Introduction to the CBA

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Definitions and Rationale

Introducing Cost Benefit Analysis (CBA)

- CBA is a **“pre-investment tool”** that can facilitate **investment decisions** (IFAD, 2015).
- Since costs and benefits of investments often do not occur at the same time, with costs usually preceding benefits, the comparison is not straightforward.
- The CBA can **provide solid indicators** to support decision-making as well as suggest the best alternatives for different stakeholders, allowing to compare projects with one another using the same underlying framework of analysis.

Introducing Cost Benefit Analysis (CBA)

Project economic analysis is an analytical framework **for converting the costs and benefits of a project to comparable monetary units**, so they can be compared systematically and incorporated in a measure of project worth

Today, the primary focus of economic analysis of projects resides in the infrastructure field. However, **CBA retains its relevance for decision-making based on the efficient allocation of resources.**

The purpose of a CBA

The starting point for project economic analysis (or cost–benefit analysis [CBA]) is that a **financial perspective alone will not capture the gains to society at large and that a quantitative assessment of economic costs and benefits is necessary**

Financial measures can be highly misleading as indicators of the social welfare improvements of a project.

- key outputs from many projects are either not sold on a market (for example, non-toll roads, solid waste management, reduction in air and water pollution, health improvements from water supply and sanitation) or are sold in distorted or controlled markets (for example, water and electricity sales subject to administrative pricing).

Because of the divergence between private and social costs and benefits, governments intervene in the economy and **CBA provides a key tool for assessing whether such intervention will improve social welfare.**

It aims to ensure that projects contribute to net social welfare and that if there are any 'losers' from a project, aggregate benefits (as reflected in a positive net present value) are large enough for gainers to potentially compensate any losers.

However, donor agencies and governments sometimes go beyond this requirement. In particular the environmental and social safeguard policies of donors have made it a requirement to compensate for certain types of easily identifiable losers of projects

- In order **to capture the full range** of outcomes generated by a certain investment, **we have to expand the boundaries of traditional CBAs,** going beyond direct costs and benefits.
- Some assessments (such as NBI) requires the assessment of an economic valuation of indirect and induced project outcomes, often labeled as “externalities”.
  - Externalities are typically estimated at the biophysical level (e.g. jobs generated, tons of air pollutants emitted, liters of water retained, hectares of forest burnt, etc.) and subsequently monetized using market- and non-market valuation methods.
- The **CBA in this case, therefore, includes project investments and operation and maintenance cost, resulting in avoided costs from the implementation of the project** (e.g. increased carbon sequestration) **as well as added benefits** (e.g. additional indirect revenue generation)**.**

Indicators of relevance

- **Investments:** the costs including but not limited to, capital costs, operating costs, development costs and other costs related to the project
- **Avoided costs:** direct avoided costs and monetized externalities that may or may not be tangible (e.g. Carbon Sequestration)
- **Added benefits:** includes both economic revenues of the project (e.g. additional crop production), as well as the tangible and intangible monetized externalities (e.g. additional income creation)

Example 1 Sustainable Buildings

Investments (?): the costs including but not limited to, capital costs, operating costs, development costs and other costs related to the project

Avoided costs (?): direct avoided costs and monetized externalities that may or may not be tangible (e.g. less operation cost)

Added benefits (?): includes both economic revenues of the project (e.g. additional asset value), as well as the tangible and intangible monetized externalities (e.g. improving air and water quality)

Example 2 Agriculture (Half-moons)

Investments (?): the costs including but not limited to, capital costs, operating costs, development costs and other costs related to the project

Avoided costs (?): direct avoided costs and monetized externalities that may or may not be tangible (e.g. Carbon Sequestration)

Added benefits (?): includes both economic revenues of the project (e.g. additional crop production), as well as the tangible and intangible monetized externalities (e.g. additional income creation)

Example 3 - Climate-resilient roads

Investments (?): the costs including but not limited to, capital costs, operating costs, development costs, and other costs related to the project

Avoided costs (?): direct avoided costs and monetized externalities that may or may not be tangible (e.g. asset damages due to flooding)

Added benefits (?): includes both economic revenues of the project (e.g. additional income), as well as the tangible and intangible monetized externalities (e.g. improved market access)

Example 4 - Water filtration and purification

Investments (?): the costs including but not limited to, capital costs, operating costs, development costs, and other costs related to the project

Avoided costs (?): direct avoided costs and monetized externalities that may or may not be tangible (e.g. Carbon Sequestration, reduce waterborne diseases and mortality rates)

Added benefits (?): includes both economic revenues of the project (e.g. additional crop productivity), as well as the tangible and intangible monetized externalities (e.g. additional income creation)

Limits of CBA

- **Data intensive and incorrect data** can skew results.
- C**hallenges in predicting all the factors** that may impact the outcome of a business decision.
- CBA **removes the human element from decision making**
- **Difficulty in assigning a monetary value to intangible items** such as the benefits and costs associated with living in a certain town.
- **More complex cost-benefit analysis** may incorporate sensitivity analysis, discounting of cash flows, and what-if scenario analysis for multiple options which can be difficult to perform.

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Applications

Example of a CBA

5%	Discount rate								
		Half-moon 15 years							
		Value							
Half-moons			1	2	3	4	5	6	7	8
		1/1/2021	1/1/2022	1/1/2023	1/1/2024	1/1/2025	1/1/2026	1/1/2027	1/1/2028	1/1/2029
Investment		175.00								
Capital cost	Construction cost									
O&M Costs	Professional/ Contractual services		30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
	Total	**175.00**	**30.00**	**30.00**	**30.00**	**30.00**	**30.00**	**30.00**	**30.00**	**30.00**
Avoided Costs										
Carbon sequestration			0.20	0.21	0.21	0.22	0.22	0.23	0.23	0.24
	Total	**-**	**0.20**	**0.21**	**0.21**	**0.22**	**0.22**	**0.23**	**0.23**	**0.24**
Added benefits										
Increased land productivity	Revenues		288.82	288.85	298.22	314.66	295.18	296.05	315.77	314.55
	Total	**-**	**289**	**289**	**298**	**315**	**295**	**296**	**316**	**315**
	Net Benefit (including externalities)	(175.00)	259.02	259.05	268.43	284.88	265.40	266.27	286.00	284.79
	Net Benefit (excluding externalities)	(175.00)	258.82	258.85	268.22	284.66	265.18	266.05	285.77	284.55
IRR	14.9%									
BCR	6.71									
NPV	2.776.94									
Payback Period	1	0%	141%	246%	331%	404%	457%	502%	545%	581%
First value above 100%	141%	0	1	0	0	0	0	0	0	0

Performance Indicators

- The IRR is defined as the discount rate (r) that produces a zero NPV. It represents the maximum interest rate that a project could face and still be profitable. **The project is considered viable when IRR is > r.**
- The benefit-to-cost ratio (BCR) represents the ratio of the present value of benefits to the present value of costs over the period considered. If **BCR ≥ to 1 then the project is viable.**
- The NPV can be defined as the sum of expected costs of the investment deducted from the discounted value of the expected revenues (or benefits). **When NPV is > 0 the project is considered viable.**

Performance indicators

Sustainable NPV (S-NPV), Sustainable IRR (S-IRR), & Sustainable BCR (S-BCR): In this case traditional financial indicators of IRR, NPV are modified by integrating environmental, social and economic costs and benefits in the calculations.

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Benefits of integrated valuations

Improved Predictability

- Efficiency and costs of infrastructure services
- Performance under different scenarios and risks
- Co-benefits and externalities
- Demonstrating revenue streams

Improved Comparability

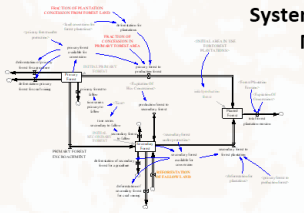
- Nature-based infrastructure (NBI) and grey infrastructure comparison
- Comparisons across locations

Methods and models for the estimation of CBA inputs

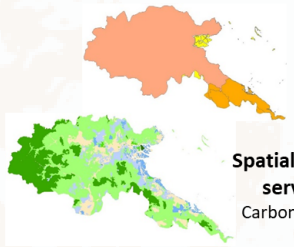
- Example 1: wetland restoration
- Example 2: climate-smart agriculture

Example 1: Wetland restoration

Project Finance Model



System Dynamics Model



Spatially explicit ecosystem services (e.g. InVEST)
Carbon, habitat, water yield, ...

NBI analysis 2020-2060	Unit	Scenario		
		A	B	C
Capital Investment	mn USD	223.2	162.5	502.0
O&M costs	mn USD	530.6	437.2	249.3
Cost of financing	mn USD	51.3	32.5	125.5
(1) Total cost	**mn USD**	**805.2**	**632.2**	**876.9**
Avoided costs				
Cost of breaching	mn USD	0.5	0.5	0.5
Flood damages	mn USD	-27.5	48.9	250.1
Social cost of carbon	mn USD	7.3	107.3	88.6
Cost of N disposed into estuary	mn USD	235.7	437.2	49.5
Cost of P disposed into estuary	mn USD	340.5	352.4	400.8
Cost of N disposed into sea	mn USD	14.7	26.6	3.7
Cost of P disposed into sea	mn USD	21.5	22.2	25.2
(2) Total avoided costs	**mn USD**	**592.6**	**995.2**	**818.5**
Added benefits				
Labor income agriculture	mn USD	140.6	140.6	140.6
Value added agriculture	mn USD	313.1	313.1	313.1
Labor income tourism	mn USD	37.5	66.8	133.4
Value added tourism	mn USD	15.0	44.0	72.2
Carbon sequestration	mn USD	0.0	0.0	4.8
Revenues from fisheries	mn USD	-33.4	128.4	155.6
Water retention	mn USD	12.0	17.4	33.5
Habitat quality	mn USD	-28.9	48.1	33.7
(3) Total added benefits	**mn USD**	**455.9**	**758.4**	**887.0**
(4) Net integrated benefits (2)+(3)-(1)	**mn USD**	**243.4**	**1,121.4**	**828.6**
Avoided costs and added benefits per USD invested	***Ratio***	***1.3***	***2.8***	***1.9***
Net integrated benefit per USD invested	***Ratio***	***0.3***	***1.8***	***0.9***

Example 1: Wetland restoration

- **The net integrated benefit of the CBA indicates whether an intervention generates a net positive or net negative impact at system level,** given the cost items and monetized externalities considered.
- Each number in the CBA corresponds to a biophysical change in the system.
  - For example, a **negative avoided cost for flood damages**

indicates that flood damages increase, leading to an additional cost at system level.

- The net benefit per USD invested indicates how much value is created for each dollar invested to implement the policy.
  - The ratio net benefit per USD invested can be used to compare the overall systemic impact across interventions

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Example 2: adaptation in the agriculture sector

Intervention	N°	Total Investment	Revenue generated	Value of externalities	NPV	S_NPV	BCR	S-BCR	IRR	S-IRR	Payback period (years)	S-Payback period- (years)
Promotion of Agroforestry (Cashew)	1a	$11,665	$3,492	$267	$(9,072)	$(8,907)	0.18	0.19	-10%	-10%	N/A	N/A
Promotion of Agroforestry (Maize)	1b	$6,665	$11,536	$267	$135	$301	1.02	1.05	5%	5%	15.00	15.00
Solar irrigation (Horticulture, animal watering)	2	$11,313	$70,517	$16,268	$39,749	$51,004	5.73	7.07	195%	252%	1.00	1.00
Sustainable cereal production (millet, sorghum, cowpea, groundnut) through the half-moon, Zaï or Tassa)	3	$625	$4,828	$4	$2,809	$2,812	6.78	6.78	151%	151%	1.00	1.00
Arboriculture and sustainable market gardening through drip irrigation	4	$21,492	$62,929	$31	$27,406	$27,427	2.68	2.68	67%	68%	2.00	2.00
Promotion of adapted poultry breed	5	$6.98	$7.89	N/A	$0.63	N/A	1.09	N/A	18%	N/A	1.00	N/A

Example 2: adaptation in the agriculture sector

Suitable crops and cultivar	6	$598	$11,092	$12	$6,758	$6,767	13.35	13.37	117%	118%	1.00	1.00
Wetland restoration	7	$68,820	$178,890	$264,637	$42,621	$207,472	1.62	4.01	12%	32%	8.00	4.00
Development of urban and peri-urban forestry	8	$8.43	$7.69	$4.84	$(6.48)	$2.54	0.91	1.48	N/A	435%	N/A	1.00
Construction of ditches to improve drainage	9	$12,600	$90,000	$119,340	$47,538	$121,503	6.57	15.25	220%	533%	1.00	1.00
Land restoration through dune fixation techniques	10	$290	$364	$45	$(38)	$(7)	0.87	0.98	3%	5%	12.00	11.00
Development of forage crops: Alfalfa	11	$625	$865	$4	$94	$96	1.19	1.20	11%	11%	9.00	9.00

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Summary

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