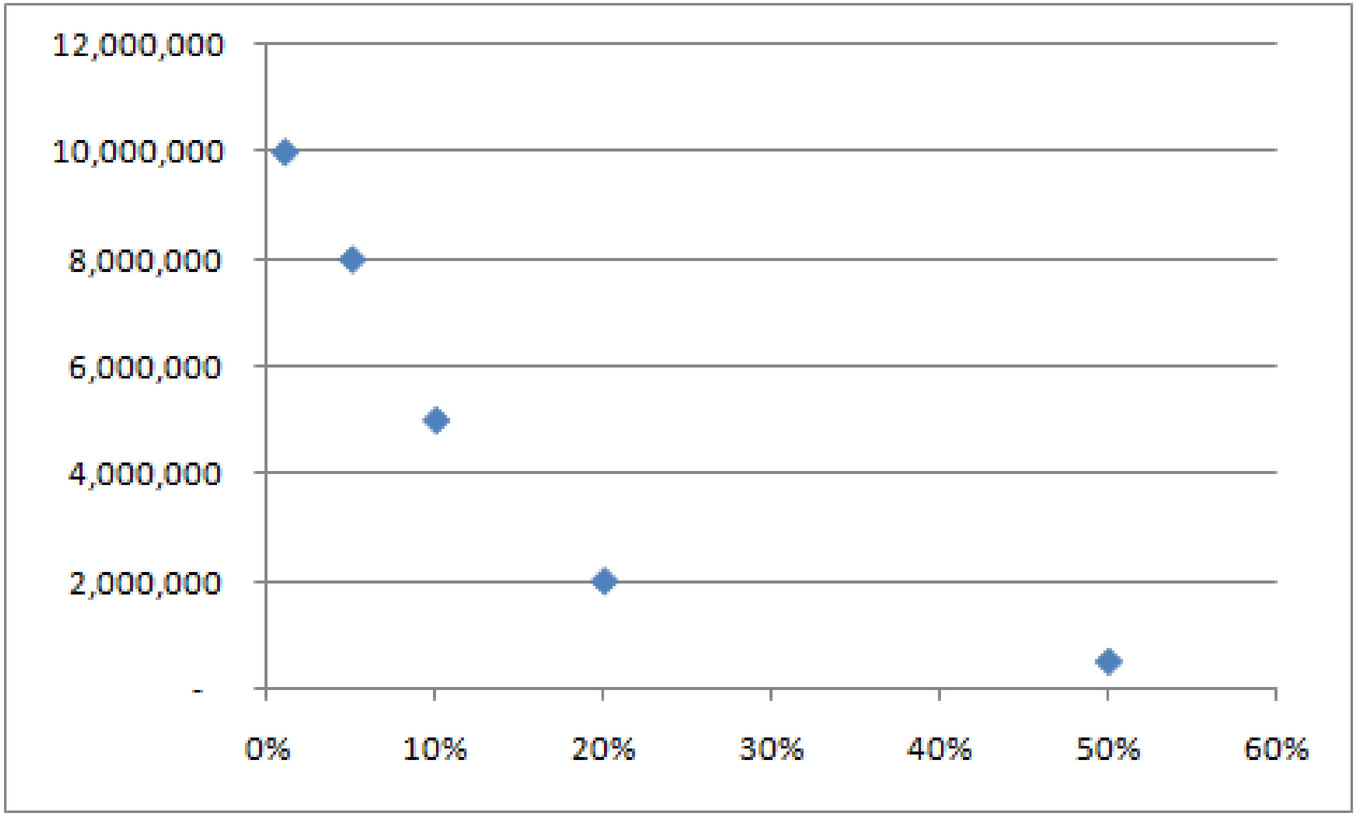
Approach 2: Expected value analysis

Example:

Exceedance probability function used in the natural hazards literature.

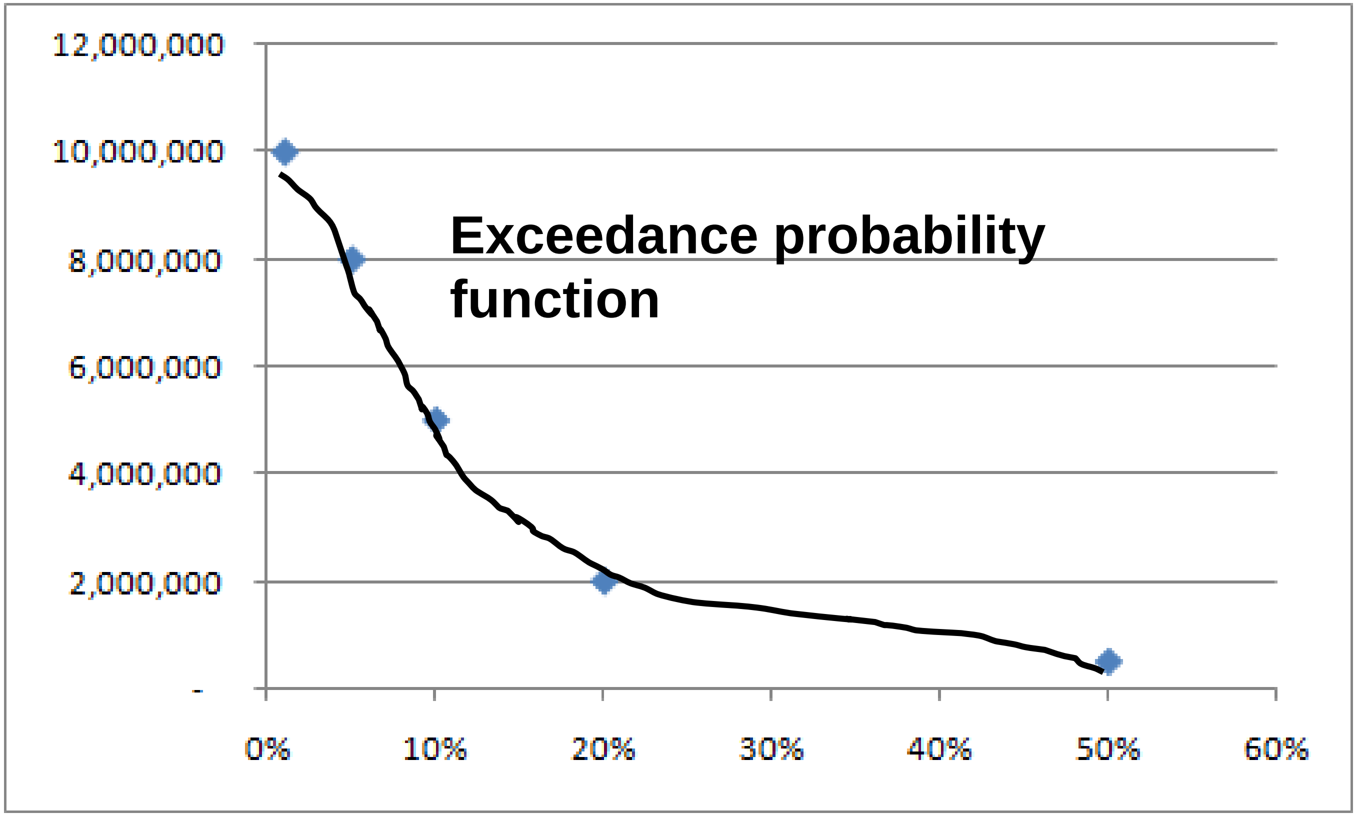
Frequency	Probability in any given year	Damages (millions)
1 in 100 year event	1%	10
5 in 100 year event	5%	8
10 in 100 year event	10%	5
20 in 100 year event	20%	2
50 in 100 year event	50%	0.5

Approach 2: Expected value analysis



Empowered lives.
Resilient nations.

Approach 2: Expected value analysis



Approach 2: Expected value analysis

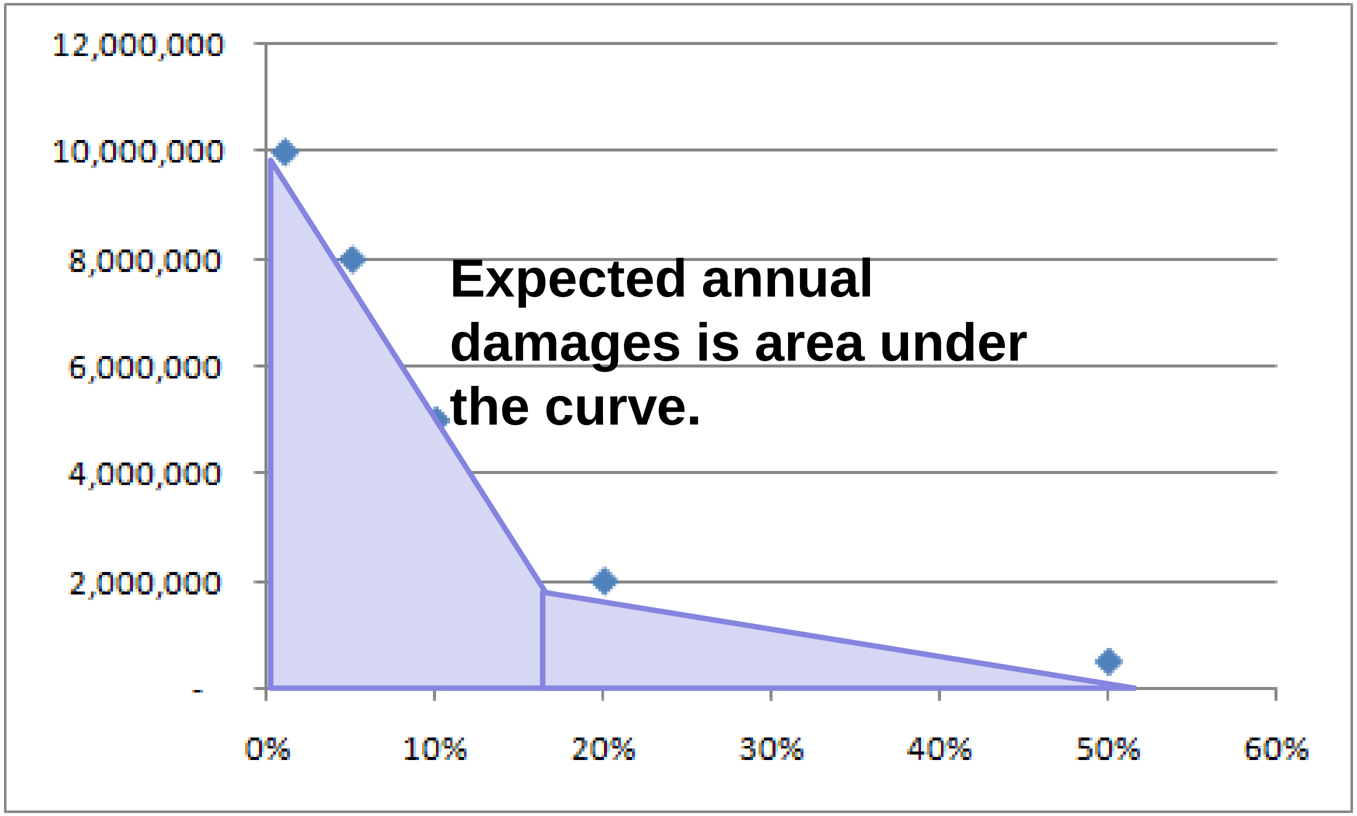
Example:

Exceedance probability function used in the natural hazards literature.

Frequency	Probability in any given year	Damages (millions)
1 in 100 year event	1%	10
5 in 100 year event	5%	8
10 in 100 year event	10%	5
20 in 100 year event	20%	2
50 in 100 year event	50%	0.5

Expected damage in any given year =
(1% * 10) + (5% * 8) + (10% * 5) + (20% * 2) + (50% * 0.5) = 1.65 millions

Approach 2: Expected value analysis



Approach 2: Expected value analysis

Example:

What's the annual benefit of an early system which would reduce damages in the following way:

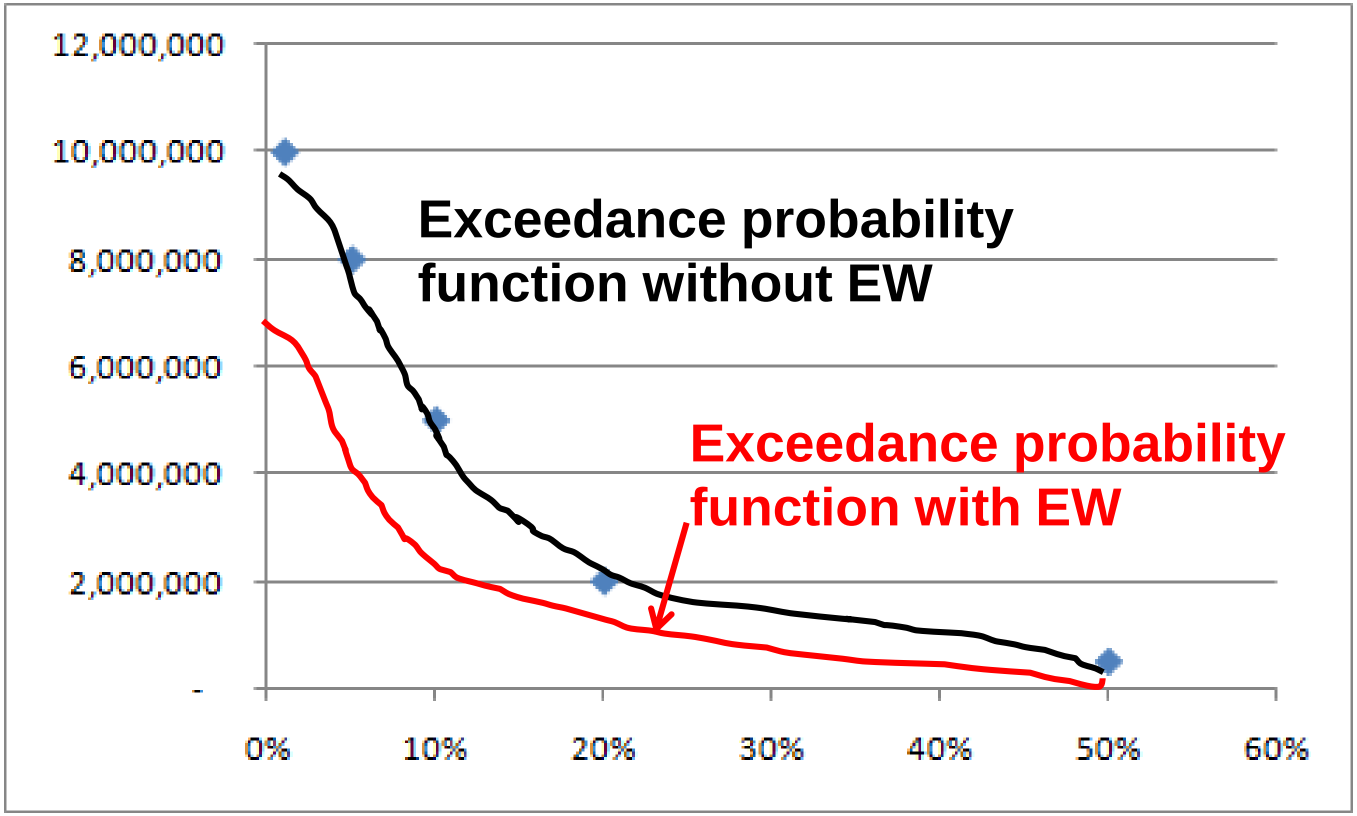
Probability in any given year	Damages without early warning (millions)	Damages with early warning (millions)
1%	10	7
5%	8	6
10%	5	4
20%	2	2
50%	0.5	0.5

Approach 2: Expected value analysis

Example:

Expected annual damage without early warning	**1.65**
Expected annual damage with early warning	**1.42**
Annual expected benefit of early warning	**0.23**

Approach 2: Expected value analysis



The area between the two curves is the expected annual benefit of the early warning system.

Approach 2: Expected value analysis

Expected value analysis

A slightly more complex approach is to allow for the fact that there may be uncertainty over more than one variable at one time. Then, a *joint probability distribution* of the expected net present value of the project can be calculated.

The *Monte Carlo sensitivity analysis* is a more sophisticated analysis that allows drawing from multiple, simultaneous probability distributions and computing joint probability distributions and expected net present value for each. By executing thousands of ‘drawings’ from the probability distributions, the software can generate a distribution of expected net present value, along with the variance.

Approach 2: Expected value analysis

Monte Carlo Analysis

Step 1: Define all parameters for which a range of values are available and over which there is uncertainty.

Step 2: For each parameter, define a probability distribution.

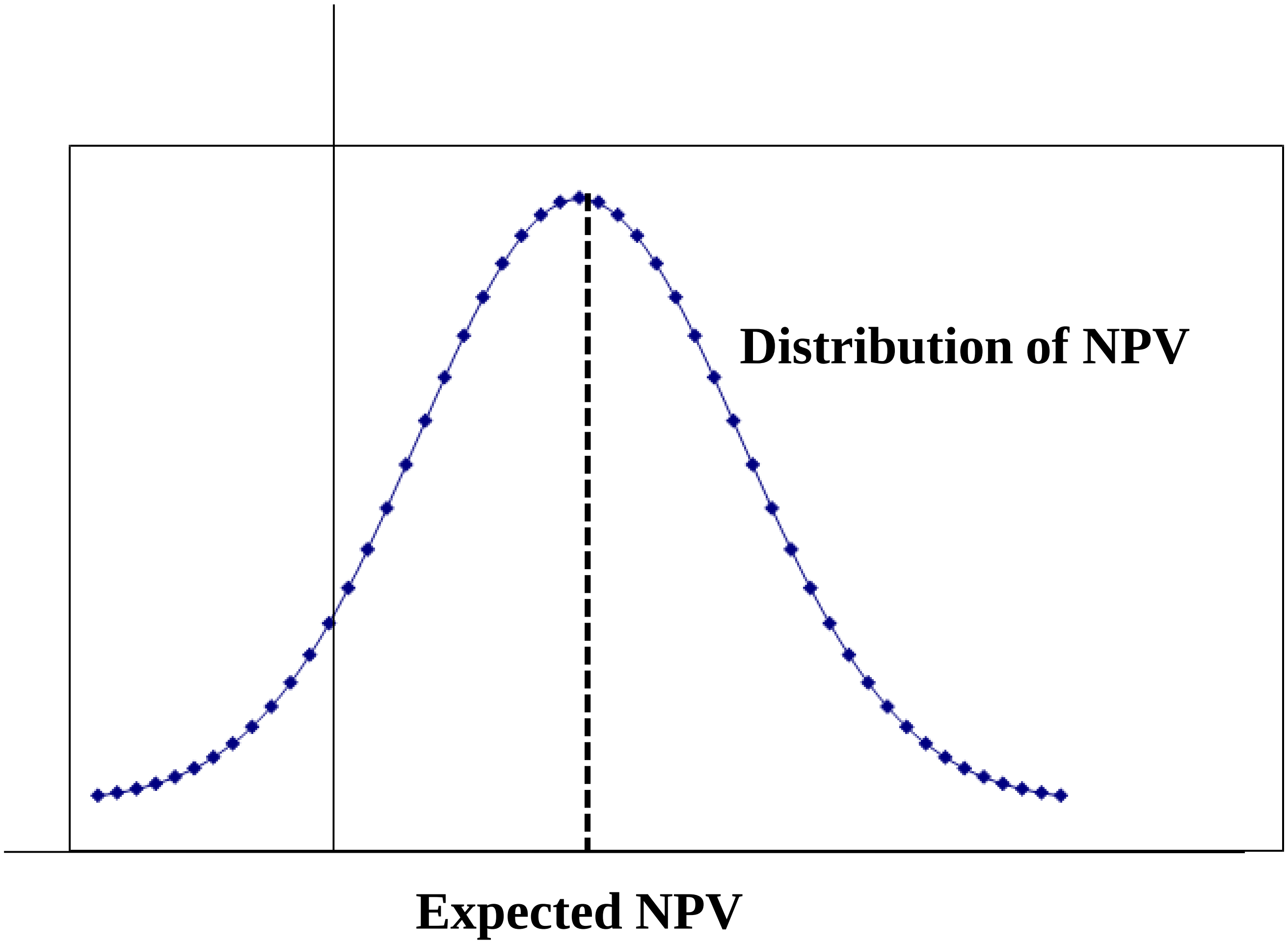
Step 3: Draw a value for each parameter according to the specified probability distribution.

Step 4: Calculate NPV for the drawn parameters' values.

Step 5: Repeat the exercise 50,000 times or more.

Approach 2: Expected value analysis

Outcome of a Monte Carlo Simulation:



Approach 2: Expected value analysis

Running Monte Carlo Simulation:

2 softwares commonly used:

- **Palisade@RISK**
- **Oracle Crystal Ball**

Note:

The outcome of an expected value analysis is only as good as the inputs into it.

Overall conclusion

Empowered lives.
Resilient nations.

Accounting for uncertainty is important.

However, not all policies or projects require the same level of scrutiny.

Prioritization of Climate Change Adaptation Options

The Role of Cost-Benefit Analysis

Session 8: Conducting CBA Step 7

Accra (or nearby), Ghana
October 25 to 28, 2016