Integrating agriculture in National Adaptation Plans

Safeguarding livelihoods and promoting resilience through National Adaptation Plans (NAPs)

The Role of Cost-Benefit Analysis

Session 8:
CBA Step 7 Dealing with Uncertainty

Presentation by Dr. Benoit Laplante
Bangkok, Thailand
March 5 to 9, 2018

Food and Agriculture Organization of the United Nations

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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.

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Outline of presentation

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

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Overall approach

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. Three approaches to account for risk or uncertainty
3. Approach 1: Sensitivity analysis
4. Approach 2: Expected value analysis
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Outline of presentation

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

Approach 3: Scenario analysis

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

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Approach 1: Sensitivity analysis

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

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.

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Approach 2: Expected value analysis

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

Expected value analysis

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.

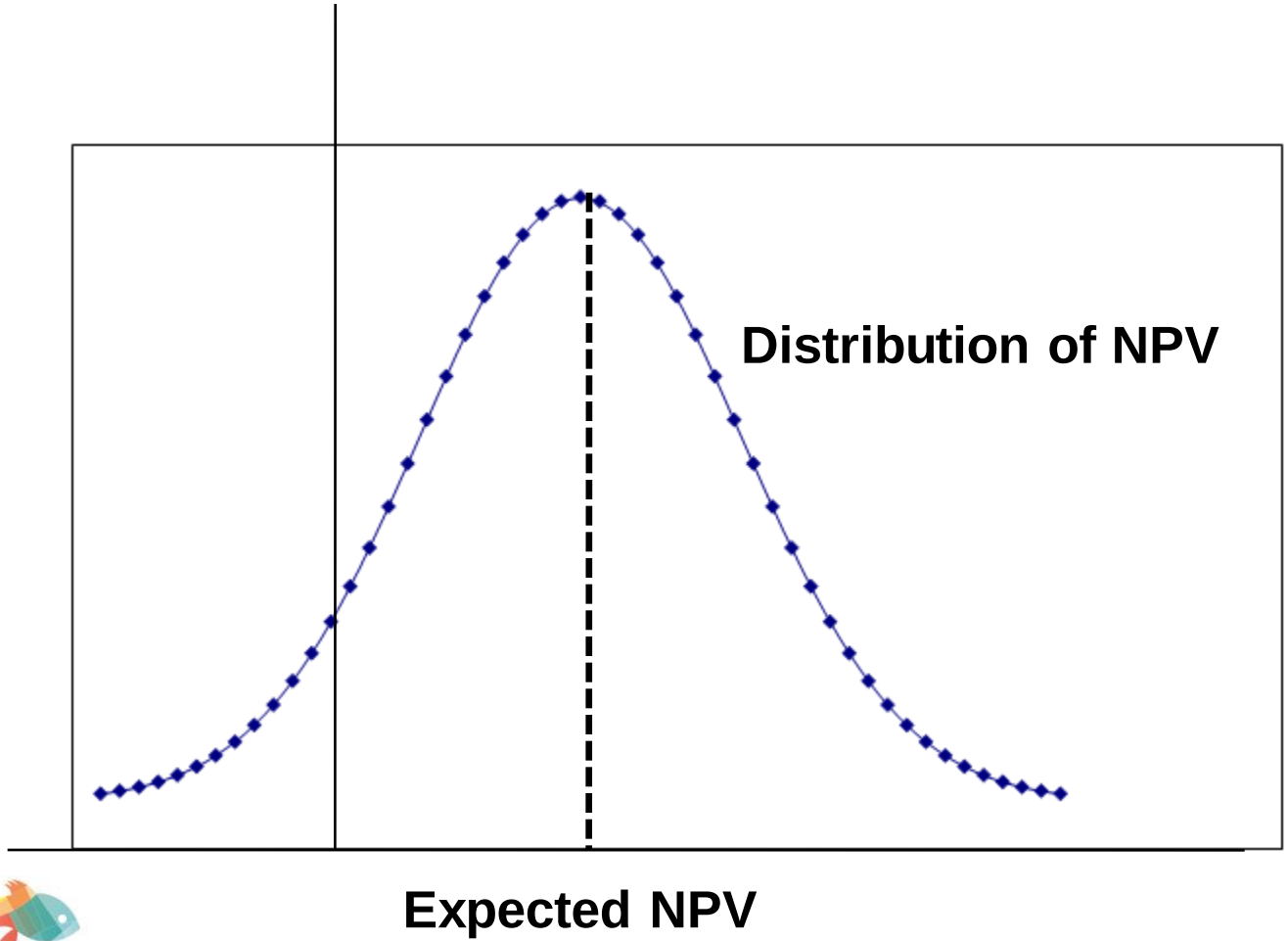
Step 3: Draw a value for each parameter according to the specified probability distribution.

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.

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Accounting for uncertainty

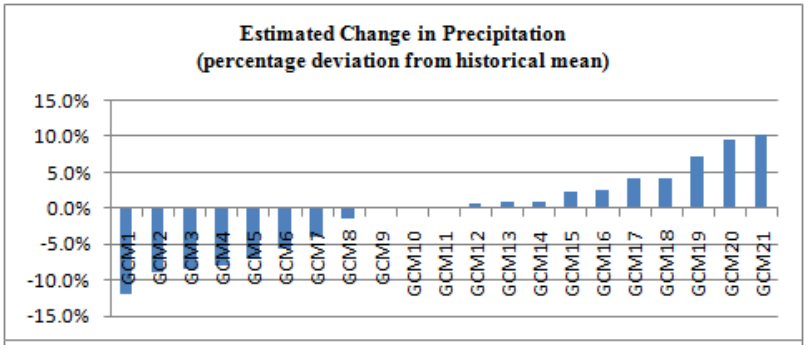
Key issue with climate change is not risk, but it is uncertainty. We do not know what will be the change in climate parameters in the future.

- **We know it will be warmer in 2050 than what it is today (assuming no other event). But is it going to be 0.6 C warmer, or 0.7, or 0.8, or 1.0, or 1.1? And we cannot attach probability on projections.**
- **Projections of precipitation change is even more difficult. Some global circulation models (GCMs) project decrease in precipitation, some GCMs project increase in precipitation. And we cannot attach probability on projections.**

Accounting for uncertainty

- **Scenario analysis**
  - **Compute NPV of investment or policy under different scenarios.**
  - **Informed decision-makers to decide.**

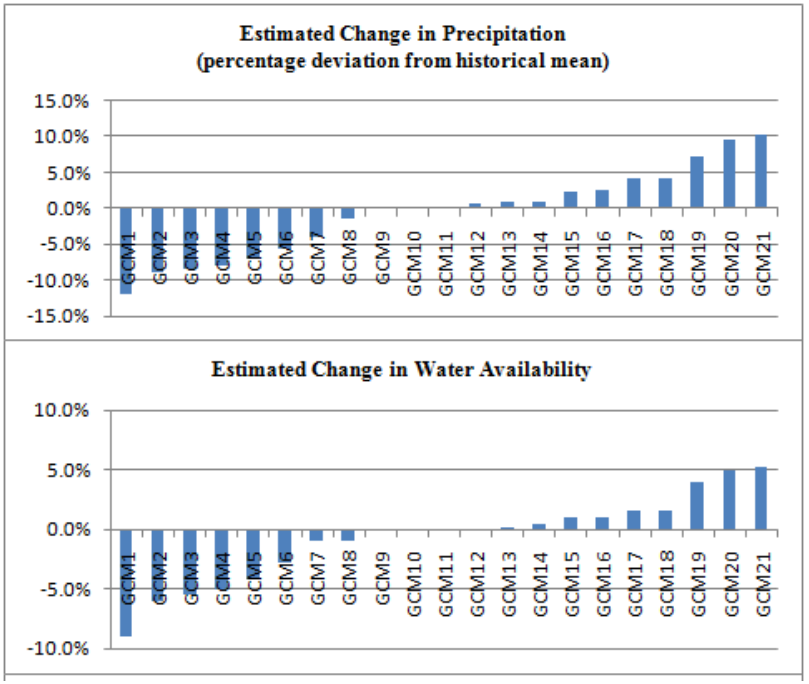
Projected changes in precipitation



Projected changes in precipitation

↓

Projected changes in water availability



Projected changes in precipitation

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Projected changes in water availability

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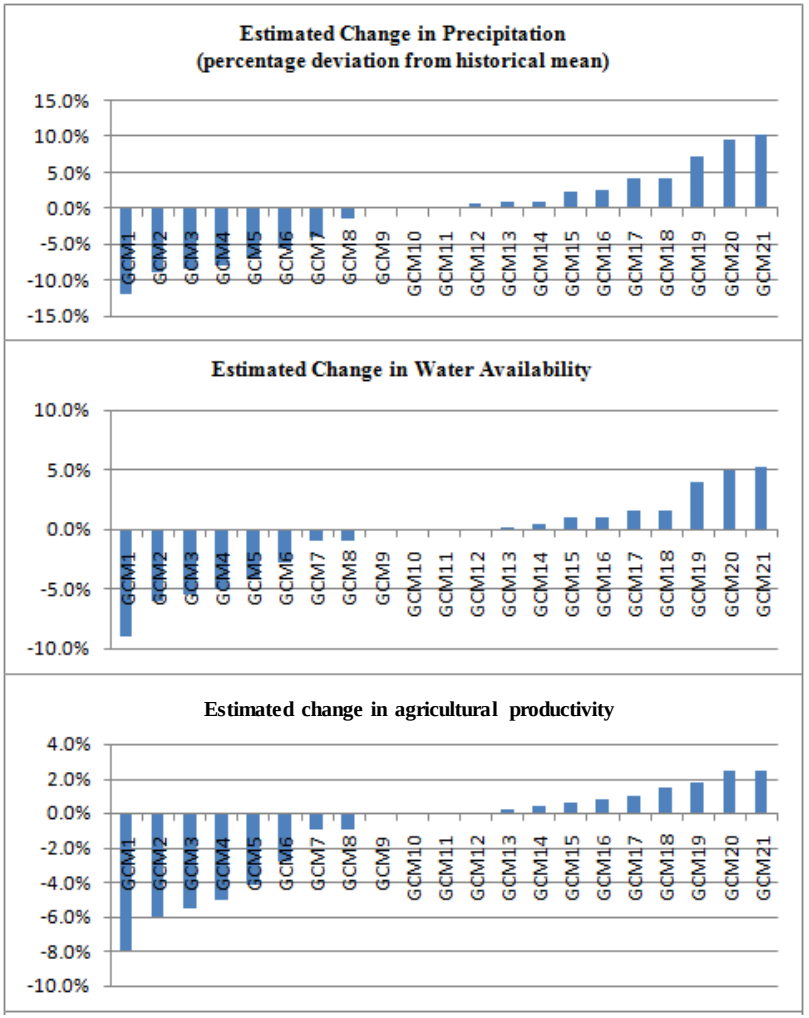
Projected changes in agricultural productivity



Projected changes in precipitation

↓

Projected changes in water availability

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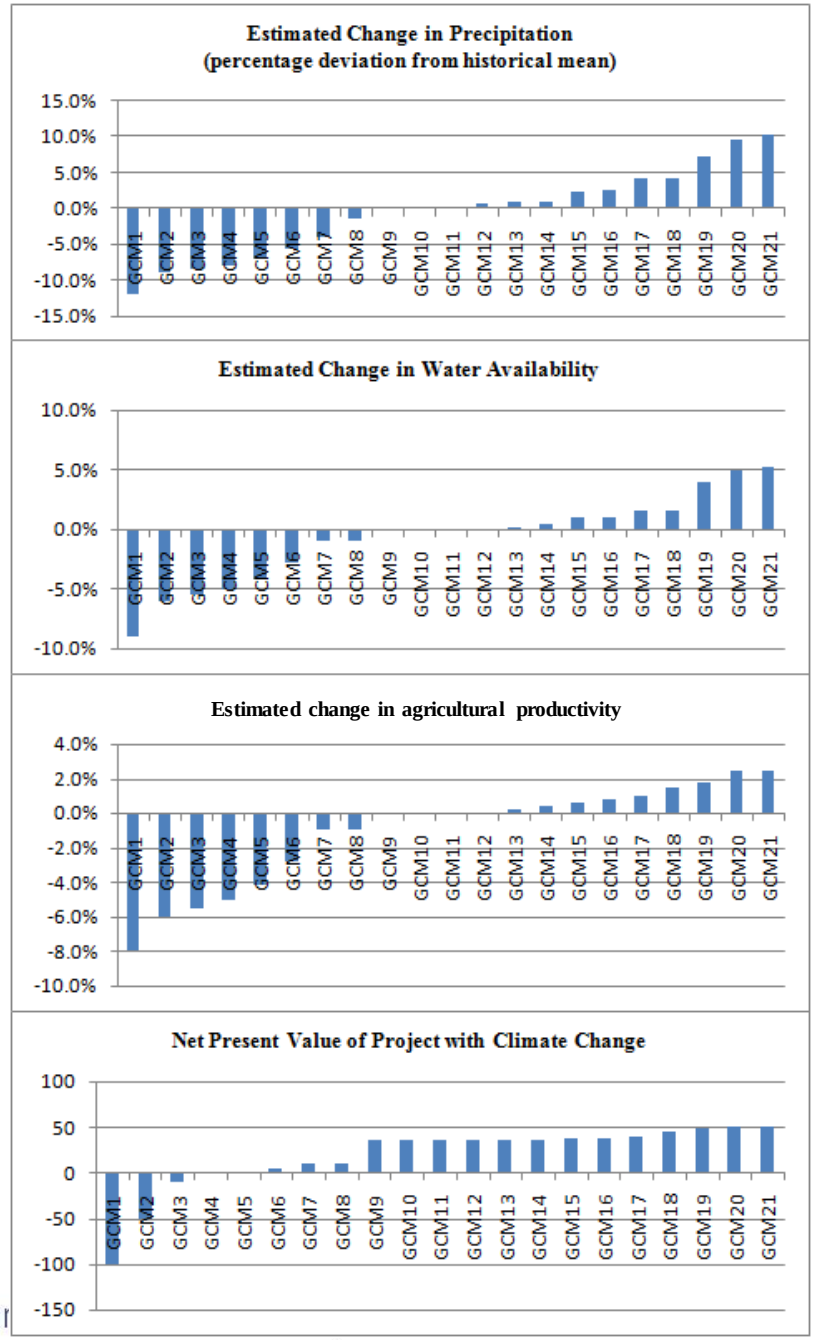
Projected changes in agricultural productivity

↓

Projected changes in NPV



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This presentation is based on this report recently published by ADB. The report is available at:

http://www.adb.org/sites/default/files/publication/173454/economic-analysis-climate-proofing-projects.pdf

ASIAN DEVELOPMENT BANK

ADB

Outline of presentation

1. Questions to be answered
2. Key message
3. Impacts of climate change on the project
4. Costs of climate change and benefits of climate-proofing
5. Traditional economic analysis
6. Types of adaptation decisions
7. Concluding remarks

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Questions to be answered

- How will projected climate change impact the estimated costs and benefits of the investment project? If there were to be no technically feasible measure to mitigate these impacts, would the project still be economically viable?
- Is climate proofing the investment project desirable from an economic efficiency point of view? If yes, should climate proofing take place at the time of project implementation (built into project design), or should it be delayed to a later point in time? What is the "best timing" to climate proof the investment?
- If there are multiple technically feasible and economically desirable climate-proofing options, which of them should be recommended?
- Should benefits other than those strictly associated with climate proofing the investment project be included in the economic analysis?

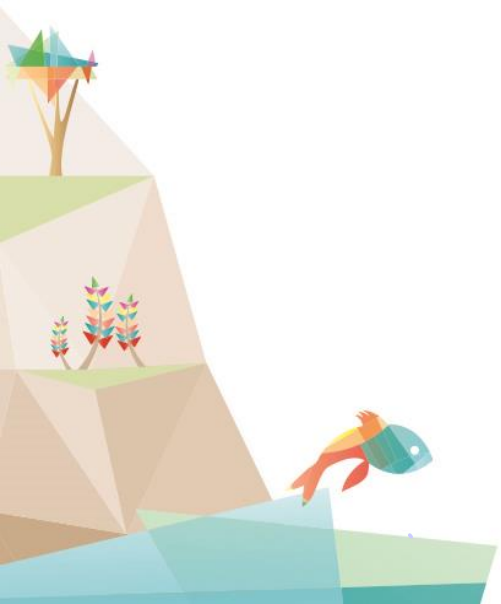
Questions to be answered

It may be argued:

There is too much unknown or uncertainty about climate. These questions cannot be answered.

Reply:

Economic analysis of investment projects has always been conducted in a context of uncertainty. Uncertainty and incomplete information is not something new to the conduct of economic analysis.



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Key message

There is no need for a new type of economic analysis to answer questions which may arise as a result of concerns about the impacts of climate change, and about how to respond to climate change.

However, we may need a better use of the economic analysis to guide project design and decision-making.

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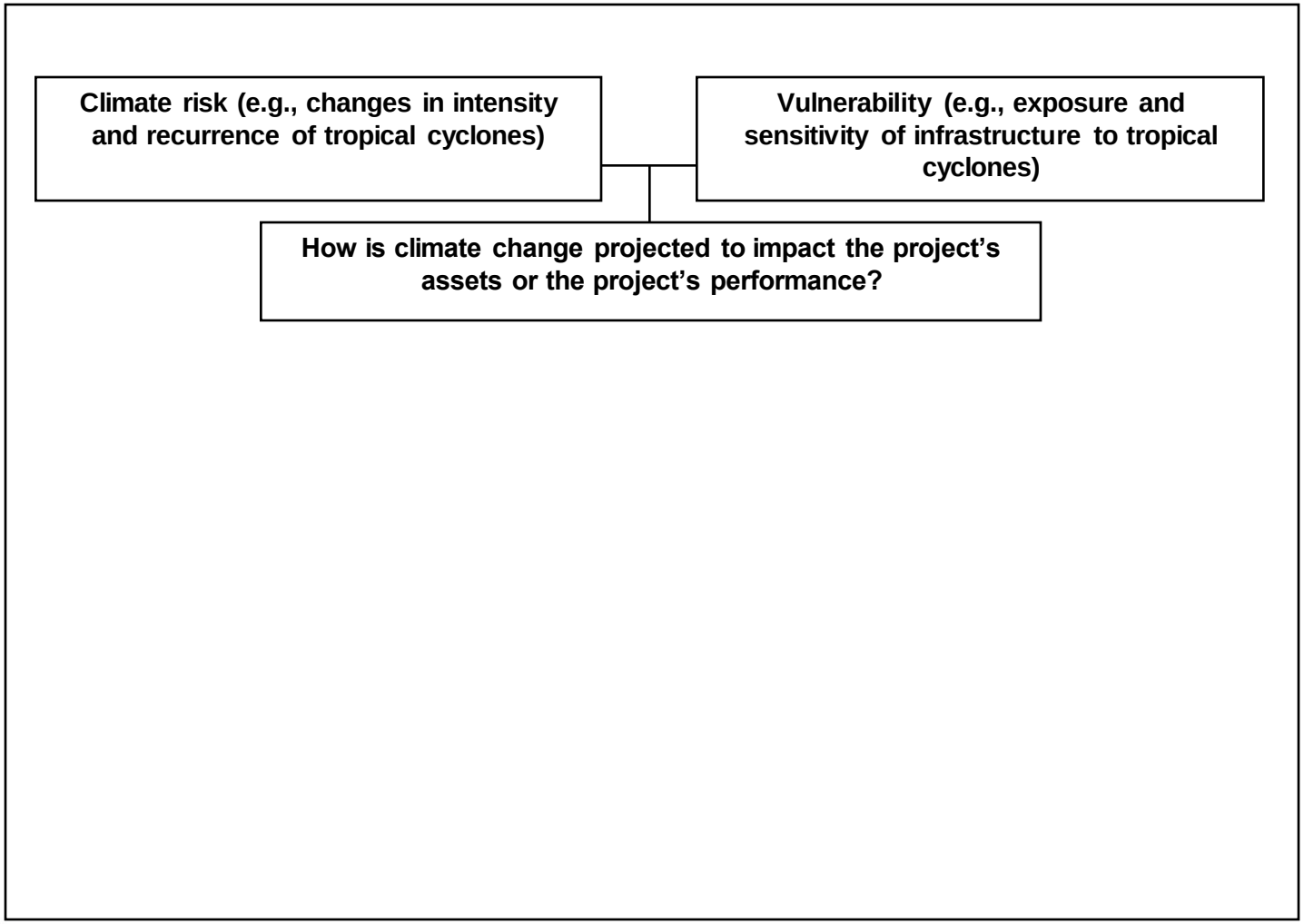
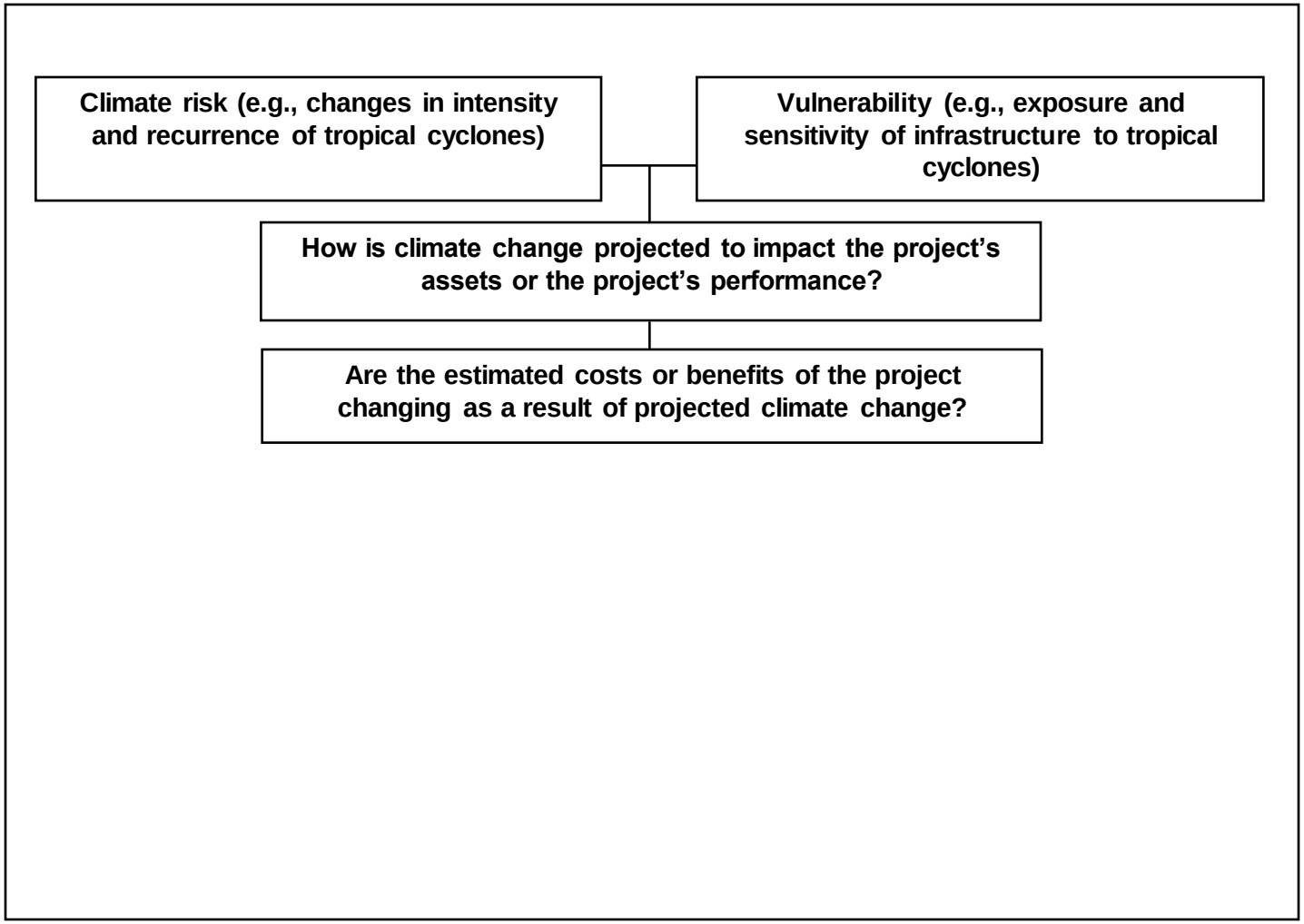
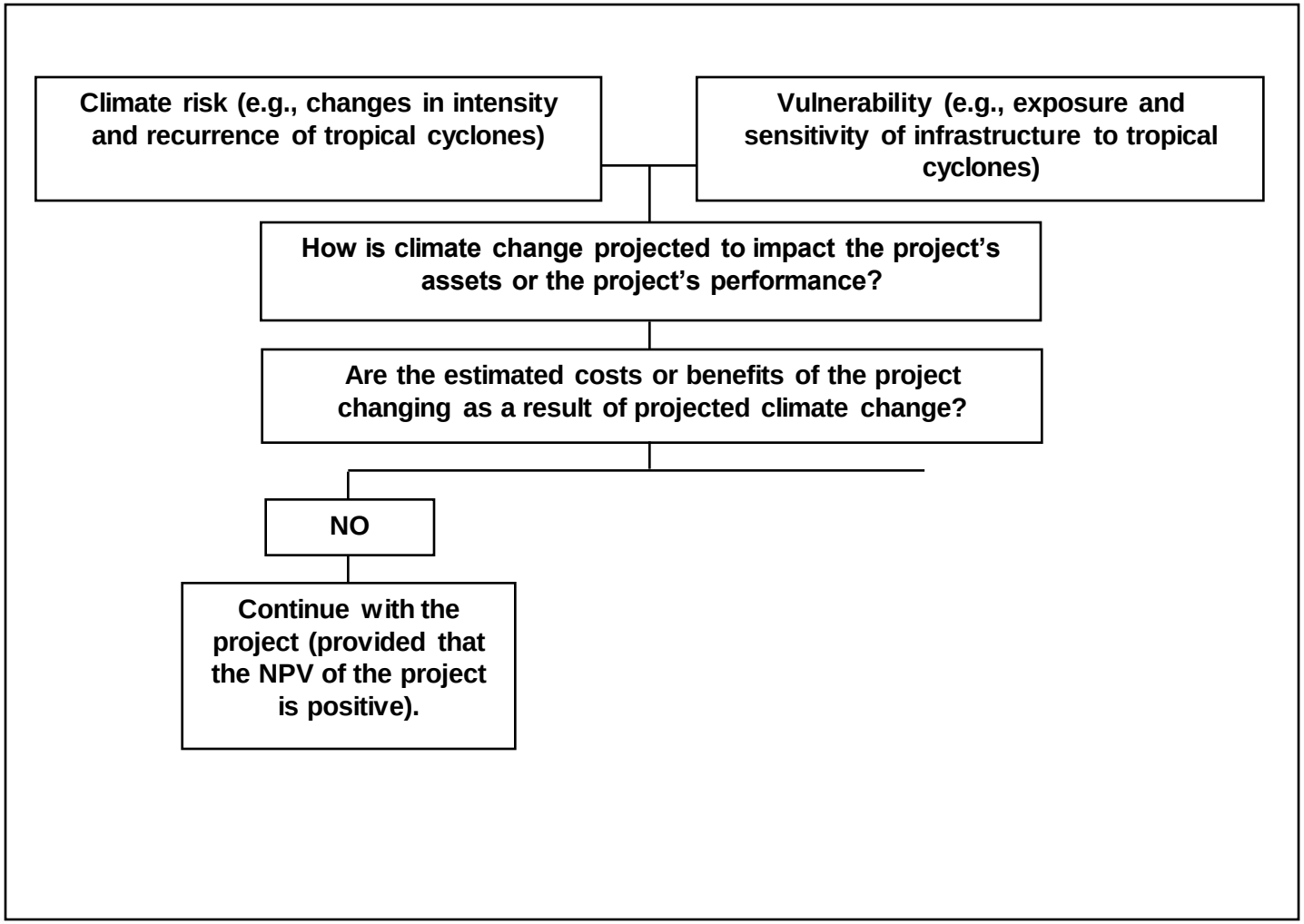
Impacts of climate change on the project



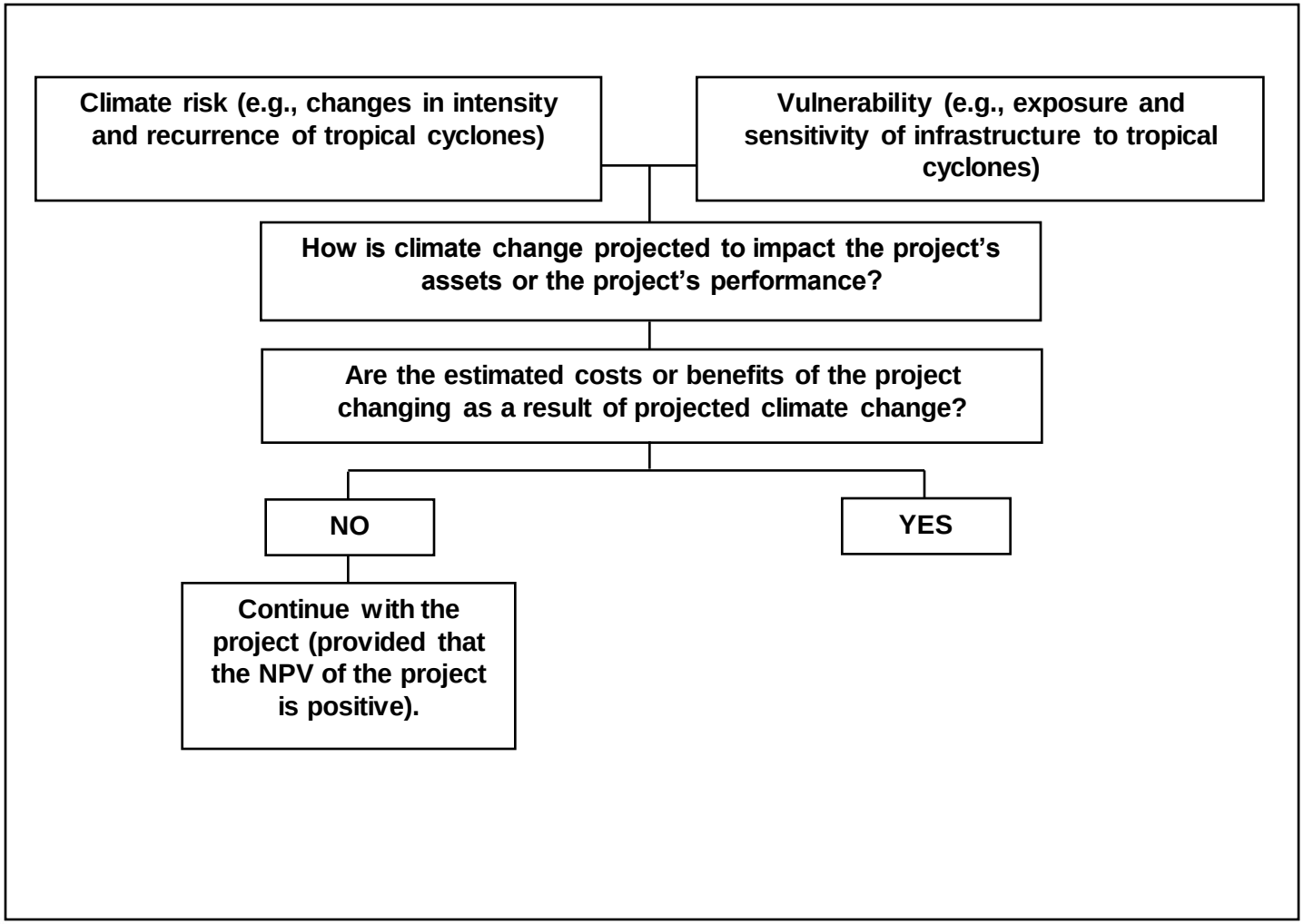
Impacts of climate change on the project



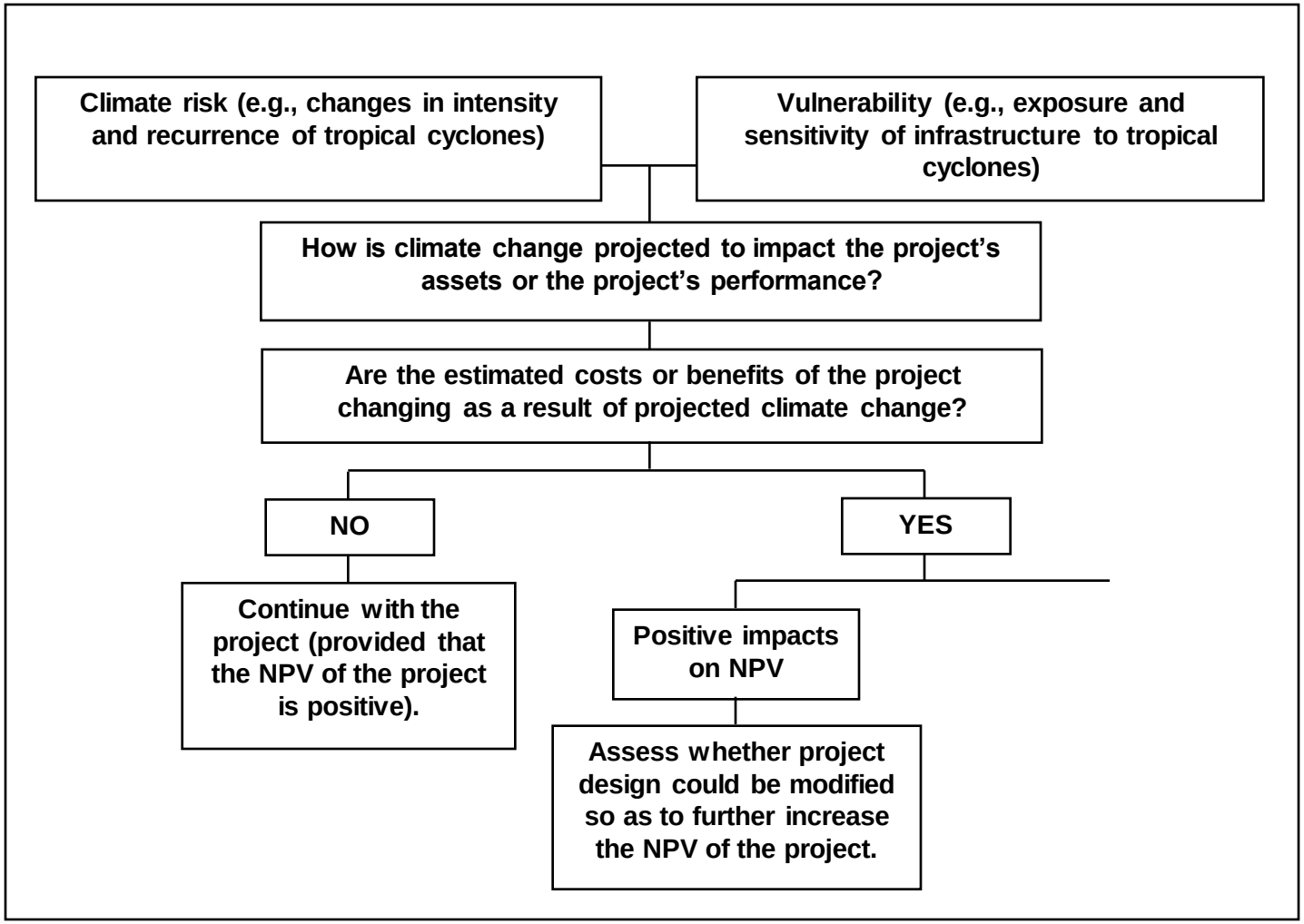
Impacts of climate change on the project



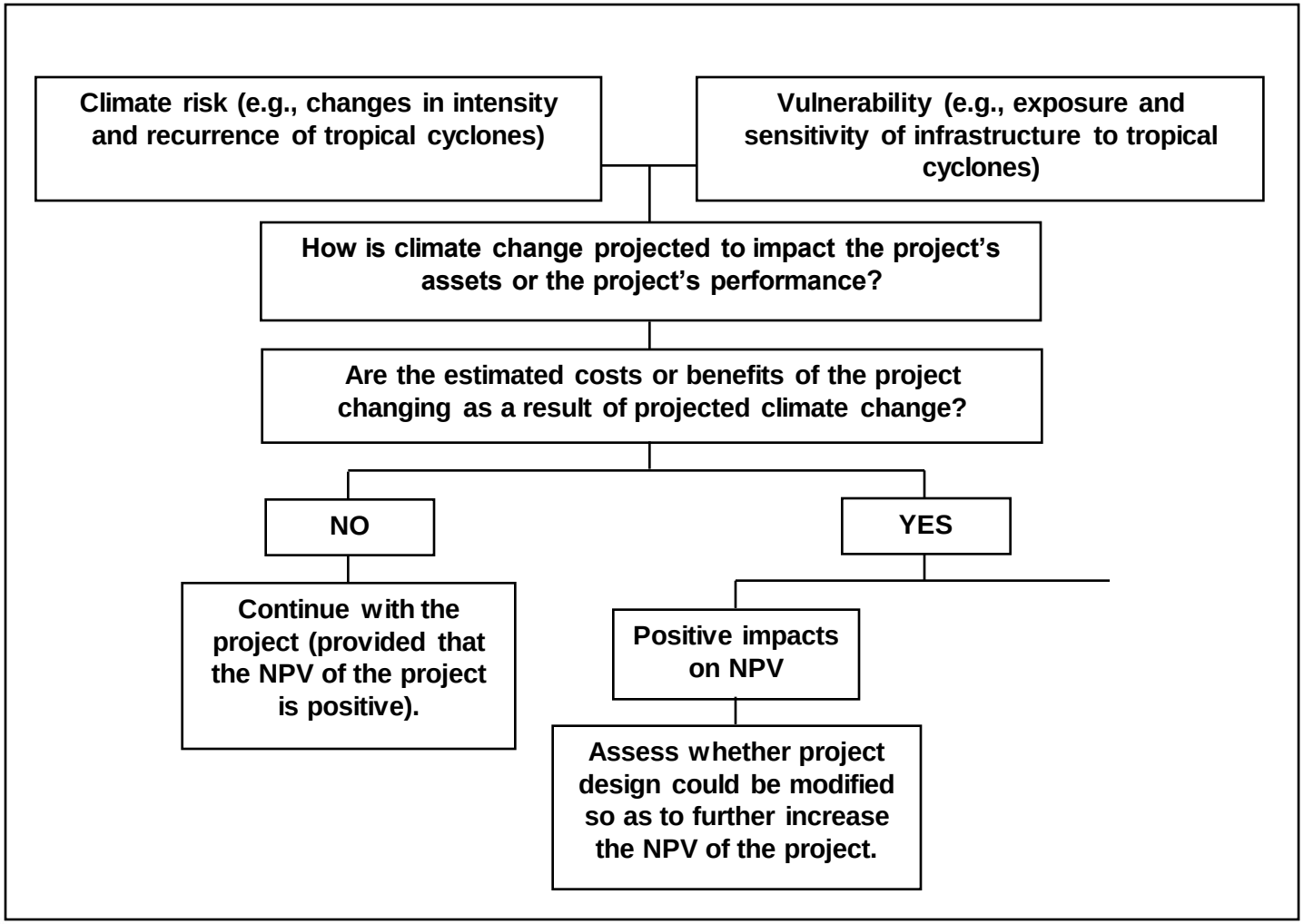
Impacts of climate change on the project



Impacts of climate change on the project



Impacts of climate change on the project



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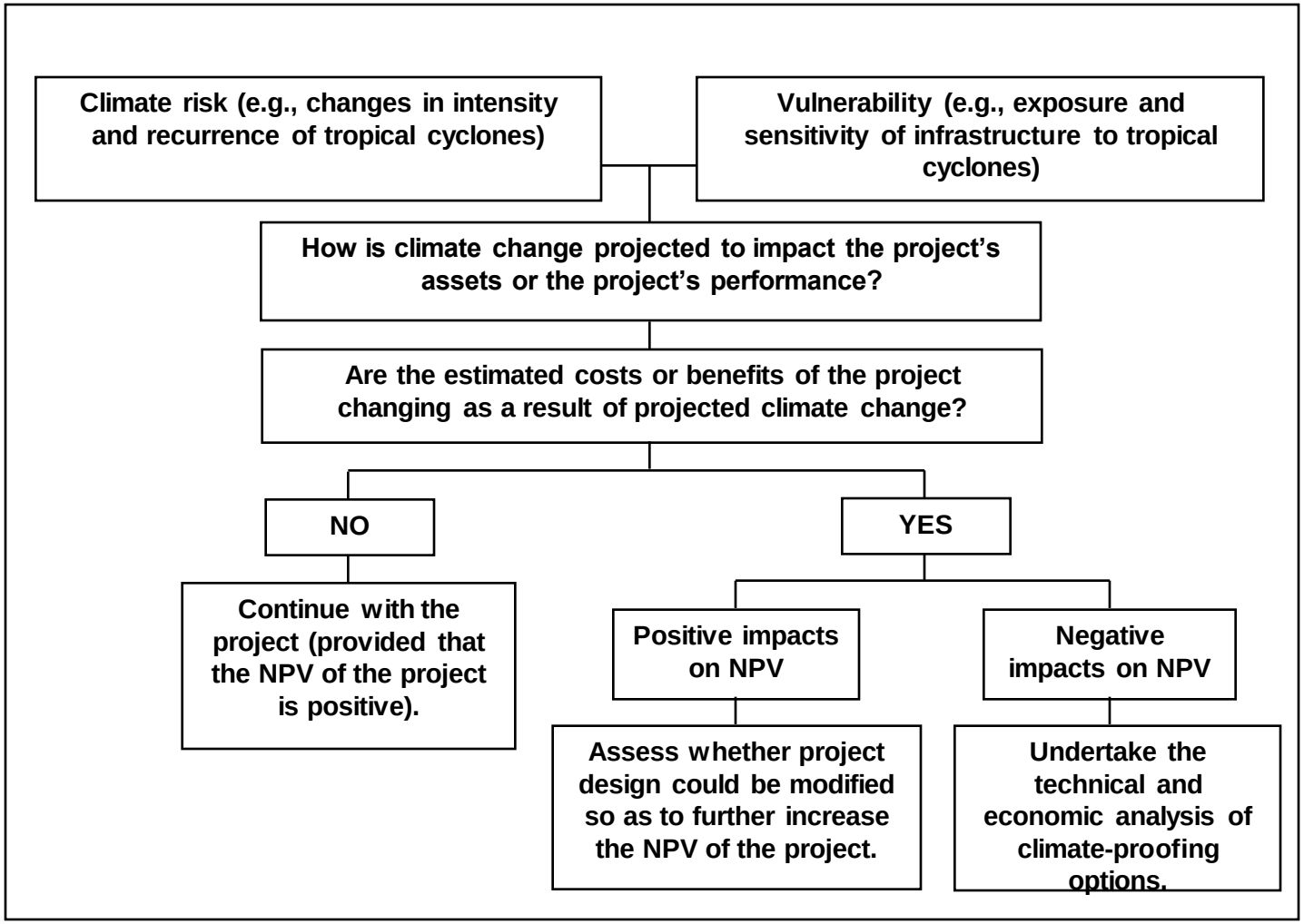

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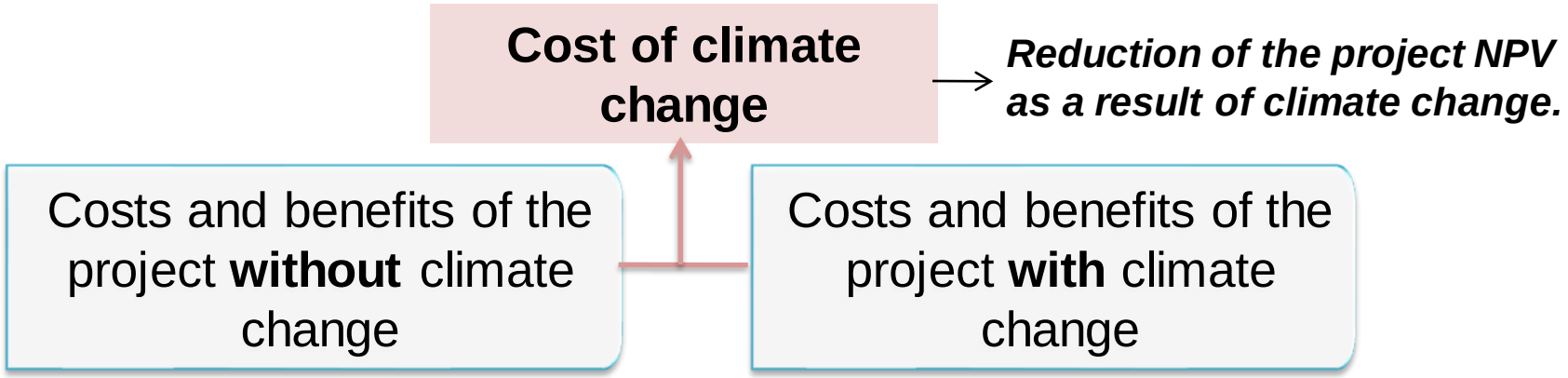
Costs of climate change and benefits of C-P

Costs and benefits of the project **without** climate change

Costs and benefits of the project **with** climate change

Costs of climate change and benefits of C-P



Costs of climate change and benefits of C-P

Costs of the project may increase.

For example:

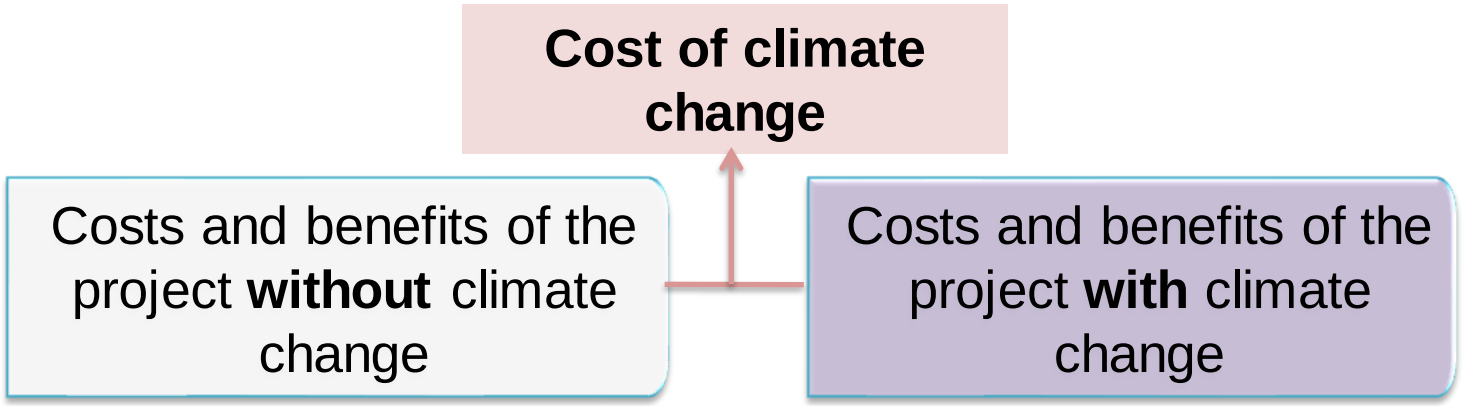
- **As a result of climate change (such as increasing temperatures), production cost of a water treatment project may increase to meet local regulatory standards.**

Benefits of the project may be reduced.

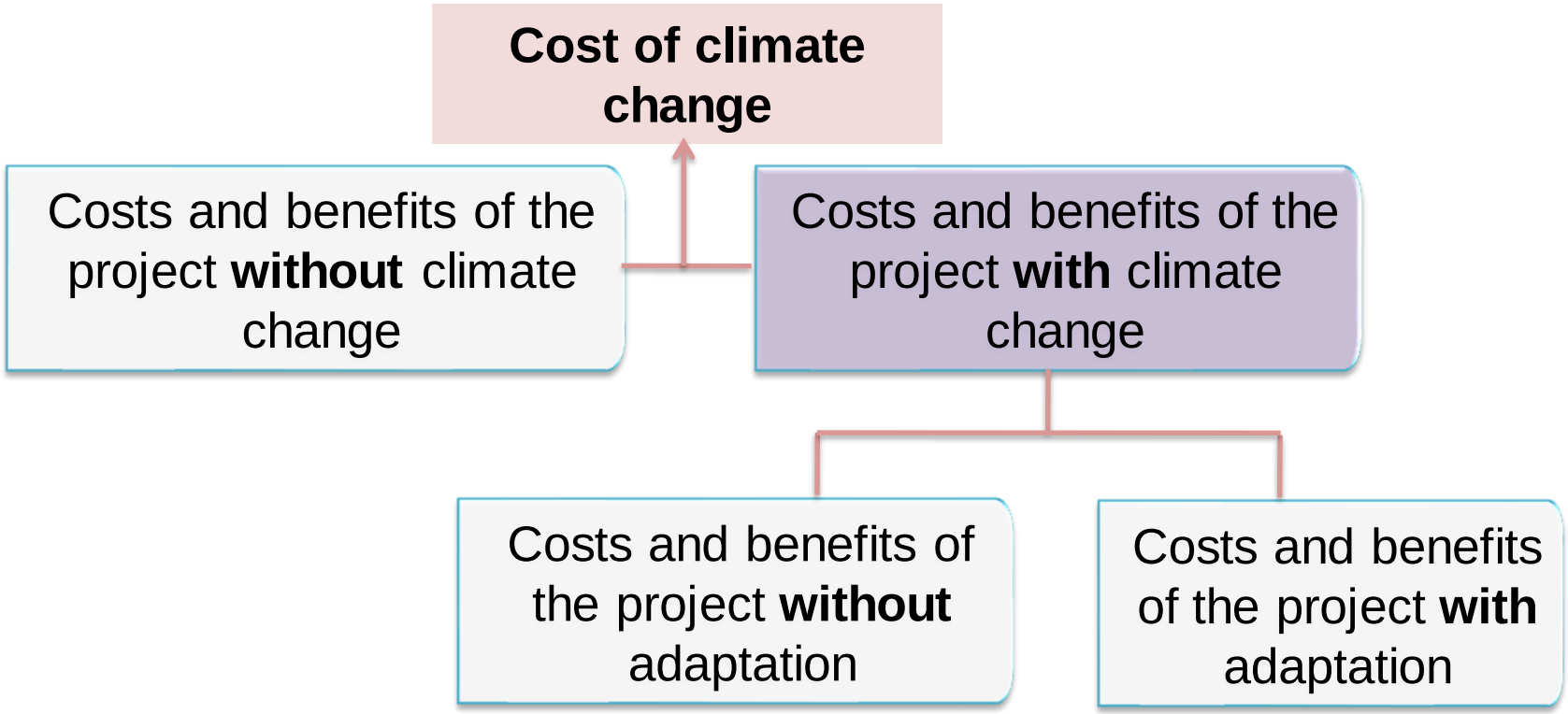
For example:

- **As a result of climate change (such as increased frequency or intensity of tropical storms) disruption of water supply services may result in reduced benefits of the project.**

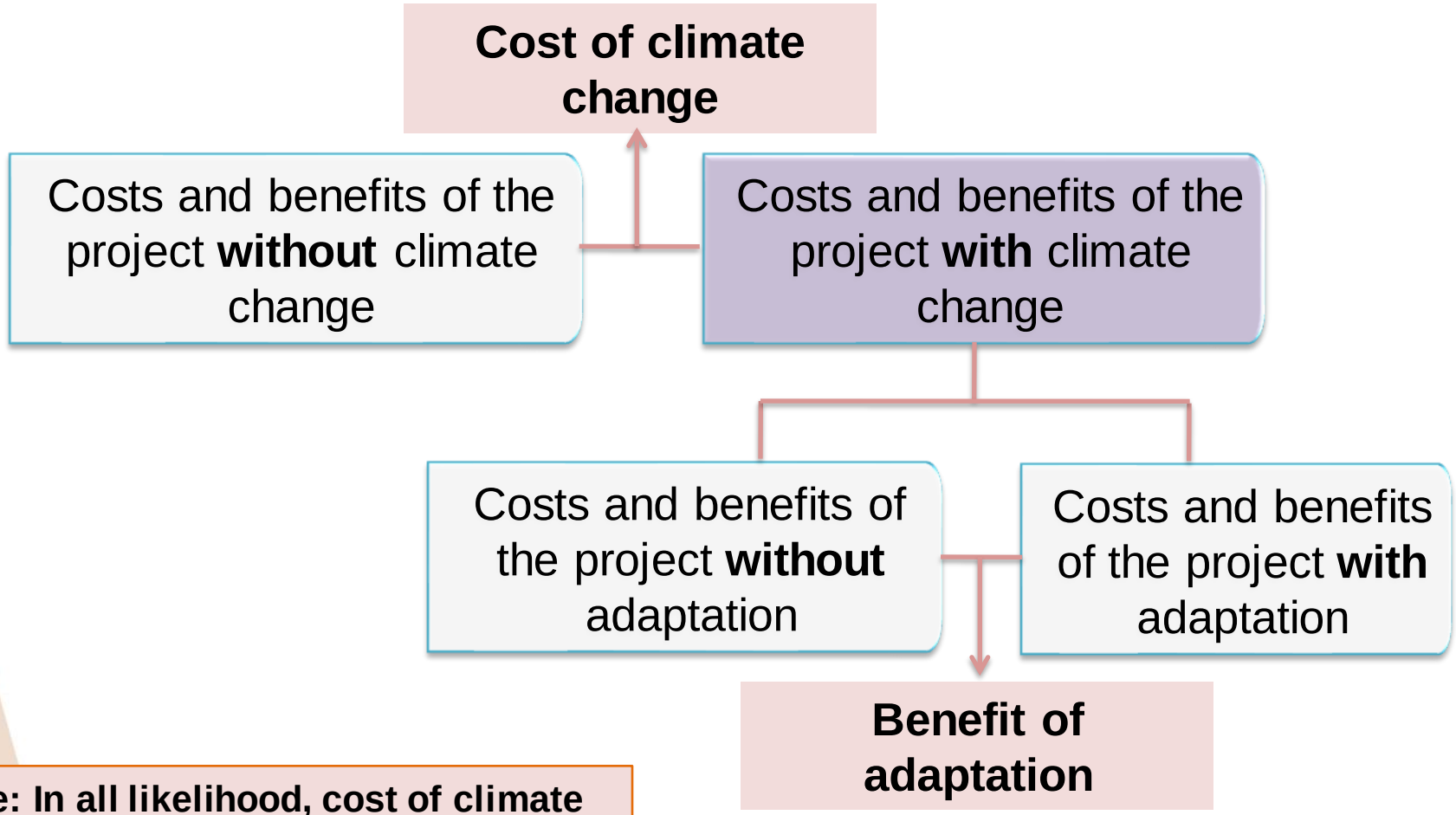
Costs of climate change and benefits of C-P



Costs of climate change and benefits of C-P



Costs of climate change and benefits of C-P



Note: In all likelihood, cost of climate change > benefit of adaptation. Hence, the presence of residual damages.

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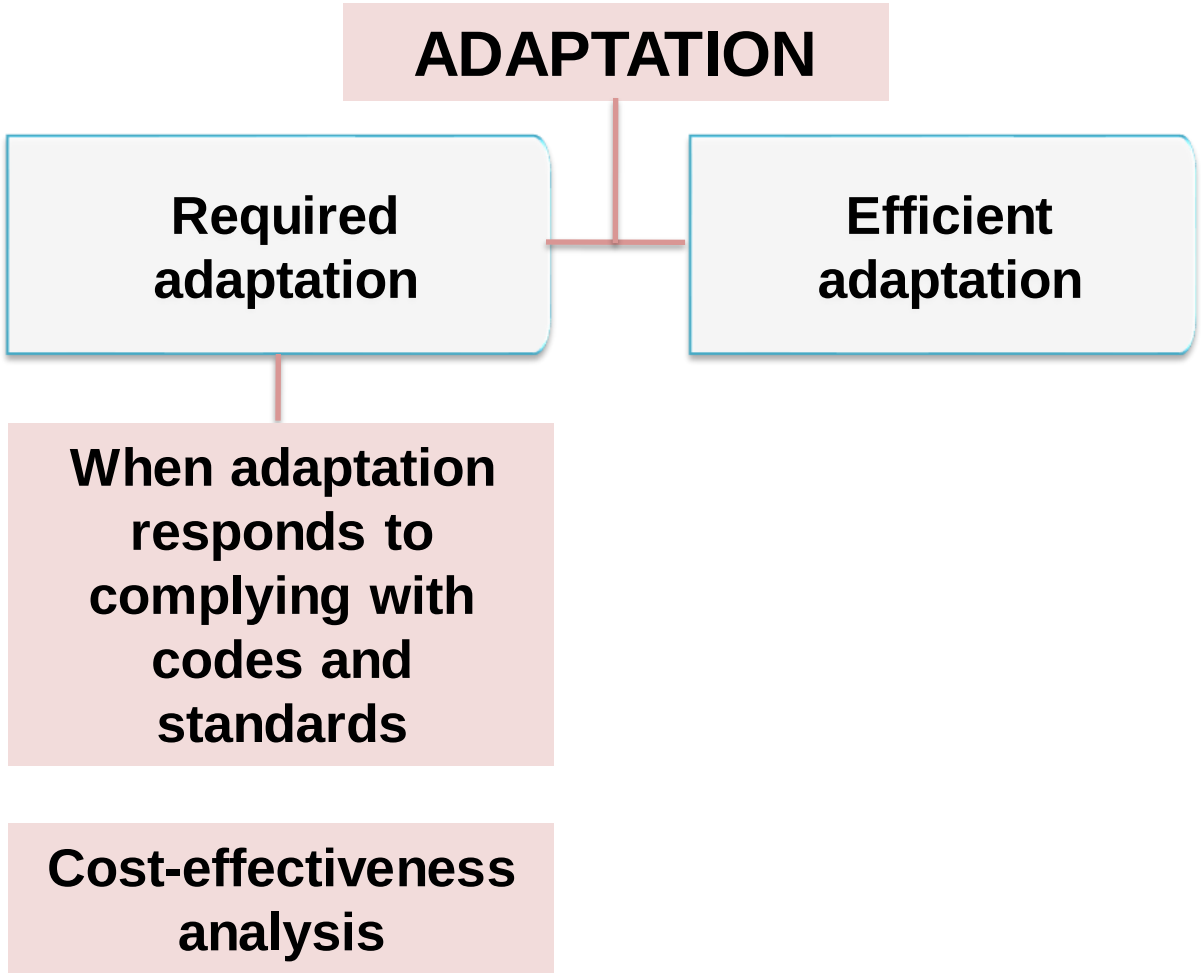
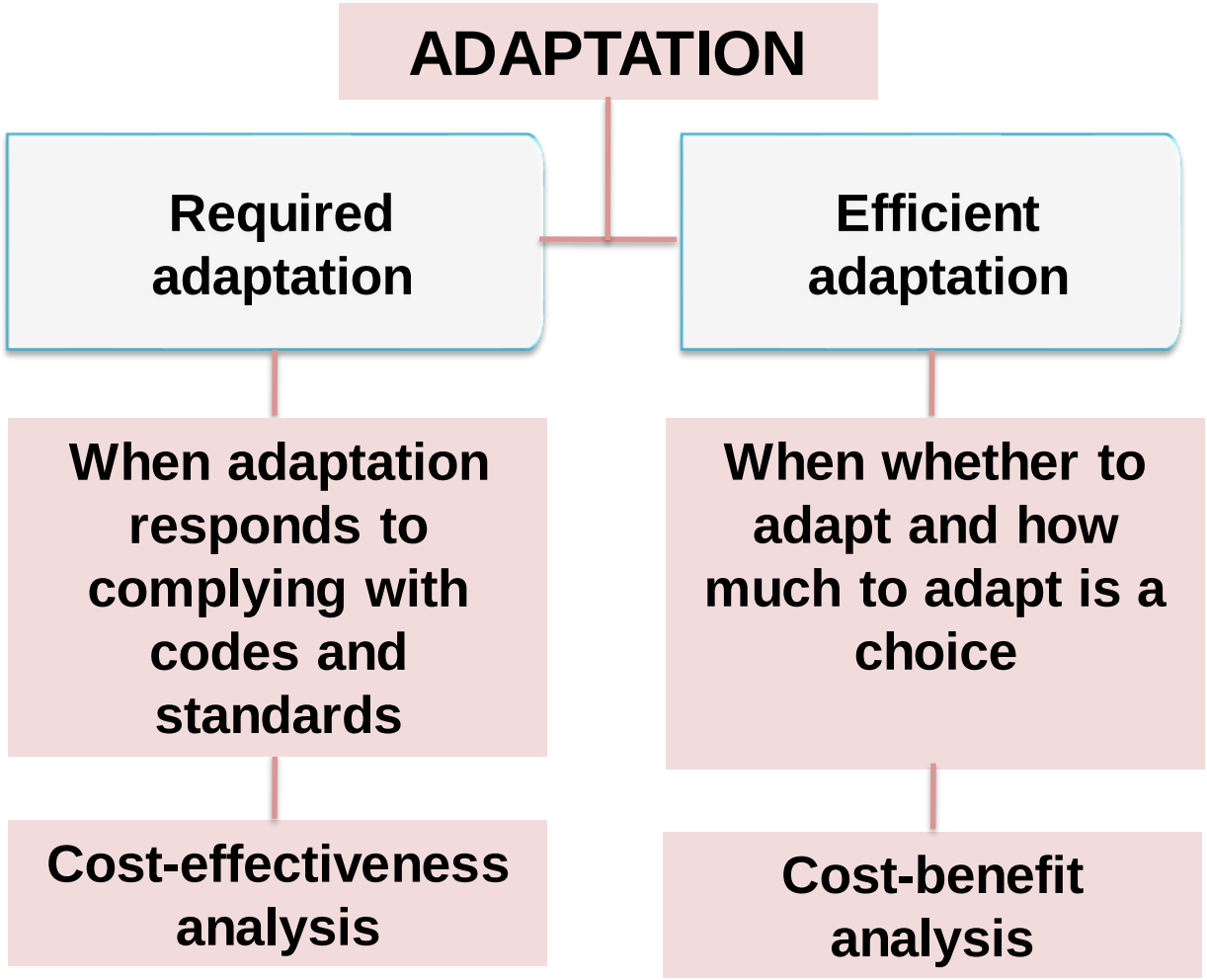
Cost-benefit analysis and cost-effectiveness analysis



Question: What is the most cost-effective way of complying with codes or standards?

Cost-benefit analysis and cost-effectiveness analysis



Cost-benefit analysis and cost-effectiveness analysis

Decision rule cost-effectiveness analysis:

- **Choose the least-cost option to achieve desired objective (e.g. compliance with regulatory standards or achieving a targeted risk reduction).**

Decision rule cost-benefit analysis:

- **Invest in climate-proofing if**
  NPV of project with CP > NPV of project without CP
- **or similarly if**
  NPV of CP is > 0
- **If many CP options, choose option with….highest NPV.**

Corollary: The fact that a project is expected to be adversely impacted by climate change does not necessarily imply that climate-proofing must be implemented.

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Possible outcomes of the analysis

A menu of possible decisions:

Invest now	Be ready and invest later if needed	Do nothing and invest later if needed

Possible outcomes of the analysis

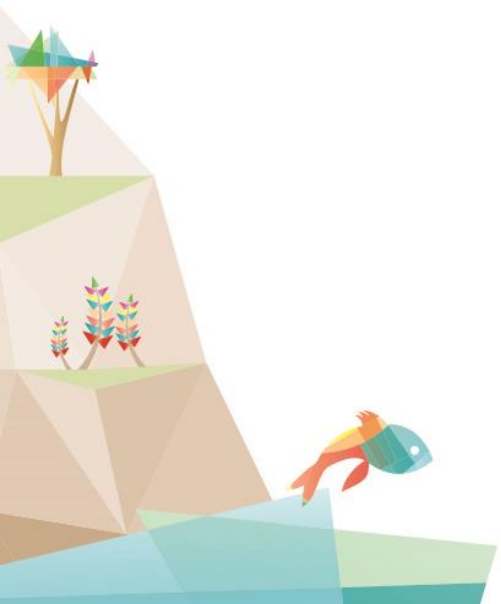
Invest now if:

- **costs of climate-proofing now are relatively small while the expected benefits are estimated to be very large (a low-regret approach), and/or**
- **costs of climate-proofing at a later point are expected to be prohibitive, or climate-proofing at a later point in time is technically not possible; and/or**
- **among climate-proofing options there exist options which deliver net positive economic benefits regardless of the nature and extent of climate change, including the current climate conditions (a no-regret approach); and/or**
- **the set of climate-proofing options includes options which not only reduce project climate risks, but also have other social, environmental or economic benefits (co-benefits). The presence of co-benefits, if any, must be included in the economic analysis of adaptation options.**

Possible outcomes of the analysis

Be ready and invest later if:

- **No climate-proofing investment is needed now, but the project can be designed to accommodate climate-proofing in the future if and when circumstances indicate this to be a better option than not climate-proofing.**
- **This type of decisions aim to ensure that a project is climate ready.**



Possible outcomes of the analysis

Do nothing and invest later if:

- **costs of climate-proofing now are estimated to be large relative to the expected benefits; and/or**
- **costs (in present value terms) of climate-proofing (e.g. retro-fitting) at a later point in time are expected to be no larger than climate-proofing now; and/or**
- **expected benefits of climate-proofing are estimated to be relatively small.**

Note: The decision to "do nothing" does not come from ignoring climate change, but from rationally deciding out of a technical and economic assessment that the best thing to do for now is to do nothing.

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Concluding remarks

There is no need to adapt cost-benefit analysis to climate change. There is a need for a better use of economic analysis.

The greatest difficulty in conducting an economic analysis of a climate-proofing investment is not with the economics.

The greatest difficulty is with the identification of projected changes in climate variables, and then of the physical impacts of these changes on infrastructure. Once these impacts are quantitatively identified, the economic analysis of climate-proofing investment is relatively straightforward.

As is ALWAYS the case, the economic analysis of an investment project is a multi-disciplinary exercise which requires the inputs of multiple experts and which is conducted in a context of uncertainty.

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Session 10:
CBA Step 8: Making Recommendations

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Making recommendations

Supremely Honorable Madam Decision-Maker:

Please find attached the economic analysis of the Jakarta coastal protection project (for example).

Among the various alternatives examined, we have estimated that the mangroves revegetation approach offers the highest net present value and is therefore recommended on the ground of economic efficiency.

However, it is my duty to point out that: (….)

Your Humble Economist Servant

P.S. Please also find attached the invoice for my professional fees.

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