Key concepts: risk and uncertainty

Cost-Benefit Analysis training workshop - Samoa

February 6-9 2012

Objectives

Understand:

1. Why accounting for risk and uncertainty is important
2. The basics of Expected Value Analysis
3. The basics of Sensitivity Analysis

Uncertainty

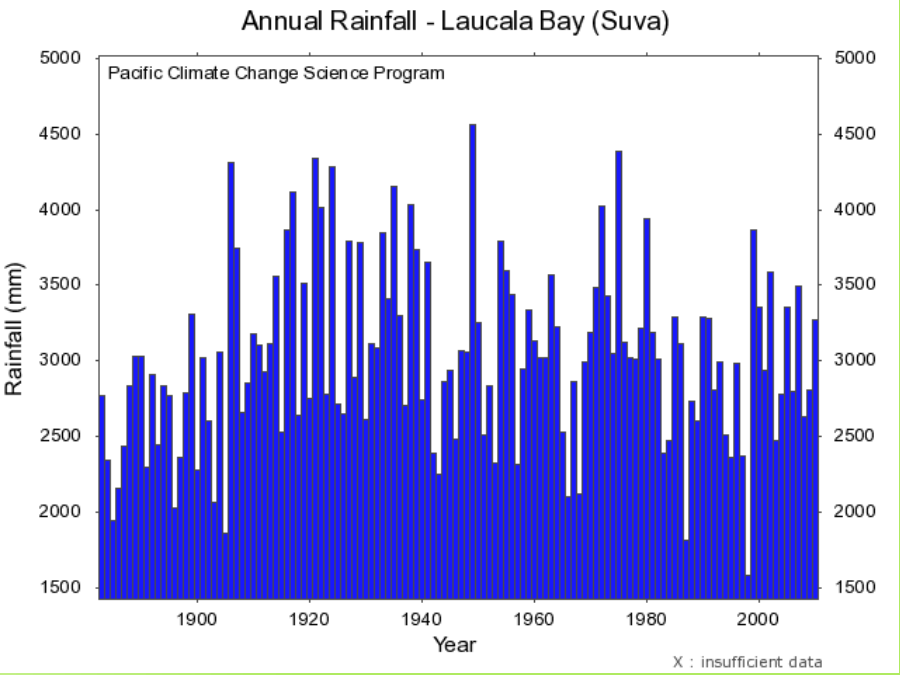
- CBA often requires us to predict the future (which is uncertain).
- Some costs and benefits are hard to value accurately (especially nonmarket values).
- Uncertainty about some aspects of a CBA may alter the results of the analysis (assessment of a project option as being worthwhile or not).
- How can we account for uncertainty in CBA?

Expected Value Analysis

- Where there are different possibilities, it is useful to undertake Expected Value Analysis

e.g. Weather: it varies from day to day and year to year

→Uncertain about whether it will be a wet or dry year or a cool or warm year



Expected Value Analysis

- If we can assign probabilities of the occurrence of each event, then uncertainty about the future becomes a problem of dealing with **risk**.

→ In relatively simple situations, risk can be readily incorporated into CBA through Expected Value Analysis.

Expected Value Analysis

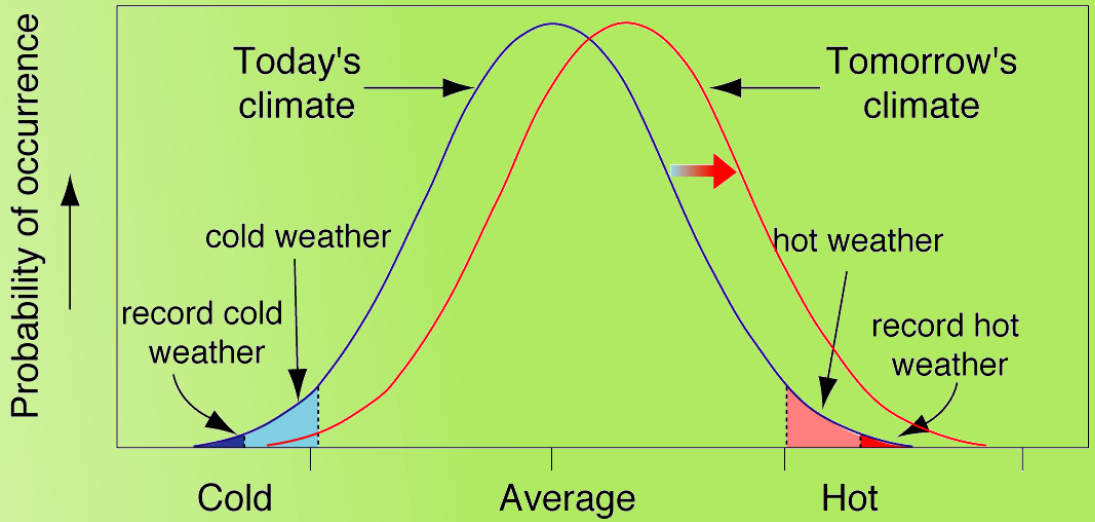
Basic steps of Expected Value Analysis are:

1. Specification of set of contingencies (possible events)

Expected Value Analysis

Basic steps of Expected Value Analysis are:

2. Assign probabilities of occurrence to each contingency
   - Historically observed frequencies
   - Scientific modelling
   - 'expert' opinion



Expected Value Analysis

Basic steps of Expected Value Analysis are:

3. Calculate expected value of net benefit

- Expected value is the weighted sum of net benefits:

$$E[NB] = p_i(B_i - C_i) + \ldots + p_n(B_n - C_n)$$

- By incorporating known probabilities, expected value analysis provides more precise and hence useful information.
  - Makes it clearer to decision maker which option is most worthwhile

Expected Losses - Flooding

With project

Normal conditions (90%), $0 damage

Flooding events (10%), $100,000 damage

Exp losses = (90%*0) + (10%*100,000) = 0 + 10,000 = 10,000

Without project

Normal conditions (90%), $0 damage

Flooding events (10%), $10,000 damage

Exp losses =(90% * 0) + (10% *10,000) = 0+ 1,000 = 1,000

Expected value of coastal rehabiliation

Uncertainty about future incidences of extreme events and storm surges

Normal conditions (95% of the time)

- Without coastal rehabiliation community has access to the beach for recreation, swimming ($10,000)
- With coastal rehabilitation reduced access so lower benefits for community ($5,000)

Storm surge events (5% of the time)

- Without coastal rehabilitation significant losses to household assets (-150,000)
- With coastal rehabiliation significantly reduced losses (-10,000)

Exp value (without project) =

prob of normal * net benefit in normal year

+ probability of storm surge * net benefit in storm surge event

(95% x $10,000) + (5% x -$150,000) =

9,500 + (- 7,500) = 2,000

Exp value (with project) =

prob of normal * net benefit in normal year

+ probability of storm surge * net benefit in storm surge event

(95% x $5,000) + (5% x $-10,000) =

4,750 + (-500) = 4,250

Expected value of drought resistant crop

Uncertainty about future rainfall conditions

Normal conditions (85% of the time)

- Current crop variety $100/ha
- Drought resilient variety $90/ha

Drought periods (15% of the time)

- Current crop variety $20/ha
- Drought resilient variety $85/ha

Expected value (without project) =

prob of normal * net benefit in normal year + probability of drought* net benefit in drought

= (85% x $100) + (15% x $20)

= 85 + 3 = 88

Expected value (with project) =

prob of normal * net benefit in normal year + probability of drought* net benefit in drought

=(85% x $90) + (15% x $85)

= 76.5 +12.75 = 89.25

Sensitivity Analysis

- Sensitivity analysis is the primary methodology for examining uncertainty of parameters (assumptions)

1. Identify key parameters that are uncertain and
2. Examine the impact that a change in each would have on the project's net present value
3. Does this change the decision about the project?

- The purpose of sensitivity analysis is to convey how sensitive predicted net benefits are to changes in assumptions.

Sensitivity Analysis

- For example, we are uncertain about the true value (benefit) of increased water supply
- The cost of supplying water was $\$5/m^3$

- If we expect the value of water to be between $\$1$ - $\$3/m^3$ the costs outweigh the benefits regardless of the value of water within this range

- But if we are unsure whether the value of water is between $4 to $6, the net benefits of the investment depends on the true value of water

Sensitivity Analysis

- If the sign of net benefits does not change when we consider the range of reasonable assumptions, then our results are robust and we can have greater confidence in them.

Key messages

- Uncertainty is an inherent part of most CBAs, particularly forward looking analyses.
- Expected Value Analysis accounts for uncertainty by explicitly incorporating probabilities of different events occurring – becomes risk analysis. Useful in CBAs of natural hazards.
- Sensitivity analysis tests how results change if we vary the value of parameters for which we are uncertain about.
- Important to properly account for uncertainty. If we don't, results may be misleading.

Further reading

- Boardman, E.A., Greenberg, D.H., Vining, A.R. and Weimer, D.L. 2006 *Cost-Benefit Analysis: Concepts and Practice*, 3rd edition.
  - Chapter 7

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Questions?