Ecosystem-based Adaptation: Economic Analysis

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Inter-regional Workshop on Mainstreaming Ecosystem-based Approach to Adaptation and Accessing Adaptation Finance

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Decision Context for Economic Analysis of EBA

Four common decision contexts where BCA is useful:

1. To evaluate a stand-alone EBA intervention against a "no project" baseline
2. To evaluate EBA intervention(s) against alternative approaches ("no project" baseline)
3. To evaluate EBA as a component (climate-proofing measure) of a proposed investment project (baseline: project without EBA intervention)
4. To evaluate EBA as one of alternative approaches to climate-proofing an investment project (baseline: project without EBA intervention)

Economic Analysis of Adaptation Projects (I)

The basic steps in an economic analysis of a project:

Step 1: Define the scope of the analysis – whose costs and benefits should be accounted for in the analysis

Step 2: Identify all potential impacts of the project within the defined scope

Step 3: Quantify the projected impacts of the project

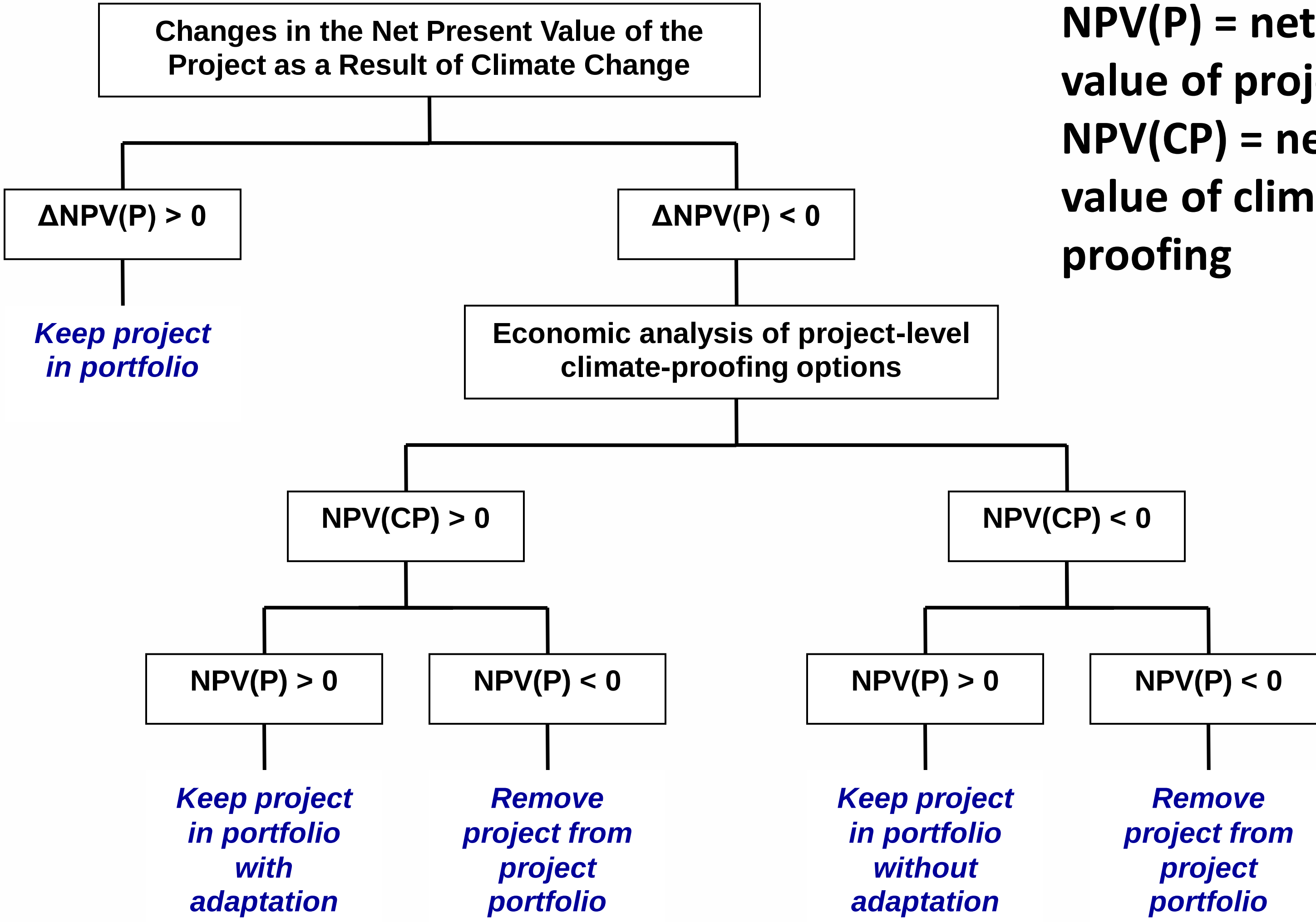
Step 4: Monetize the negative and positive impacts of the project (transform impacts into costs and benefits)

Step 5: Calculate the net present value of the project

Step 6: Perform sensitivity analysis

Step 7: Make recommendation

Economic Analysis of Adaptation Projects (II)



NPV(P) = net present value of project
NPV(CP) = net present value of climate proofing

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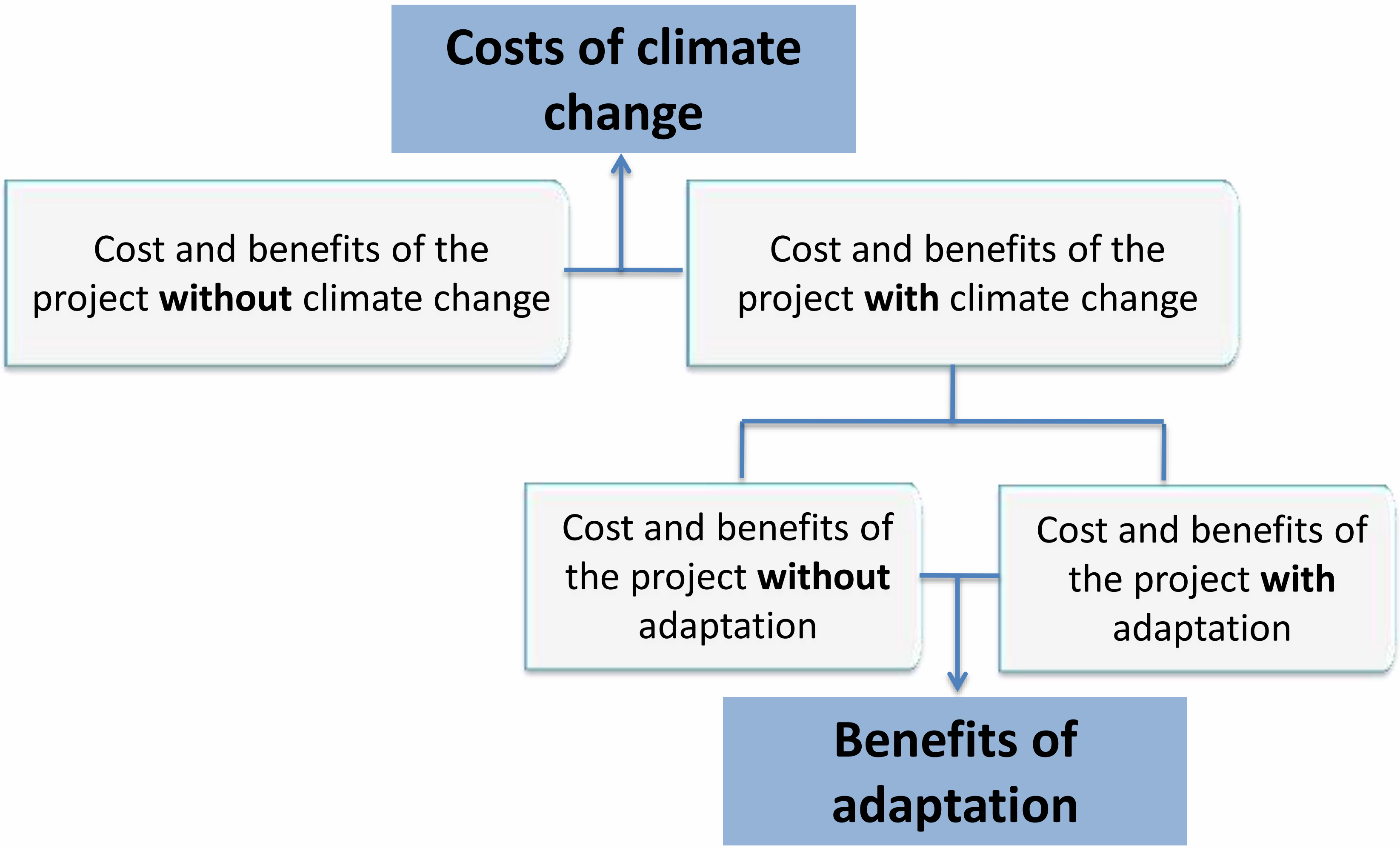
Projects adversely impacted by climate change do not necessarily need to be climate-proofed; and not all projects that can be climate-proofed should be conducted!

Costs of Climate Change vs Benefits from Adaptation



Benefit-Cost Analysis Basics

Least-cost approach: useful when data are limited

$$C = \sum_{t=0}^{T} c_t (1 + r)^{-t}$$

C = total project costs
c_t = costs in year t
t = time (year)
T = project lifespan
r = discount rate

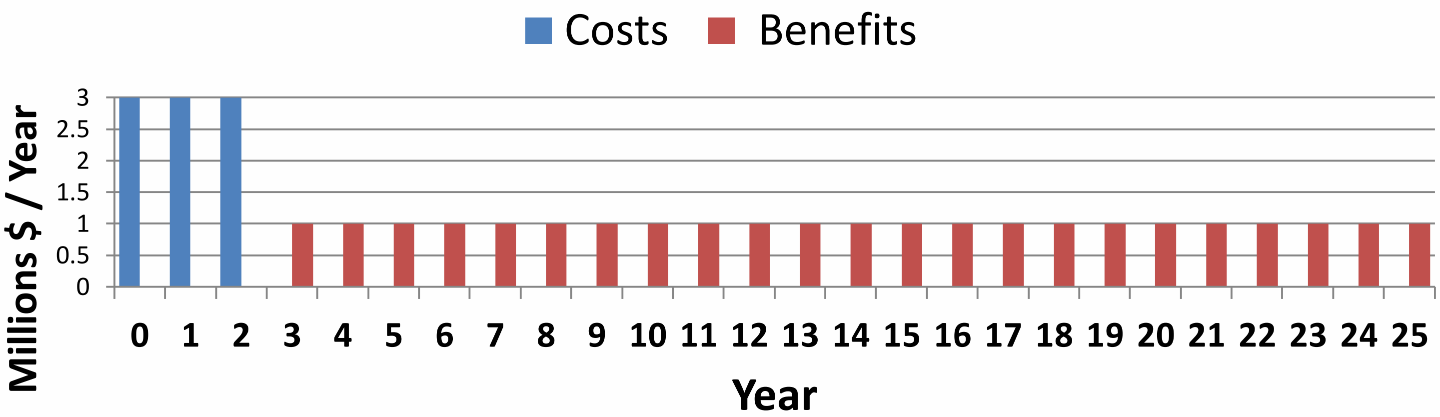
Net Present Value approach: recommended

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

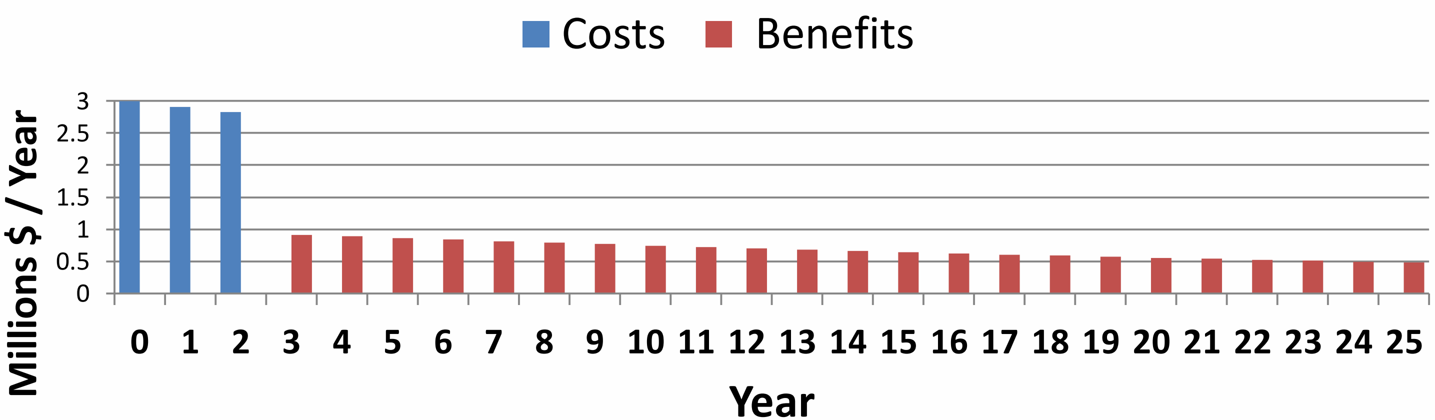
NPV = net present value
B_t = benefits in year t
C_t = costs in year t
t = time (year)
T = project lifespan
r = discount rate

Impact of Discounting

Assume: costs of $3.0 million/year for three years; benefits of $1.0 million/year for duration of 25-year project

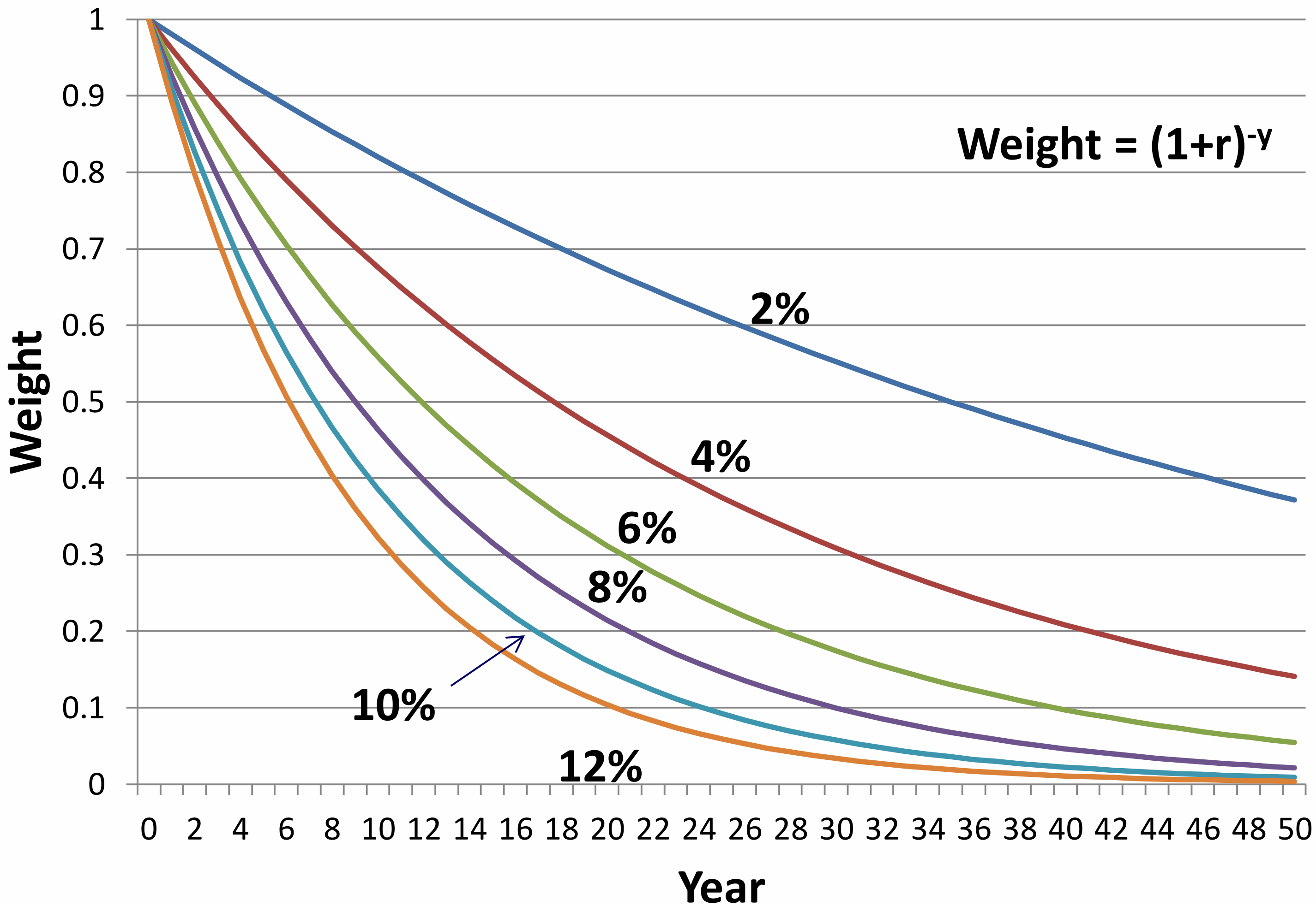


Without discounting:
Costs = $9.0 m
Benefits = $23.0 m
NPV = $14.0 m



With discounting (3%):
Costs = $8.7 m
Benefits = $15.5 m
NPV = $6.8 m

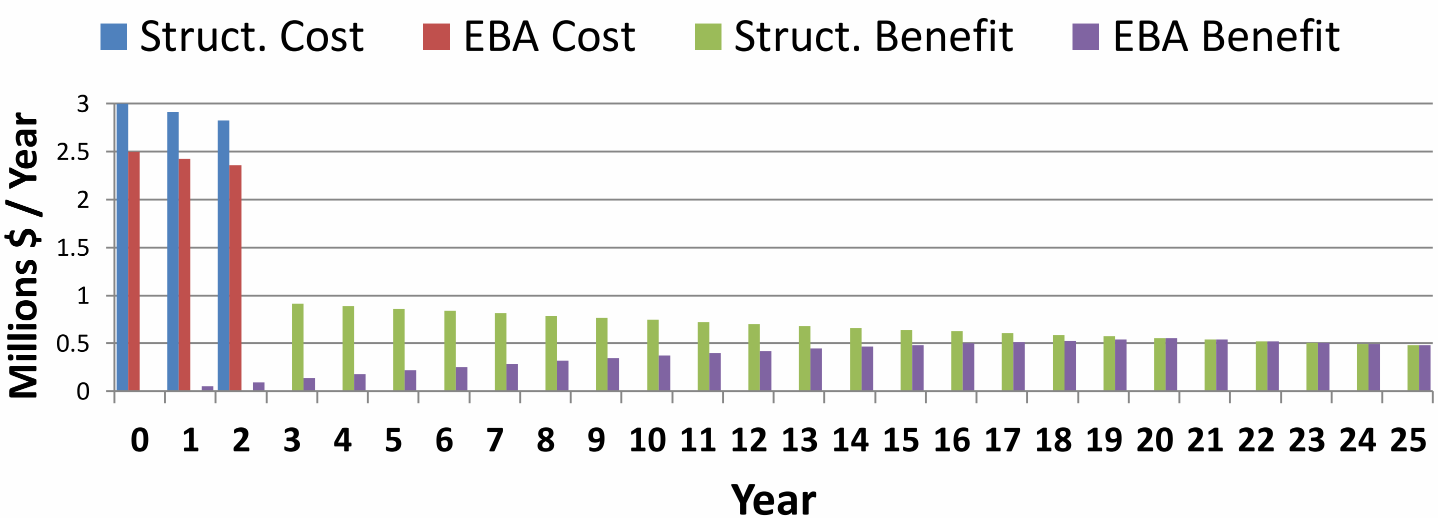
Impact of the Discount Rate



EBA vs Structural Approaches

Assume:

- **Costs and benefits of structural approach as before**
- **EBA costs of $2.5 million/year for three years**
- **EBA benefits of $1.0 million/year for duration of 25-year project but EBA requires 20 years to mature**
- **Discount rate of 3% applies to all**



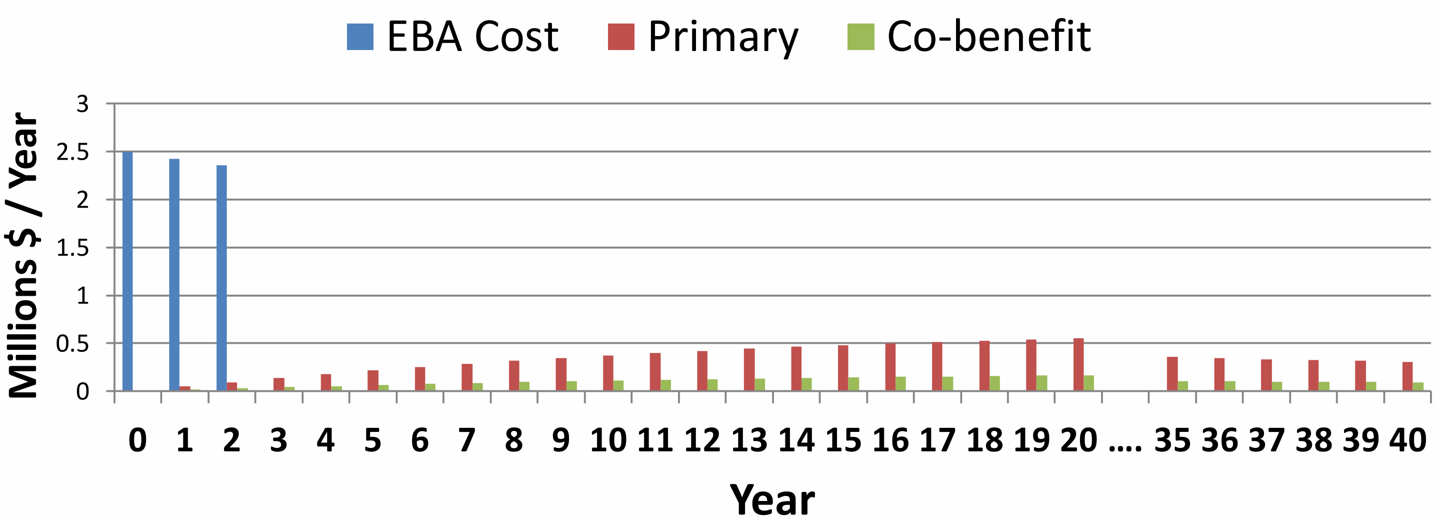
Structural:
Costs = $8.7 m
Benefits = $15.5 m
NPV = $6.8 m

EBA:
Costs = $7.3 m
Benefits = $9.6 m
NPV = $2.3 m

Ancillary and Other Benefits of EBA

Assume:

- **EBA costs and primary (adaptation) benefits as before**
- **EBA intervention delivers benefits for 40 years (20 to mature)**
- **EBA co-benefits of $300,000 per year for 40 years (20 to mature)**
- **Discount rate of 3% applies to all**
- **All examples ignore recurring costs, which will not be 0!**



EBA:

Costs = $7.3 m

Benefits = $15.3 m

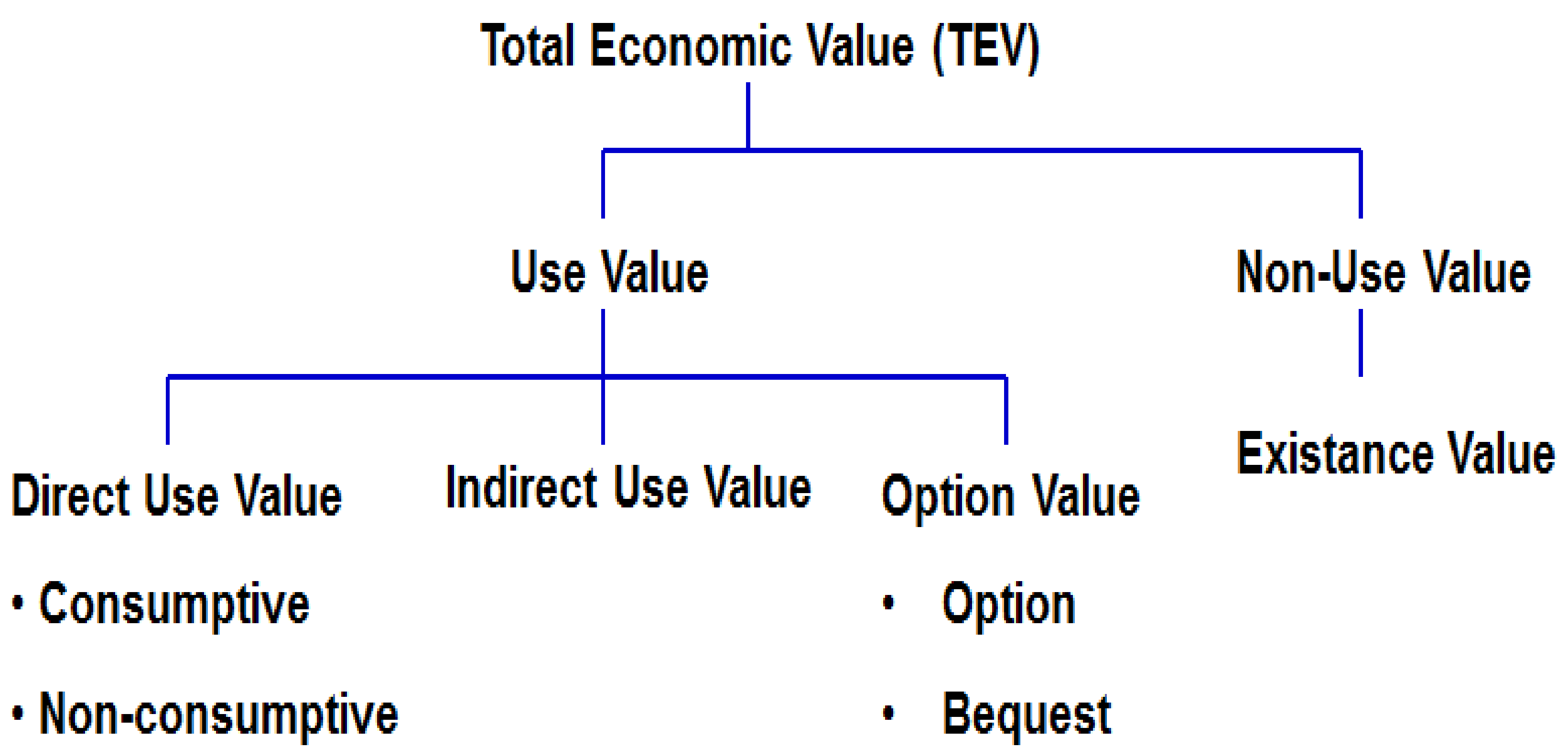
NPV = $8.0 m

Co-benefit = $4.6 m

NPV(2) = $12.6 m

Valuation of Non-Market EBA Benefits

Many of the ancillary benefits of EBA - wildlife habitat and protection of species diversity; improved stewardship of land and water resources; restoration of degraded ecosystems; various ecosystems services – may be difficult to value since they are non-market goods, yet they have economic value:



Methodology	Approach	Application	Data required	Limitations
Change in Productivity	Impact of change on produced goods	Any impact influencing goods production	Change in service; impact on production, value	Data scarce
Cost of Illness (human capital)	Impact on health indicators	Any impact influencing health	Change in service; impact on health, value	Dose-response functions often lacking
Replacement Cost	Market costs of replacing lost goods, services	Any loss of goods or services	Extent of loss; costs of replacing them	Tends to over-estimate costs
Travel Cost	Derived demand curve	Recreation	Survey to record travel costs, locations	Limited to recreational benefits
Hedonic Pricing	Discrete contributions of environmental factors	Air quality, aesthetics, cultural benefits	Prices, characteristics of composite goods	Requires huge, high quality data sets
Contingent Valuation	Ask WTP for specific services	Any service	Survey presenting scenario, recording stated WTP	Many sources of bias in responses; hypothetical;
Choice Modeling	Ask preferences among options	Any service	Survey	As above
Benefits Transfer	Transfer from one context to another	Wherever suitable analogues exist	Valuation exercise at a similar site	Misleading if analogue not appropriate

Source: World Bank/IUCN 2004


A comparative analysis of ecosystem-based
adaptations and engineering options for Lami
Town, Fiji (UNEP, SPREP and partners)

Context of Vulnerability, Lami Town

Vulnerability to Flooding:

- coastal flooding from storm surges or large waves from Suva Harbour
- flash flooding from rapidly rising rivers where hillslopes have been cleared of vegetation
- surface flooding where high rainfall pools in low lying areas

Vulnerability to Erosion:

- Shoreline erosion during storms from surge, waves, or longshore drift of sediment
- Riverbank erosion risk where rivers flow rapidly through the hills and where the river has been constrained by engineering
- Upslope or inland erosion occurring on hill-slopes, especially after forest clearing.

Source: Lami Town Synthesis Report

Adaptation Options to Reduce Coastal Vulnerability

Ecosystem-based options:

- Re-plant mangroves
- Re-plant stream buffers
- Reduce upland logging
- Reduce coral extraction

Policy and social options:

- Regulating land tenure & informal settlements
- Re-zoning land use
- Re-location of highly vulnerable households
- Flood warning system and mapping

Source: Lami Town Synthesis Report

Engineering Options to Reduce Coastal Vulnerability

Reinforce Rivers:

- Protect river banks
- Dredge rivers
- River re-alignment

Build sea walls

Increase drainage

Improve bridges

Land reclamation

Storm surge barriers

Beach replenishment

Sea dikes

Elevation of infrastructure

Developing Unit Costs for Alternatives

Adaptation options	Unit cost	Cost in FJD 10y	Cost in FJD 20y
Replant mangroves	m^2	$2.76	$4.67
Replant stream buffer	m^2	$2.88	$4.87
Increase drainage	m	$16.29	$20.00
Build sea walls	m	$1,670.00	$2,050.00
Reinforce rivers			
Protect river banks	m	$1,144.00	$1,404.00
Dredge rivers	m^3	$18.52	$22.72
River realignment	m	$923.00	$1,133.00

Source: Lami Town Synthesis Report

Cost Effectiveness Analysis of Alternatives

Sensitivity analysis of effectiveness of interventions

Cost of damage avoided per dollar spent (FJD)

Adaptation options	Assumed % damage avoided: 50%	25%	10%
Replant mangroves	$77	$38	$15
Replant stream buffer	$146	$73	$29
Monitoring & enforcement	$1,498	$749	$300
Reduce upland logging	$2,035	$1,018	$407
Reduce coral extraction	$2,988	$1,494	$598
Build sea walls	$15	$8	$3
Reinforce rivers	$96	$48	$19
Increase drainage	$140	$70	$28

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Source: Lami Town Synthesis Report

Estimates of Ecosystems Services Values

Ecosystem	Type of value	Value (FJD)	Unit/year		Benefits (FJD year⁻¹)
			Hectare	Household	
Mangroves	Direct	$41	-	200	$8,200
	Indirect	$471	320	-	$150,720
			Ecosystem benefits of mangroves		**$158,920**
Coral reefs	Direct	$521	-	10	$5,210
	Indirect	$471	1,387	-	$653,277
			Ecosystem benefits of coral reefs		**$658,487**
Mudflats/seagrasses	Direct	$123	-	200	$24,600
	Indirect	$139	330	-	$45,870
			Ecosystem benefits of mudflats/seagrasses		**$70,470**
Upland forests	Indirect	$7	1,151	-	$8,057
			Ecosystem benefits of upland forests		**$8,057**
Streams	Direct	$60	32.5		$1,950
			Ecosystem benefits of streams		**$1,950**
			Total ecosystem benefits for Lami Town		**$897,884**

Source: Lami Town Synthesis Report

Development of Adaptation Scenarios

	Percentage implementation of adaptation options			
	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Adaptation options	Ecosytem-based options	Emphasis on ecosystem-based options	Emphasis on engineering options	Engineering options
Replant mangroves	100%	75%	25%	0%
Replant stream buffer	100%	75%	25%	0%
Monitoring & enforcement	100%	40%	20%	0%
Reduce upland logging	100%	50%	20%	0%
Reduce coral extraction	100%	50%	20%	0%
Build sea walls	0%	25%	75%	100%
Reinforce rivers	0%	25%	75%	100%
Increase drainage	0%	25%	75%	100%

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Source: Lami Town Synthesis Report

Benefit-Cost Analysis of Adaptation Scenarios

Scenario	Benefit-to-cost ratio (FJD)	Assumed damage avoidance
Ecosystem-based options	$19.50	10–25%
Emphasis on ecosystem-based options	$15.00	25%
Emphasis on engineering options	$8.00	25%
Engineering options	$9.00	25–50%

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Source: Lami Town Synthesis Report