# Economics of Cost-Benefit Analysis


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ECONOMICS & THE ENVIRONMENT

# Need of Cost-Benefit Analysis?


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# Cost-Benefit Analysis

- CBA appraises costs and benefits of **a particular action**
- Particular action:
  - Project or investment project
  - Policy
- Examples:
  - Restoration of mangroves with Silvo-aquaculture
  - Protection of mangroves
  - Taxing shrimp producers


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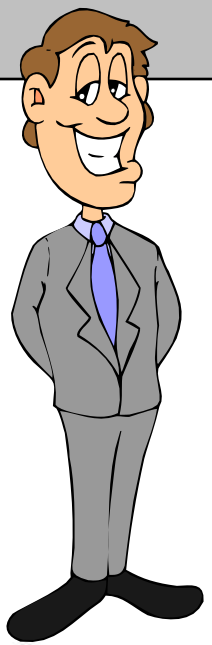
# Economic versus financial analysis

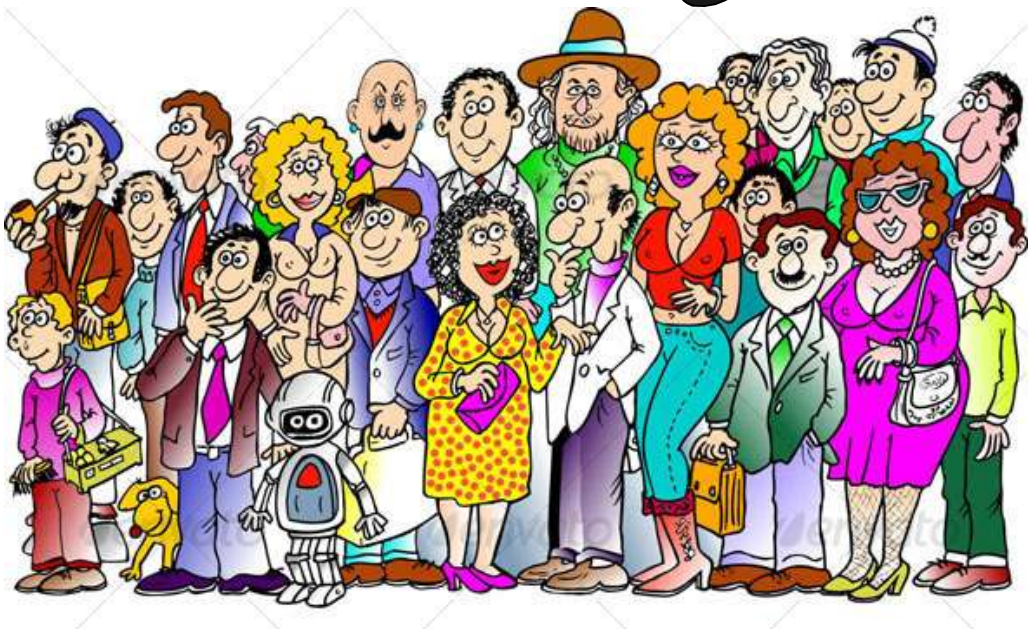
Financial analysis:

Will this project increase investors' wealth?



Economic analysis:

Will this project increase society's well-being (welfare)?



# Cost-Benefit Analysis of a Project/Policy

- Private CBA: (financial viability)
  - Any firm or investor, person, household
  - Ignores **external effects**
- Social CBA: (economic viability)
  - Similar to private CBA but also includes all costs and benefits to **society as a whole**
  - Need to define scope of society: state, national, global?
- Societal CBA
  - Similar to social CBA but also includes analysis on costs and benefits of a project to **different groups** in society

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# Economic versus financial analysis

| Financial profitability for investor | Economic profitability for society: Yes | Economic profitability for society: No |
|---|---|---|
| Yes |  | Good project for investor but not for society. Control and regulate (role of economic instruments). |
| No | Good project for society but not for investor. Consider support (role of economic instruments and environmental funds). |  |

# Rationale for Cost Benefit Analysis

- Scarce resources
  - To allocate to their highest valued use in terms of the goods and services they create.
- To select a project/policy that leads to greatest net gain to society
  - Benefits minus Costs are the highest
- Achieve most efficient use of scarce resources and increases the size of the pie
  - But does that make us better off?

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# Key Feature: With and Without Analysis

- Comparing two alternatives holding everything else constant
- Isolate the net change in benefits and costs due to a project/policy
- Requires establishing a baseline without the project
- Compare it to outcomes with a project

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# Not Before vs. After

Since other things could have changed over time that would be wrongly attributed to the project/policy

In "before vs after" we cannot control for all other factors that might have changed over that time period

Suppose a biodiversity conservation plan led to a decrease in species habitat by 10% in 5 yrs – is it a failure?

Not if the habitat would have decreased by 80% in 5 yrs without the plan.

# Costs and Benefits over time

- Generally a project can have costs and benefits that occur over a long time period
- For example:
  - Converting shrimp farm into integrated mangrove-aquaculture
- CBA is a tool for assessing and comparing the impacts of a project/policy, even when benefits and costs occur over long time horizons.

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# Discounting Benefits and Costs Over Multiple Years

$$PV(B) = \frac{B_0}{(1+r)^0} + \frac{B_1}{(1+r)^1} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \frac{B_4}{(1+r)^4} + \frac{B_5}{(1+r)^5}$$

$$PV(B) = \sum_{t=0}^{t=n} \frac{B_t}{(1+r)^t}$$

$$PV(C) = \sum_{t=0}^{t=n} \frac{C_t}{(1+r)^t}$$

$$NPV = \sum_{t=0}^{t=n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{t=n} \frac{C_t}{(1+r)^t}$$

$$or\ NPV = \sum_{t=0}^{t=n} \frac{B_t - C_t}{(1+r)^t}$$

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# Step-by-step CBA

***Step 1: Define the referent group.***

***Step 2: Select the portfolio of alternative project formulation.***

***Step 3: Catalogue all potential physical impacts of the project.***

***Step 4: Define what would happen without the project.***

***Step 5: Predict quantitative impacts over the life of the project.***

***Step 6: Monetize impacts.***

***Step 7: Discount to find present value of costs and benefits.***

***Step 8: Calculate net present value.***

***Step 9: Perform sensitivity analysis.***

***Step 10: Make a recommendation.***

# Step 1:

## Define the referent group

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## *Step 1: Define the referent group or Scoping*

- ***Who do you include in your analysis? Whose costs and benefits?***
- ***Should it be local? Provincial? National? Global?***
    - ***Geographical scoping: Setting the boundaries / Where to stop?***
        - Stakeholders scoping: whose costs and benefits to include in the analysis**?**

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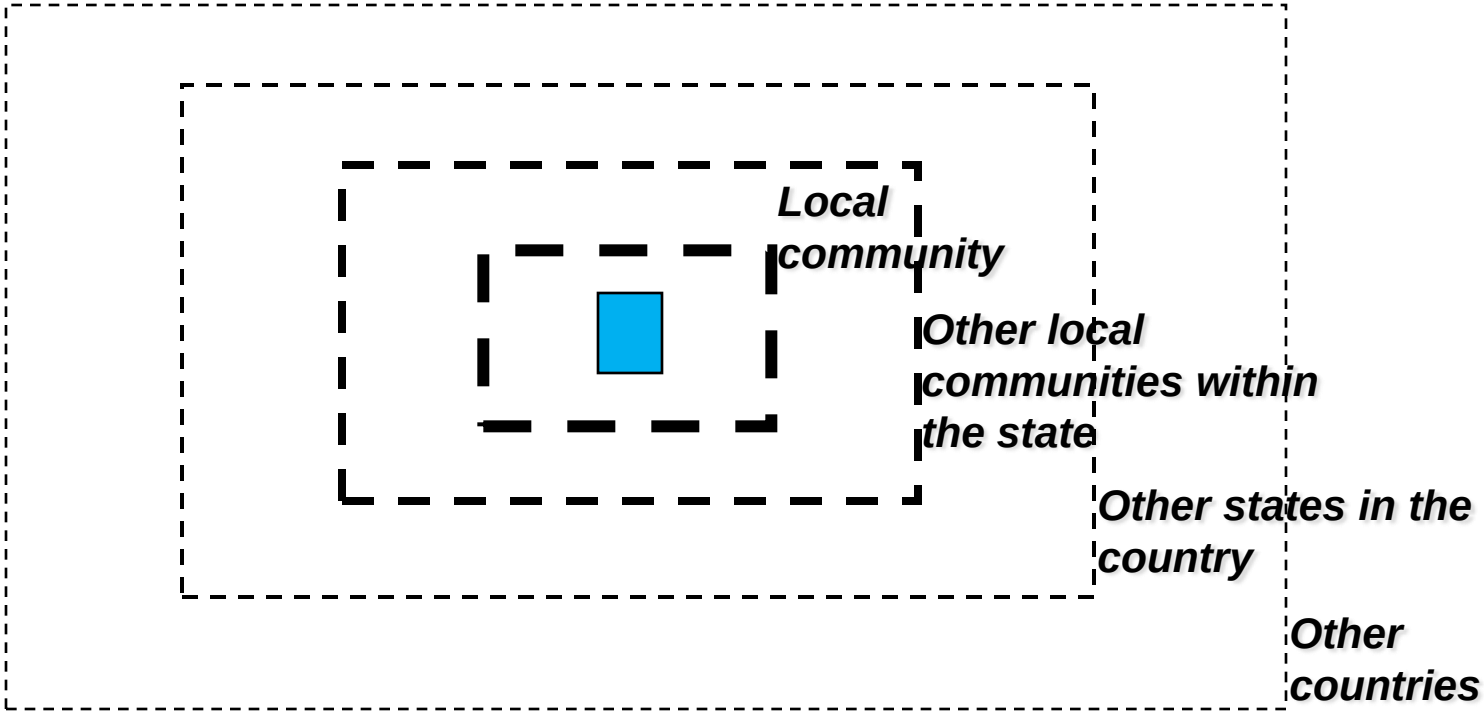
# *Step 1: Define the referent group.*

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# Step 2:

Select the portfolio of alternative project formulation.

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## Step 2: Select the portfolio of alternative project formulation

***Difficulties:***

- *It is perhaps impossible to define ALL possible alternative project formulations.*

***In practice:***

- *Most of the time, the economist will do a CBA of only one project at a time, and will seek to determine whether or not the project offers the potential for a social welfare.*
- *For this single project, typically only a limited number of options will be analyzed.*

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# Step 3:

## *Catalogue all potential physical impacts*

***This is perhaps the most important and most common failure in CBA.***

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## *Step 3: Catalogue all potential physical impacts*

- ***Meaning: List ALL impacts of the projects.***

***<u>Difficulties</u>:***

- ***Many of the impacts may not be known;***
- ***Need to identify major/important ones***

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# Step 4:

## Define what would happen without the project

***This is perhaps the most important and most common failure in CBA.***

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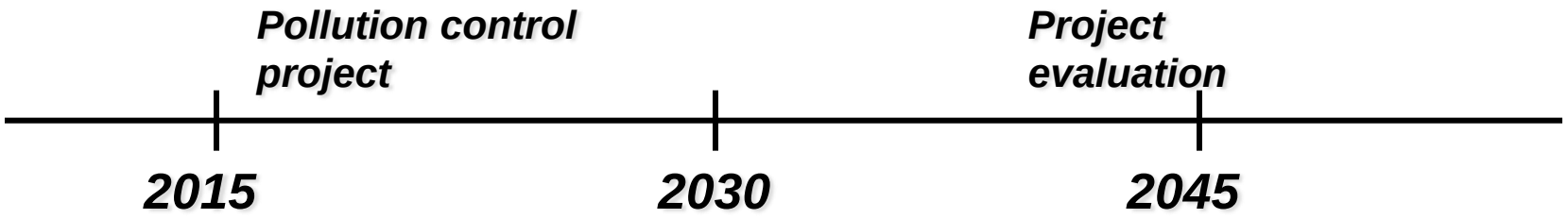
## Step 4: Define what would happen without the project




Total pollution: 100T

Before

Total pollution: 150T

After

Maybe without project:
Total pollution: 200T

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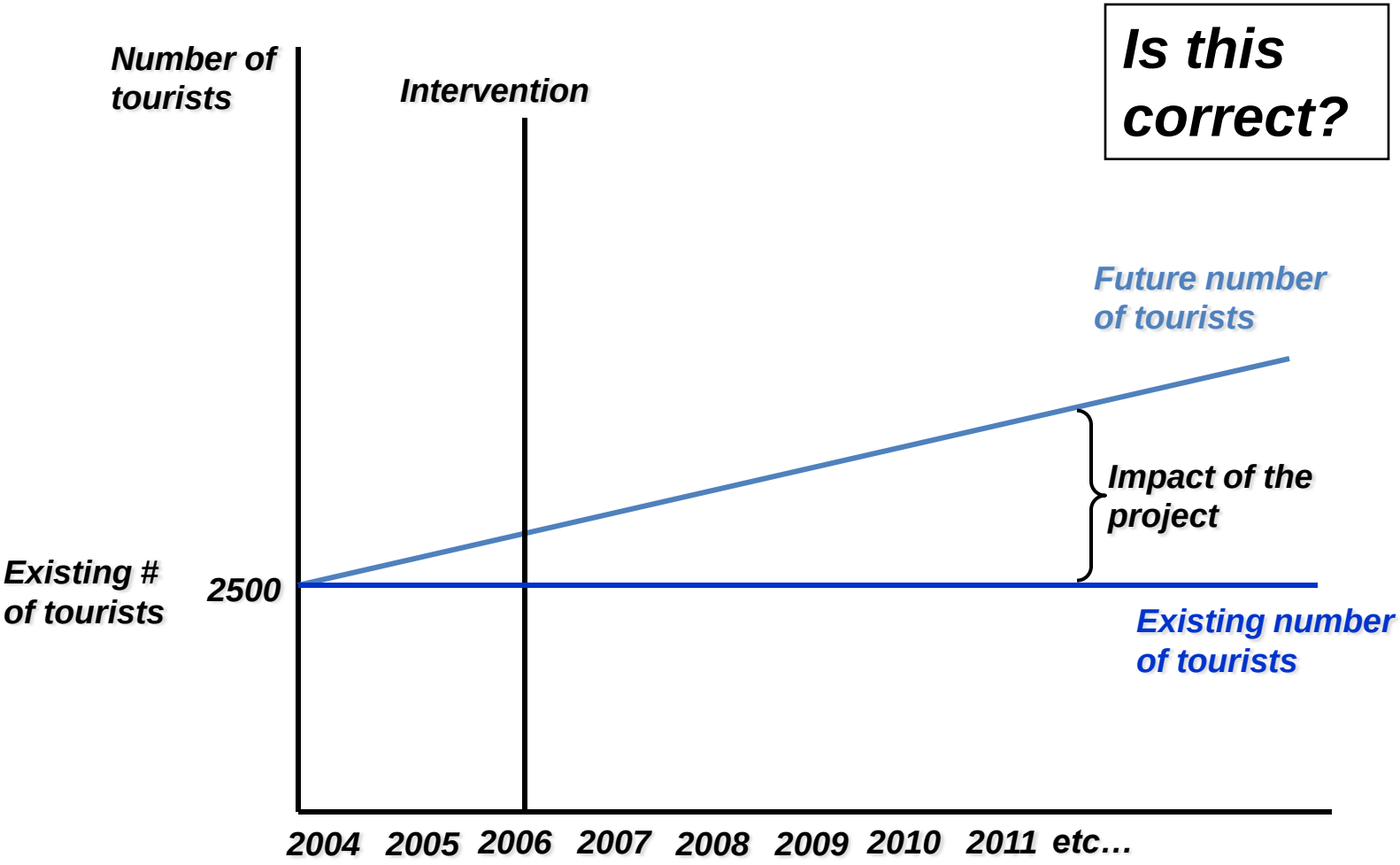
# Number of Tourists

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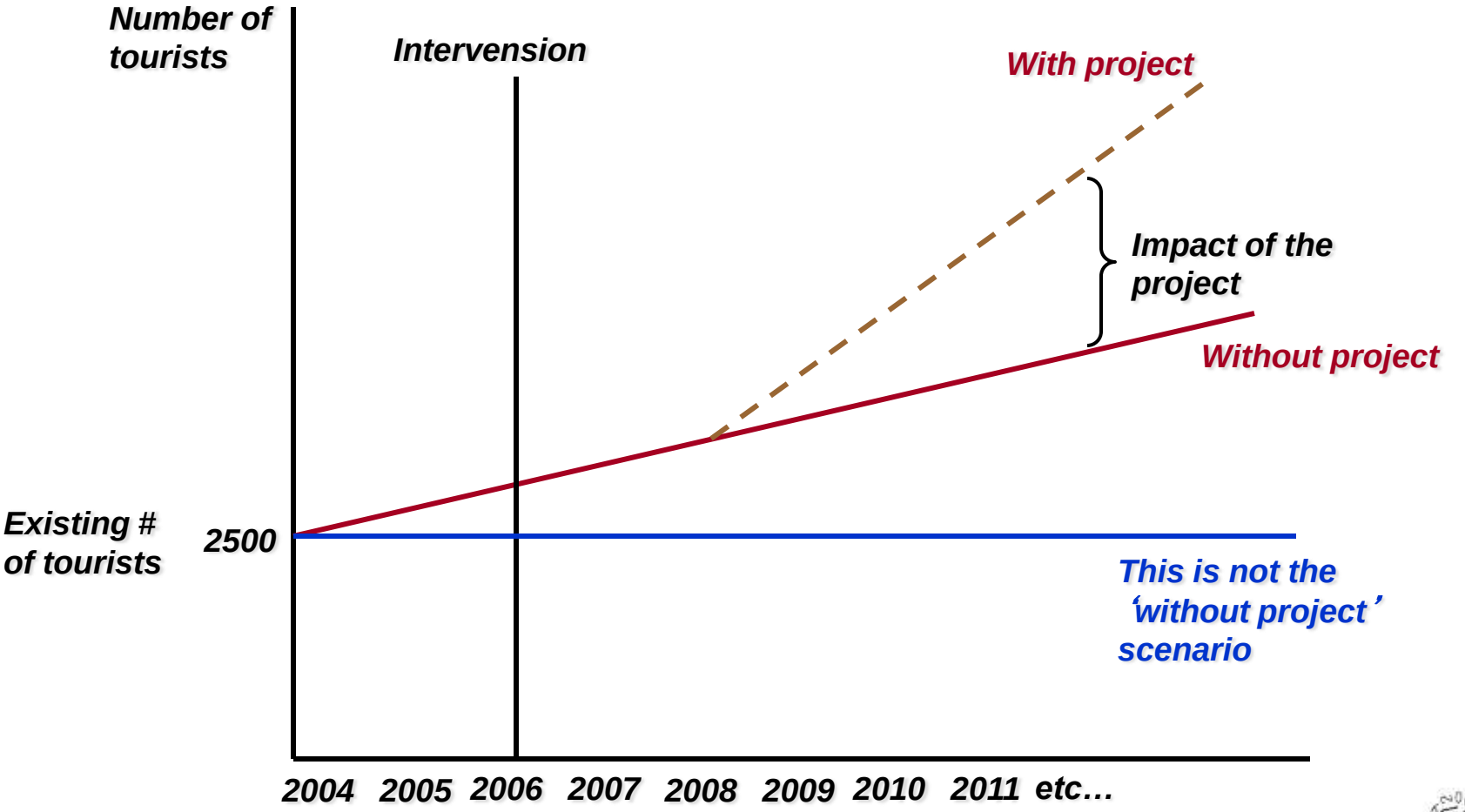
# Number of Tourist

## What we would like to do:

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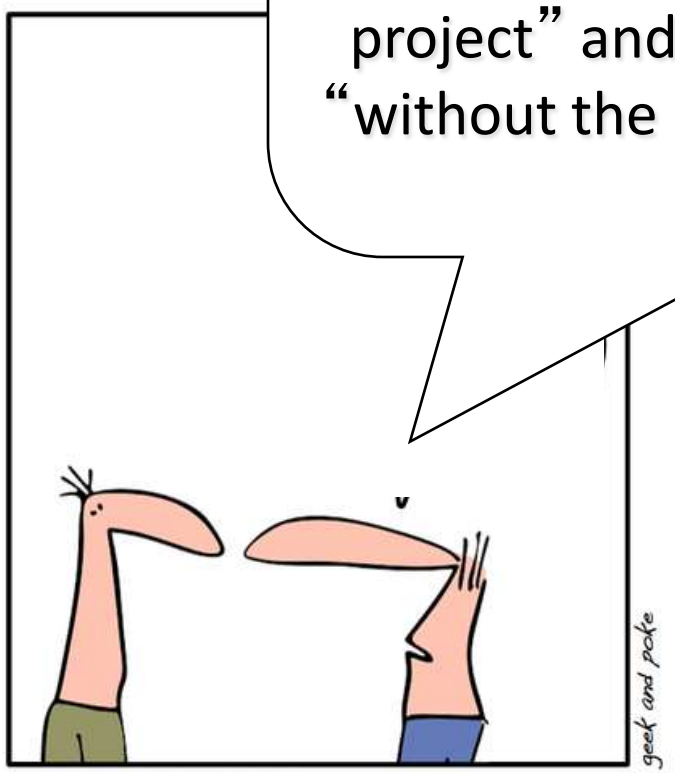
We must always ask: What would happen if the project does not take place. We must compare how the situation will be “with the project” and how it is expected to be “without the project”.

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# Step 5:

Predict quantitative impacts over the life of the project.

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# Step 5: Predict quantitative impacts

***Difficulties:***

**Always have to make assumptions; always have to extrapolate from other similar situations elsewhere**

At best, the data is incomplete.
At worse, it simply does not exist.


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# Step-by-step CBA

***Not economics:***

***Step 1: Define the referent group. Who has standing?***

***Step 2: Select the portfolio of alternative project formulation.***

***Step 3: Catalogue all potential physical impacts of the project.***

***Step 4: Define what would happen without the project.***

***Step 5: Predict quantitative impacts over the life of the project.***

***Economics:***

***Step 6: Monetize impacts.***

***Step 7: Discount to find present value of costs and benefits.***

***Step 8: Calculate net present value.***

***Step 9: Perform sensitivity analysis.***

***Step 10: Make a recommendation.***

***Need multi-disciplinary team***

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# Step 6:

## Monetize impacts.

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## Step 6: Monetize impacts

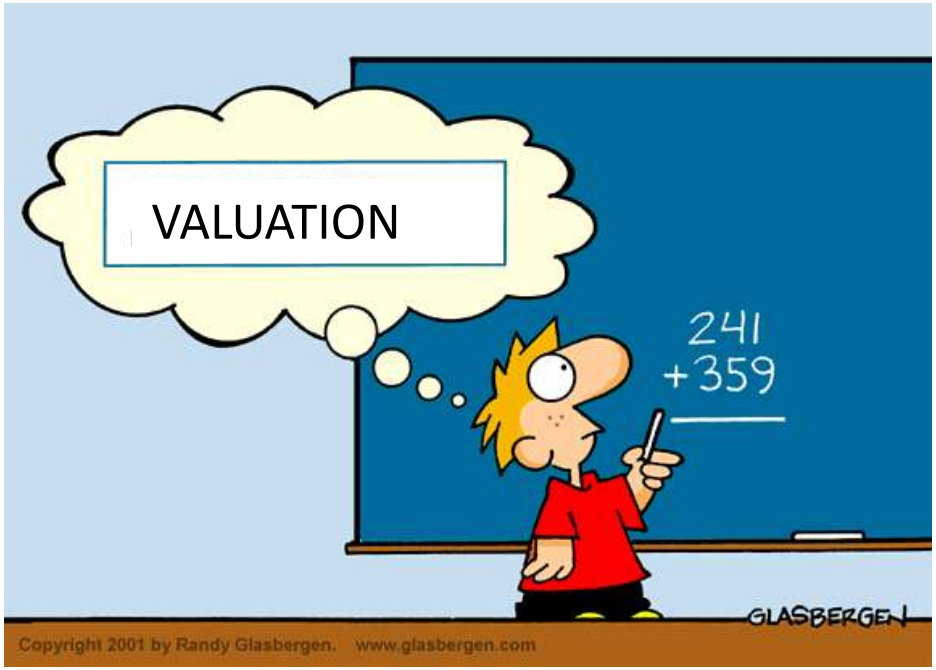
***Group 1: Direct use of market prices;***

***Group 2: Revealed preferences:***

- ***Avertive behavior;***
- ***Replacement cost;***
- ***Hedonic pricing;***
- ***Travel cost.***

***Group 3: Stated preferencaes:***

- ***Contingent valuation;***
- ***Choice experiment.***

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# Step 7:

Discount to find present value of costs and benefits.

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# Step 8:

Calculate net present value.

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# Net present value

***Net Present Value = PV of Benefits – PV of Costs***

$$= \sum_{t=0}^{\infty} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{\infty} \frac{C_t}{(1+r)^t}$$

$$= \sum_{t=0}^{\infty} \frac{(B_t - C_t)}{(1+r)^t}$$

***Decision rule:***

***Project is good if NPV is positive; or***

***Choose project (or option) with the largest NPV.***

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# Step 9:

Perform sensitivity analysis.

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***Principle**: Test the sensitivity of your results to various possible realizations of the key variables of the analysis.*

## *3* Options

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

*Ultimately this leads to the undertaking of a Monte Carlo simulation.*

***Option 2**: Try out worst-case or best-case scenario.*

***Option 3**: Suppose NPV is positive. Then ask: What is the maximum realization of a negative impact that would turn the NPV negative. And then ask: How likely is this maximum realization?*

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# Step 10:

## Make a recommendation

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## Step 10: Make a recommendation

### Part I:

- Present the results of the analysis and state, on the basis of these results, whether or not the project or policy is good or bad.

### Part II:

- Discuss the important sources of uncertainty, where the lack of information created important difficulties, and where further resources should be devoted to collect additional data;
- Discuss the fact that not all the impacts have been subjected to economic assessment, and that these impacts should be considered in the decision-making process even though they were not captured in the economic analysis;
- Distributional issues. Who gains and who lose?
- Suggest incentives

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# Thanks

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CBA books

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