NAP-GSP

NATIONAL ADAPTATION PLAN GLOBAL SUPPORT PROGRAMME

Session 5
Reviewing and appraising adaptation options

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250 MW Bujagari dam construction disputes on economic, financial benefits (1999-2012)

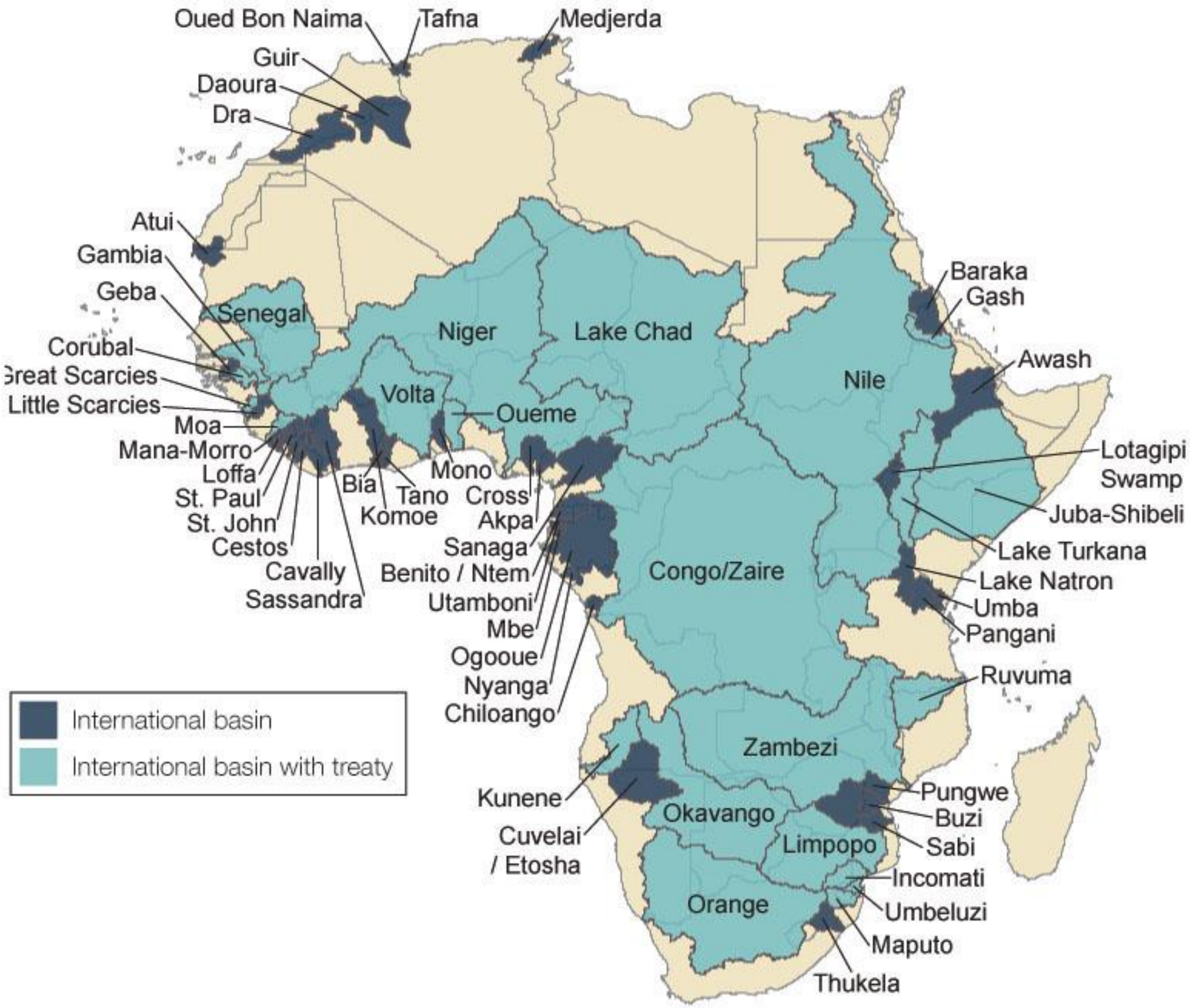
Appraisal informs decision making

Expected outputs from the appraisal of options include:

- Economic analysis report of the adaptation options
- Ranking adaptation options
- Recommendation options:
  - (i) early implementation
  - (ii) marginal/require modification;
  - (iii) not viable

Transcboundary , regional dimension important

- 276 Shared river basins in world
- 64 in Africa such
- Ground water aquifers:
    - North western Sahara aquifer system
- Consider impacts on other sectors: energy, agriculture, tourism
- Regional approach better



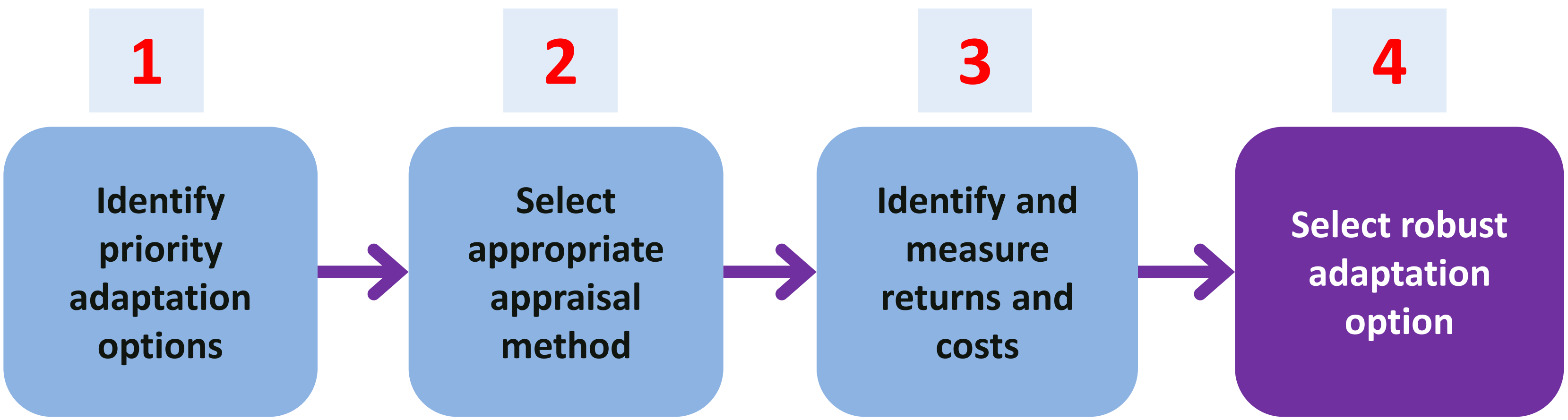
Water adaptation options examples:

- Rainwater harvesting
- Demand management
- Waste water reuse
- Desalination (co-benefits with mitigation)
- Multipurpose dams-energy, agriculture, tourism, water supply)
- Watershed management
- Land management
- Coastal embankments, dykes
- Ecosystems, biodiversity conservation (headwaters)
- etc

Cost of water adaptation options in Mena (World Bank, 2012)

Adaptation measure	Cost USD/m3
Improve agriculture practice	0.02
Expand reservoire small scale reservoir capacity	0.03
Domestic, industrial water resuse	0.03
Irrigation water reuse	0.04
Expand large scale resorvir capacity	0.05
Reduce irrigates areas	0.1
Desalinate with renewable energy	1.3

GENERAL APPRAISAL PROCESS

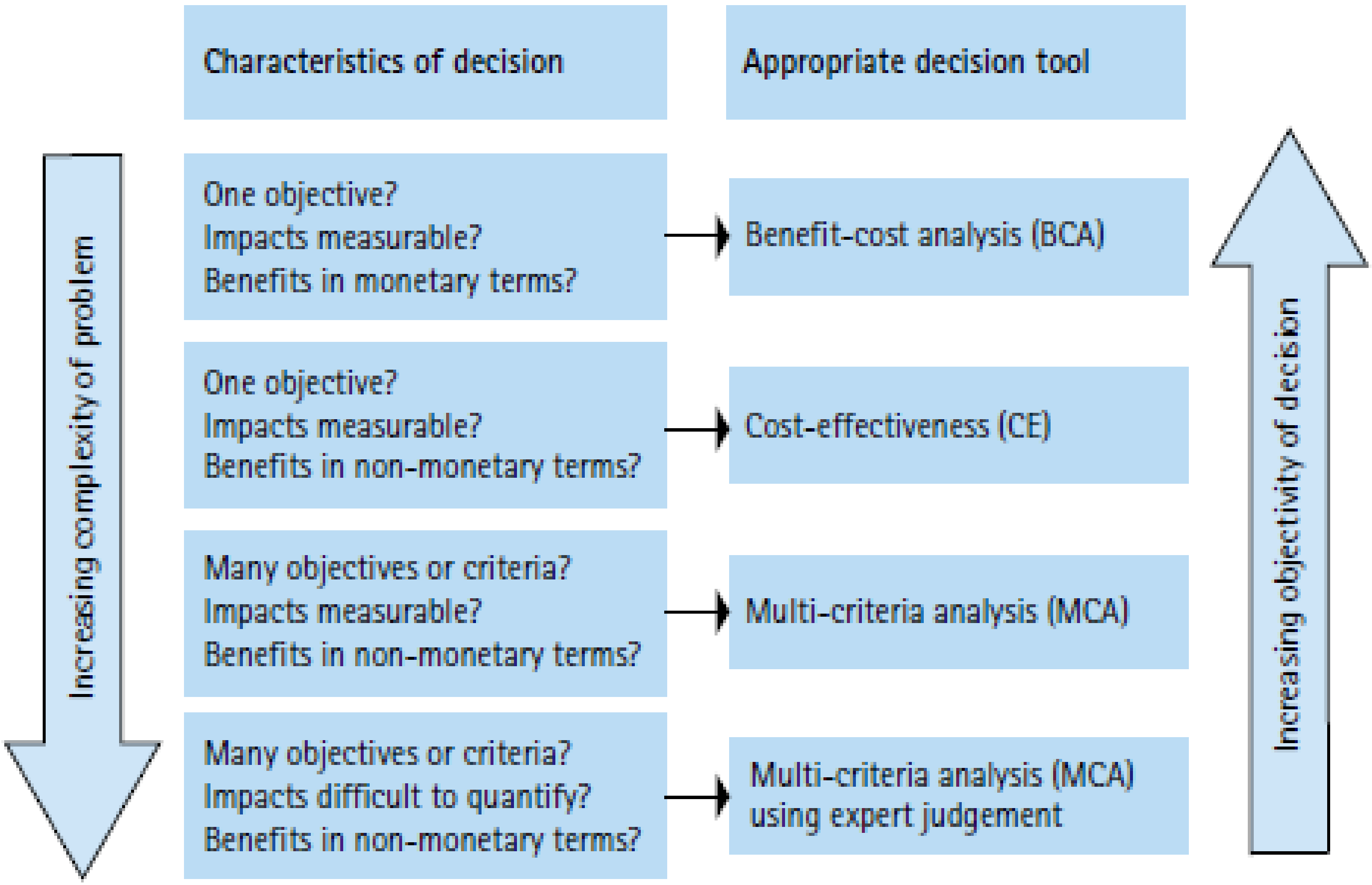


Wide range of methods available

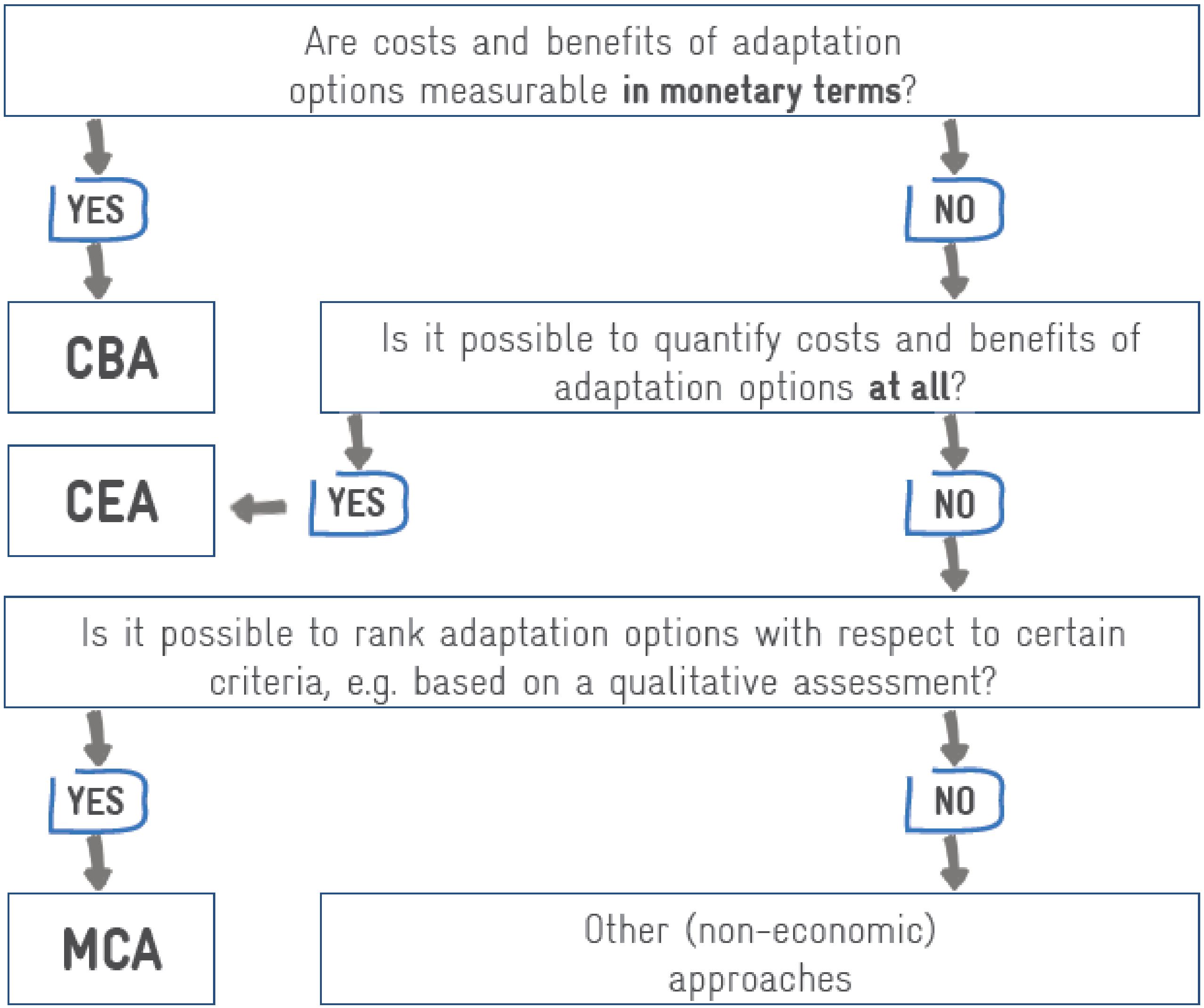
- Standard decision making techniques – limited by uncertainty in future climate and development pathways
  - **Benefit cost analysis**
  - **Cost-effectiveness**
  - **Multi-criteria analysis**
- **Uncertainty should be included using sensitivity analysis**- which assumptions/variables are more sensitive to change

Tools inform the decision process

Methods vary based on objectivity and complexity



Method Selection for dam project



Source: Based on UNFCCC (2002) and Niang-Diop and Bosch (2011).

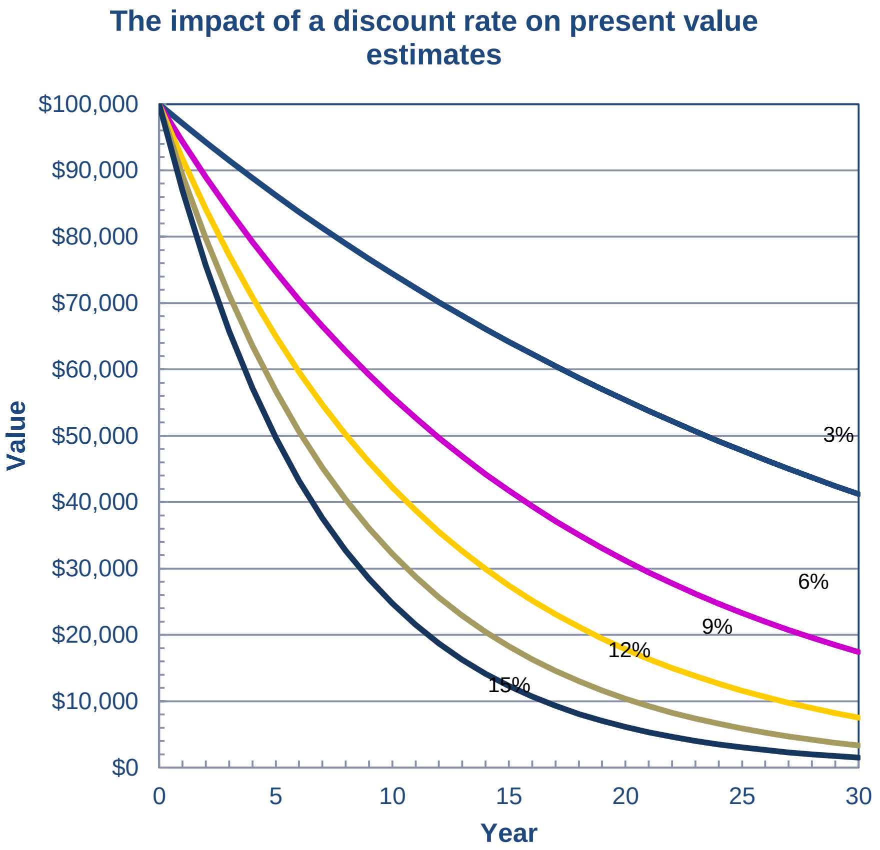
Cost benefit analysis: 8 suggested steps

1. Define the scope of analysis
2. Identify all potential impacts of the project.
3. Quantify the predicted impacts.
4. Monetize impacts
5. Discount rate to find present values of costs and benefits
6. Calculate the net present value (NPV)
7. Perform expected value and/or sensitivity analysis
8. Make recommendations.

Discount rate affects results:

- Use this formula to convert all future values to present values:
  - $PV = FV(t) / (1+r)^t$

  Where
    - FV is expected future value
    - r is the discount rate (value between 0 and 1)
    - t is time.
- Example: How much is $100000 in 30 years worth today? Try it using different values for r!



Source GIZ (2013)

Hydropower Dam project to mitigate climate risks for water availability in a region

- Assume CBA is the method chosen
  - Suppose a low dam costs $1 billion, a high dam costs $1.5 billion and with current climate, a low dam has benefits of $1.2 billion and high dam of $1.6 billion-
    - low dam is better with $200 million net gain
  - With future wetter climate, suppose benefit of low dam rises to $1.3 billion and benefit of high dam rises to $2 billion-
    - high dam now better option with $500 million net gain

Bujagali scenarios
Source: IFC study,2007)

1. Hydrological review of lake Victoria since 1900 to determine future ‘flows’
2. Two distinct flow regimes
   - 1900-1960 (low water flows)
   - 1961- 2000 (high water flows)

Appraisal made for the two scenarios

			Low Hydrology	High Hydrology
Hydro plants	Units	Qmax m^3/s	Mean Energy GWh/yr	Mean Energy GWh/yr
Bujagali	Units 1 to 5	1240	1 165	1 991
Karuma	Units 1 to 4	792	1 324	1 609

(1) energy figures include the impact of scheduled maintenance.
(2) Qmax is the flow required to produce the total rated output of the turbine generators.

Appraising two dam projects showed that Bujagali cost was lower

Bujagali. USD 521

Kuruma: USD 588

Not enough to make decision based on cost alone !

NPV analysis-Bujagari Dam (IFC, 2007)

A full risk analysis was made for the ‘with Bujagali’ and ‘without Bujagali’ cases, with the following probabilities assigned to the key variables:

- Demand forecast: base/high/low - 40%/30%/30%
- Hydrology: high/low - 21%/79%
- Fuel Prices base/low/high – 40%/30%/30%
- Bujagali Cost base/low/high - 60%/20%/20%

Assigning the probability weightings to the costs resulted in a total NPV advantage of US$ 184.0 million (in 2006 US$ with discounting to 2006) in favour of the ‘with Bujagali’ cases.

With or without Dam scenario

- If 100% probability is assigned to either the low or the high hydrology scenarios, the NPVs, representing the differences between the 'with Bujagali' and 'without Bujagali' programmes, are:

- Low hydrology US$ 202 million, and
- High hydrology US$ 116 million

✓ in favour of the 'with Bujagali' cases.

Expected Internal rate of return (EIRR)

High hydrology : EIRR 21.7% , Low Hydrology 22.0%

When the benefits of avoided greenhouses cases are included the EIRRs increase to 22.0% for the high hydrology and 22.9% for the low hydrology.

Sensitivity studies results:

- EIRR is **robust** against all key risk factors, including: hydrology, demand forecast, fuel prices and the capital cost of the project.

Expected Internal rate of return (EIRR)

- The demand scenario has the greatest impact on EIRR.

- Most adverse combination of scenarios using the low demand case the resulting EIRR value of 12.5% greater than the 10% benchmark discount rate for World Bank Group-supported projects

Summary of Key Findings from the Inspection Panel Investigation (IRN, 2008)

Hydrological and Climate Change Risks

- The Panel is very troubled by the Bank's "bold" conclusion that climate change will not have an adverse effect on water releases from the dam.

- The project does not assess Bujagali's potential impact on Lake Victoria

➢ **Hydrological change affects how costs and impacts were analyzed, leading to more positive conclusion to the Economic Study than would have been the case**

President Museveni commisioned Bujagari in Oct. 2012

Cost benefit analysis

- Cost Benefit Analysis (CBA) is the most commonly used economic analysis for decision making due to its ‘simplicity’ in systematically comparing all the costs and benefits that are accrued from a project.

Cost Effectiveness analysis

- Cost Effectiveness Analysis (CEA) is an economic valuation to compare intervention options by comparing the gains to the costs of the intervention.
- It is not meant to be a sole evaluation tool -widely used in assessing intervention in health sector.
- In practice, CEA is often preferred when the benefits of investment project are difficult to measure in monetary terms.

Multicriteria analysis

- Used when there are a number of criteria that need to be taken into account rather than the focus on a single criterion, such as CBA and CEA.

- MCA techniques in general consist of two stages:
  1. Weighting
  2. Scoring

- MCA includes a “Performance Matrix”

No silver bullet, context , trade offs, consultation key

- No one single bullet method for appraisal
- Consider method characteristics, requirement, advantages and contexts.
- Clear analysis scope of returns and costs.
- Stakeholders inputs and participation
- Trade-offs among options and the distribution of benefits and costs among stakeholders
- Consider level of risk or uncertainty, sources of this risk.
- Take into account uncertainty under a wide range of uncertainty scenarios or by incorporating sensitivity analysis.
- Methods can be used in combination not, mutually exclusive

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COST BENEFIT ANALYSIS PROCEDURE (1)

- Cost Benefit Analysis (CBA) is the most commonly used economic analysis for decision making due to its 'simplicity' in systematically comparing all the costs and benefits that are accrued from a project.
- Steps in conducting CBA:
  1. **Specify adaptation investment options to be compared.**
  2. **Define the lenses and scope of impacts.**
     - The lenses are the perspective of the decision makers who value the benefits and costs. The construction of highway with or without tol pricing option, for example, can be a cost or a benefit (revenue) depending on whose lenses.
     - Ideally, the 'lense' to be used is of a "social welfare planner" who aims to maximise the net benefits of the society within the scope of analysis.
     - A clear boundary definition of impact scope will also enhance the effectiveness of CBA by focusing on a system boundary upon which the impacts are estimated.

COST BENEFIT ANALYSIS PROCEDURE (2)

3. **Classify and assess the benefits and the costs.**
   a. Determine measurement variables and quantify the impacts
   b. Determine valuation methods

   This step will draw on identification of returns and selection of valuation methods. It also requires defining a baseline upon which each investment option will be compared to. The baseline scenarion is normally called “Do Nothing” scenario.
4. **Provide qualitative analysis of non-monetised impacts (*optional*).**

   This step is an optional step and normally not conducted in traditional CBA. However it is important for investment in public sector in which some key impacts cannot be monetised.
5. **Choose discount rate and calculate Net Present Value of investment options**

   The stream of future costs and benefits in a project occur in different years. To compare future benefits and costs in one project to those in other projects, these future costs and benefits need to be discounted relative to the present values in order to obtain their *present values.*

COST BENEFIT ANALYSIS PROCEDURE (3)

5. **Choose discount rate and calculate Net Present Value of investment options.**
   - *Discount rate*: the interest rate that is used to discount future costs and benefits of a project.
   - *Net Present Value (NPV)*: the difference between the present values of future benefits and costs.

     NPV = Present Values of Future Benefits - Present Values of Future Costs
   - The choice of *discount rate* is the most contentious aspect of using CBA.
   - In practice, the discount rates might refer to those interest rates suggested by the relevant financial institution, e.g. 10-12% for World Bank and AfDB;
   - For nationally funded projects, the discount rates might be different to those funded by multilateral development banks.

COST BENEFIT ANALYSIS PROCEDURE (4)

6. **Perform sensitivity analysis.**
   - In conducting CBA, there is always some degree of uncertainty regarding the magnitude of impacts or the value assigned to each impact.
   - Sensitivity analysis is conducted to acknowledge this uncertainty and to inform decision makers of how and in what direction this uncertainty might affect the results on which alternative.
   - Sensitivity analysis can be done using three approaches and the three of them can be conducted in each CBA
     - Partial sensitivity analysis: it is conducted by varying one assumption at a time while holding the other assumptions constant.
     - Worst and best scenario assumption:

       As these two scenarios are probably the ones decision makers are most concerned about, sensitivity analysis of the two scenarios provide extreme values that decision makers can prepare themselves for before making the decision.

COST BENEFIT ANALYSIS PROCEDURE (5)

6. **Perform sensitivity analysis.**
   - Monte Carlo simulation: uses random probability distribution of key numerical values to see if it affect the results.
   - Calculate switching values of key parameters which values are not known with certainty. Switching values are the values of parameters that significantly change the results of CBA and the decision on which alternative yields highest net benefits.
7. **Analyse the results and provide recommendation.**

DECISION RULE

1. A project (adaptation option) is feasible if NPV > 0
2. Choose project (adaptation option) with the greatest net benefit or Net Present Value (NPV)

Notes:

- Another decision rule that is commonly used is Benefit Cost Ratio (BCR)
- BCR of a project should be greater than 1
- NPV criterion should take priority than BCR criterion as:
  - NPV focuses on the amount of net benefits rather than merely the ratio. This is in line with the objective of maximising net social benefit from the investments.
  - BCR is highly sensitive to how impacts are categorised as benefits or costs, while NPV does not face this problem.

DECISION RULE - EXAMPLE

Choosing among projects: NPV vs BCR

Project	Costs ($ million)	Benefits ($ million)	NPV ($ million)	BCR ($ million)
Do Nothing	0	0	0	-
Project A	1	10	9	10
Project B	10	30	20	3
Project C	4	8	4	2
Project D	3	5	2	1.7
Project C & D	7	21	14	3
Project E	10	8	-2	0.8

Source: Boardman et al (2000) Cost Benefit Analysis: Concepts and Practice

TREATMENT OF UNCERTAINTY IN CBA

- **Apart from using sensitivity analysis, the treatment to uncertainty in CBA can also be done by assessing how well each investment option work under a wide range of climate scenarios.**
- **Example: Tank Management in Kala Aya River Basin, Sri Lanka.**
  - **Four investment options (“scenario” in this case) were identified.**
  - **The results are as below.**

Cost-Benefit Assessment of Alternative Tank Management Scenarios					
Scenario	Net Present Value in US$‘000			Indirect use trends (Index)	Natural Capital in 30 years
	Cost	Incremental tank benefits	Quantiflable net benefit		
S1: Do nothing	0	0	0	-7	⬇⬇
S2: Raise spill	0.4	24.2	23.8	-4	⬇
S3: Raise spill and rehabilitate	35.8	64.6	28.8	6	⬆
S4: Remove silt and rehabilitate tank reservation	62.8	120.7	57.9	7	⬆⬆

Reference: Russi *et al.*, 2010 (Reference #5)

COST EFFECTIVENESS ANALYSIS (1)

- Cost Effectiveness Analysis (CEA) is an economic valuation to compare intervention options by comparing the gains of objective (in appropriate unit) to the costs of the intervention.
- It is not meant to be a sole evaluation tool and it is widely used in assessing intervention in health sector.
- In practice, CEA is often preferred when the benefits of investment project are difficult to measure in monetary terms.
- McKinsey developed Economics of Climate Adaptation that use CEA method to produce adaptation cost curve (ACC) for each unit of benefit. The ACC is considered a novel approach in which a single criterion of non-monetary benefit can be used to a wide range of different adaptation investments. Nevertheless, this approach also contains flaws as the single criterion might overlook a number of important impacts.

COST EFFECTIVENESS ANALYSIS (4)

- **Example: Valuation of climate change impacts on human health**

  Annual Cost per Case of Diarrhea Avoided with Water and Sanitation Programs 2000-2015 (US$, 2000)

Annual Cost per Case Avoided by Intervention Scenario (US$, 2000)				
Halving proportion people without access to improved water	Halving proportion of people without access to improved water and sanitation	Access for all to improved water and sanitation	Access for all to improved water and sanitation, with water disinfected	Access for all to regulated piped water and sewage connection at home
11.52	20.71	25.04	8.61	36.72

Source: based on cost estimates from Hutton and Haller [27].

Source: Markandya 2009 (Reference#6)

MULTICRITERIA ANALYSIS

- Multi-criteria analysis (MCA) is useful when there are a number of criteria that need to be taken into account rather than the focus on a single criterion, such as CBA and CEA.
- MCA can provide simple yet rich insight on key criteria and it can be graphically represented by mapping the distribution of the values of its criteria.
- This simple graphic representation illustrate the trade-offs between different criteria
- MCA techniques in general consist of two stages:
  1. Weighting
  2. Scoring
- A standard analysis of MCA includes a “Performance Matrix” or evaluation matric

CAVEATS

- This lecture is only an introductory material for participants to be aware of various investment appraisal methods. Further study on relevant references and/or training specific to each investment appraisal method is required before participants can conduct the method independently and sufficiently in order to meet their needs in investment appraisal.
- There is no one single bullet method for investment appraisal that works well regardless of the circumstances. It is important to be aware of the characteristics, requirement, advantages and shortcoming of each method in relevance to the contexts being evaluated.
- Clear definition of the scope of analysis is crucial for the identification and measurement of investment returns and costs.
- Stakeholders inputs and participation in the appraisal process is also important to define the goal of the appraisal and the criteria upon which investment options are evaluated.
- Trade-offs among investment options and the distribution of benefits and costs among stakeholders also need to be taken into account in the decision making.

WEB REFERENCES 1

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