Cost Assessment of Water Resources Degradation (CAWRD)
Case Study Workshop
Environmental Valuation Technique # 2

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Athens, June 23-25, 2014

Environmental Valuation Techniques
Plan of the Presentation

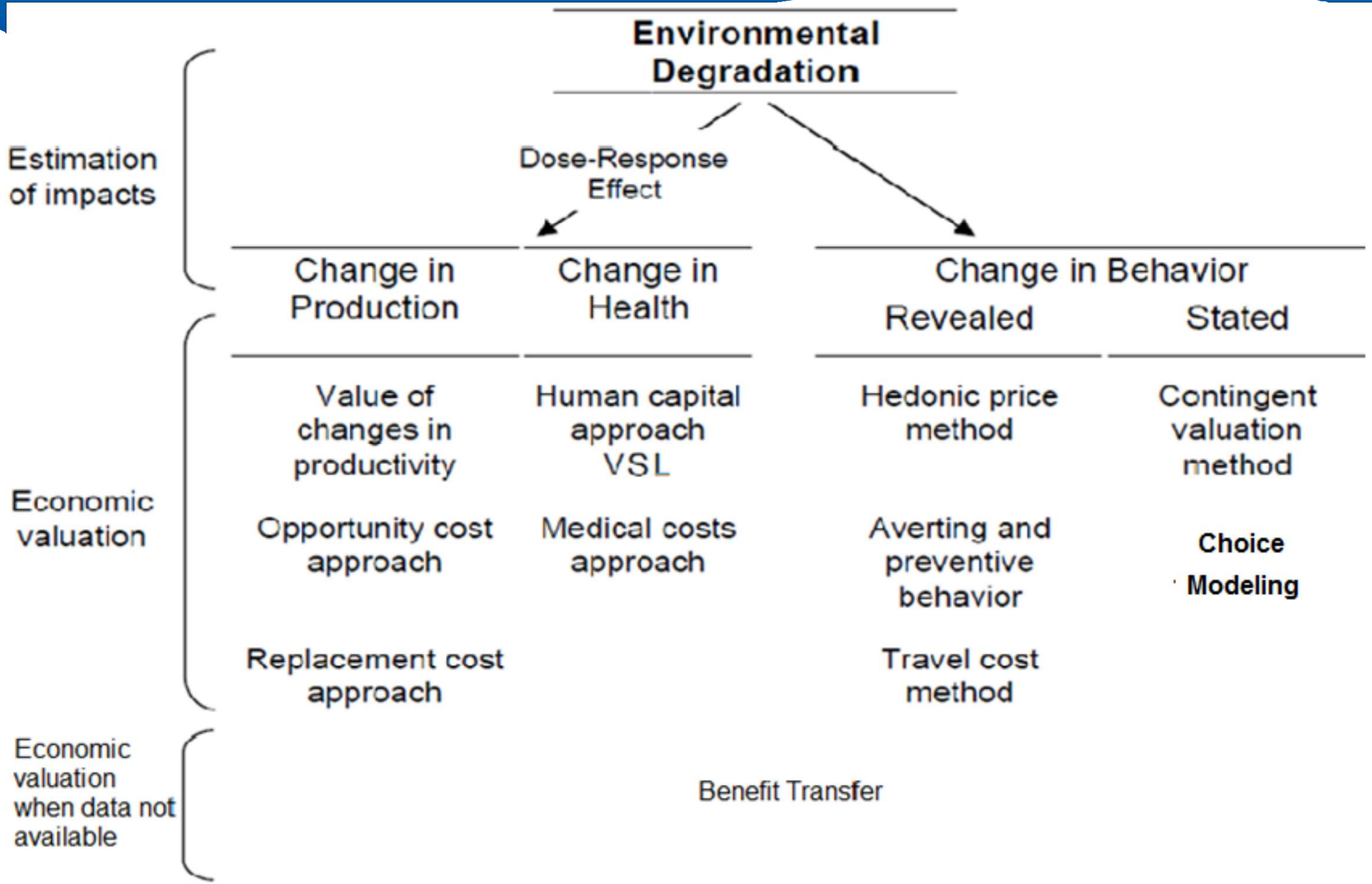
Total Economic Value of a Resource

Valuation Techniques 2nd part

Benefit Transfer

Cost/Benefit Analysis

Techniques d'évaluation environnementale afin de déterminer la dégradation/les avantages



Environmental Valuation Techniques
Revealed Preference

La méthode des prix hédoniques (HPM) est utilisé pour estimer la valeur ou le prix d'une caractéristique de l'environnement par la recherche sur les marchés réels où les attributs sont négociés. Il est le plus souvent appliquée dans le cadre de la volonté du public de payer pour le logement / propriété et les marchés du travail pour l'évaluation économique de la santé.

Environmental Valuation Techniques
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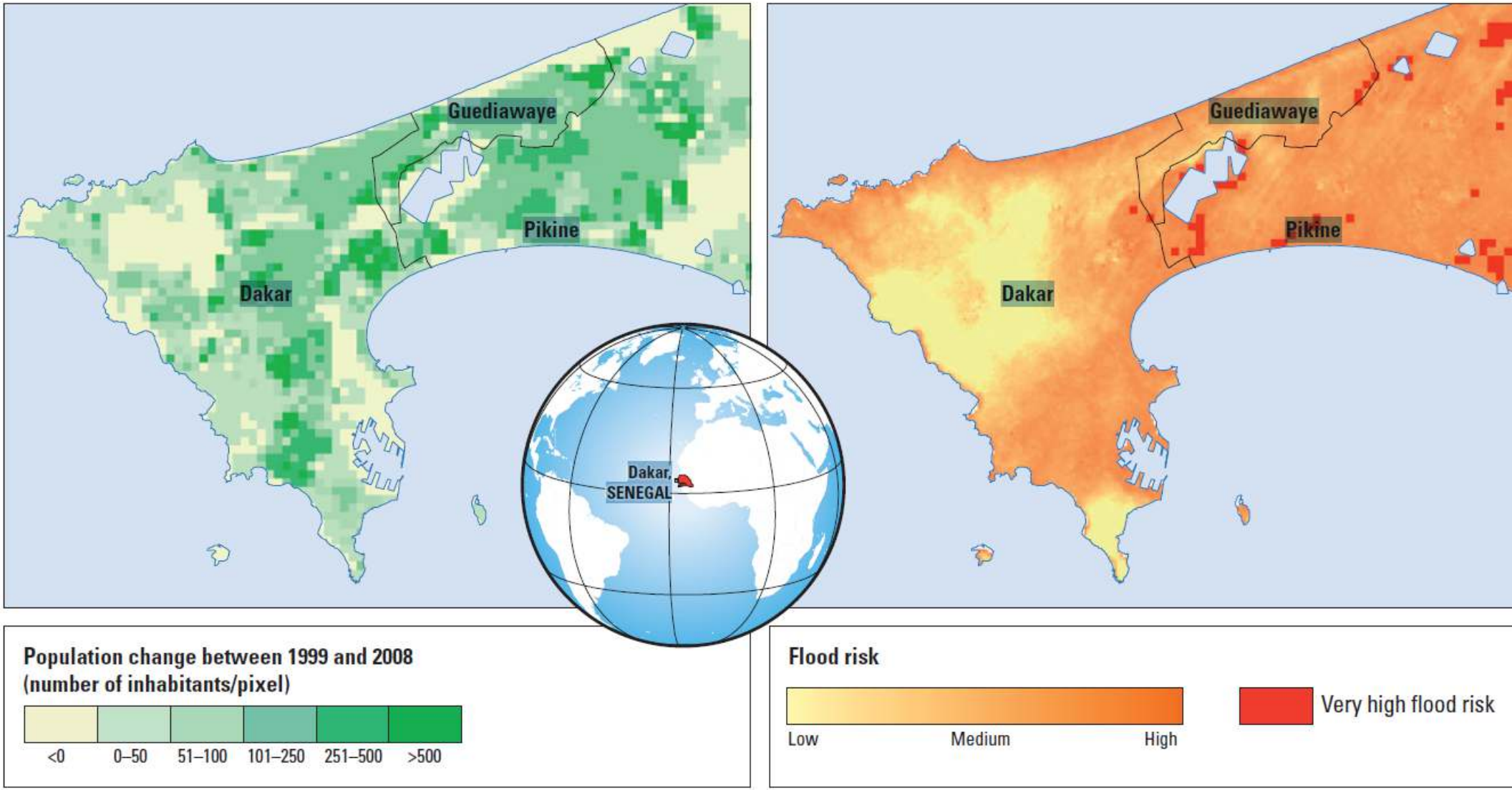
Flooding in Dakar



Source: World Development Report 2010.

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Table 9: Hedonic Pricing Dataset

City	Commune	#	Zone	Neighborhood	Cost log CFAF/m²	Cost CFAF/m²	Flooding 0=No; 1=Yes	Density ha	Malaria EIR
	Plateau	2	Secteur 1 Corniche Pompidou	Bordure Corniche	5.5	300000	0	70	1.4
		2		Place de l'Indépendance	5.4	250000	0	70	1.4
		2		Autres terrains	5.2	150000	0	70	1.4
		2	Secteur 2 Corniche	Corniche	5.5	300000	0	70	1.4
		2		Bordure grands axes	5.3	200000	0	70	1.4
		2		Autres terrains	5.0	100000	0	70	1.4
		2	Secteur 3 Ave Blaise Diagne	Corniche	5.3	200000	0	70	1.4
		2		Grands axes	5.0	100000	0	70	1.4
		2		Autres terrains	4.9	80000	0	70	1.4
	Médina	3	Canal IV	Bld De Gaule	5.0	100000	0	367	1.4
		3		Grands axes	4.9	80000	0	367	1.4
		3		Autres terrains de la Médina	4.9	75000	0	367	1.4
	Gueule Tappée/Fass/Colobane	4		Autres terrains de Fass	4.8	65000	1	235	1.4
	Dakar	4		Autres terrains de Colobane	4.8	65000	1	235	1.4
	Hann	5		Plage	4.7	50000	0	34	1.3
		5		Parc Forestier	4.5	35000	0	34	1.3
		5		Rufisque	4.4	25000	0	34	1.3
		5		Village	4.2	15000	1	34	1.3
		5		Pécheurs	4.2	15000	1	34	1.3
		5		Montagne	4.2	15000	0	34	1.3
		5		Ferrailles	4.2	15000	1	34	1.3
		5		Portuaire	4.8	65000	0	34	1.3
		5		Industrielle	4.8	65000	0	34	1.3
	HLM Cité des Eaux	6		Cité Port	4.8	65000	0	244	1.3
		6		HLM V	4.8	65000	0	244	1.3
		6		HLM I	4.8	60000	0	244	1.3
		6		SODIDA	4.8	70000	0	244	1.3
		6		Cité des Eaux	4.8	60000	0	244	1.3

Source: Doumani in World Bank Dakar Stormwater Management and Adaptation Project, 2012.

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$$Costlog_i = \beta_0 + \Sigma\beta_j flooding_{ji} + \Sigma\beta_j densityha_{ji} + \Sigma\beta_j malariaeir_{ji} + \varepsilon_i$$

$Costlog_i$	is the natural logarithm of the land price *i*
β	are the various regression coefficients
$flooding_{ji}$	is to determine variable *i* consisting of having the land in a flood-prone area (dummy variable F=0 means no flooding and F=1 means flooding)
$densityha_{ji}$	is to determine the population density of the land variable *i*
$malariaeir_{ji}$	is to determine variable *i* consisting of having the malaria EIR in various areas
ε_i	is the error term for land i, with $E(\varepsilon) = 0$ and $V(\varepsilon) = \sigma^2 > 0$.

Table 2: Regression Results for Land Price ≤ CFAF 90,000 per m^2

Source	SS	df	MS		
Model	2.45115675	3	.817052251	Number of obs =	69
Residual	2.29696128	65	.035337866	F(3, 65) =	23.12
				Prob > F =	0.0000
Total	4.74811804	68	.069825265	R-squared =	0.5162
				Adj R-squared =	0.4939
				Root MSE =	.18798

costlog	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
flooding	-.3372285	.0461496	-7.31	0.000	-.4293955	-.2450615
densityha	.0005883	.000188	3.13	0.003	.0002129	.0009638
malariaeir	.0002922	.0077904	0.04	0.970	-.0152663	.0158507
_cons	4.700534	.0528537	88.93	0.000	4.594978	4.80609

Source: Calculations for the PAD.

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Results:

R^2 = 52%: the model explains 52% of the variances

Table 3: Land Price Premium in Pikine and Guédiawaye

Commune with Considered Land ≤ CFAF 90,000/m²	Flooding	Area	Weighted Average Land Cost/m²		Benefits
		m²	CFAF	Coef. β for flooding	CFAF billion
Dakar, Pikine and Guédiawaye land	Area not prone to major flooding	51,213,333	76,021	-34.6%	
	Area prone to or affected by major flooding	101,066,667	28,106		
Pikine and Guédiawaye land	Area not prone to major flooding	7,180,000	60,000		
	Area prone to or affected by major flooding	85,770,000	27,168		805.7

Source: Doumani in World Bank Dakar Stormwater Management and Adaptation Project, 2012

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Table 3: Economic Analysis Summary (Source: Annex 6)

Items	Economic Analysis Results Discount rate: 12%
Project Level	
Cost/Benefit Analysis	
NPV/30 years	US$27 million
IRR/30 years	26%
Modified IRR/30 years	14%
Present value Benefit/Cost Ratio/30 years	2
Sensitivity Analysis	
Reduction of flood-day to 10, -10% of land flooded and -10% of land value increment	Viable
Increase of investment by 20% and OMEX increase by 10% per year	Viable
Scenario Analysis	
NPV > 0; IRR/30 years > 12% and PV Benefit/Cost ratio > 1	Viable
Risk Analysis	
NPV/8 years ≥ US$100 million (Monte Carlo method)	100% likelihood
Drainage Component Level	
Cost/Benefit Analysis	
NPV/30 years	US$ 39 million
IRR/30 years	43%
Modified IRR/30 years	16%
Present value Benefit/Cost Ratio/30 years	3
Sensitivity Analysis	
Reduction of flood-day to 10, -10% of land flooded and -10% of land value increment	Viable
Increase of investment by 20% and OMEX increase by 10% per year	Viable
Scenario Analysis	
NPV > 0; IRR/30 years > 12% and PV Benefit/Cost ratio > 1	Viable
Risk Analysis	
NPV/8 years ≥ US$100 million (Monte Carlo method)	100% likelihood

Source: Doumani in World Bank Dakar Emergency Urban Project, 2012.

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Travel Cost Method (TCM)

- The travel cost method (TCM) is useful in planning for the provision and management of outdoor recreation, such as changes in access costs for a recreational site, elimination of an existing recreational site, addition of a new recreational site, and changes in environmental quality at a recreational site.
- The travel cost method is based on the premises that the cost an individual incurs in visiting a site reflects his valuation to the site, and that individuals will react to an increase in entry fees the same way as they would react to an increase in travel cost.

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Preventive Behavior

Actions are taken to reduce or avoid the consequences and costs of environmental damage. The costs incurred due to these actions are considered equivalent to the costs of environmental degradation. Averting behaviors may include, drinking bottled water or purchasing water filters due to polluted water, frequent painting of dwellings due to smoke emissions from a nearby factory, moving away from a polluted location, installing air purifiers, staying indoors, installing soundproof walling to reduce noise, etc.

Environmental Valuation Techniques
Stated Preferences

Contingent Valuation and Choice Modeling

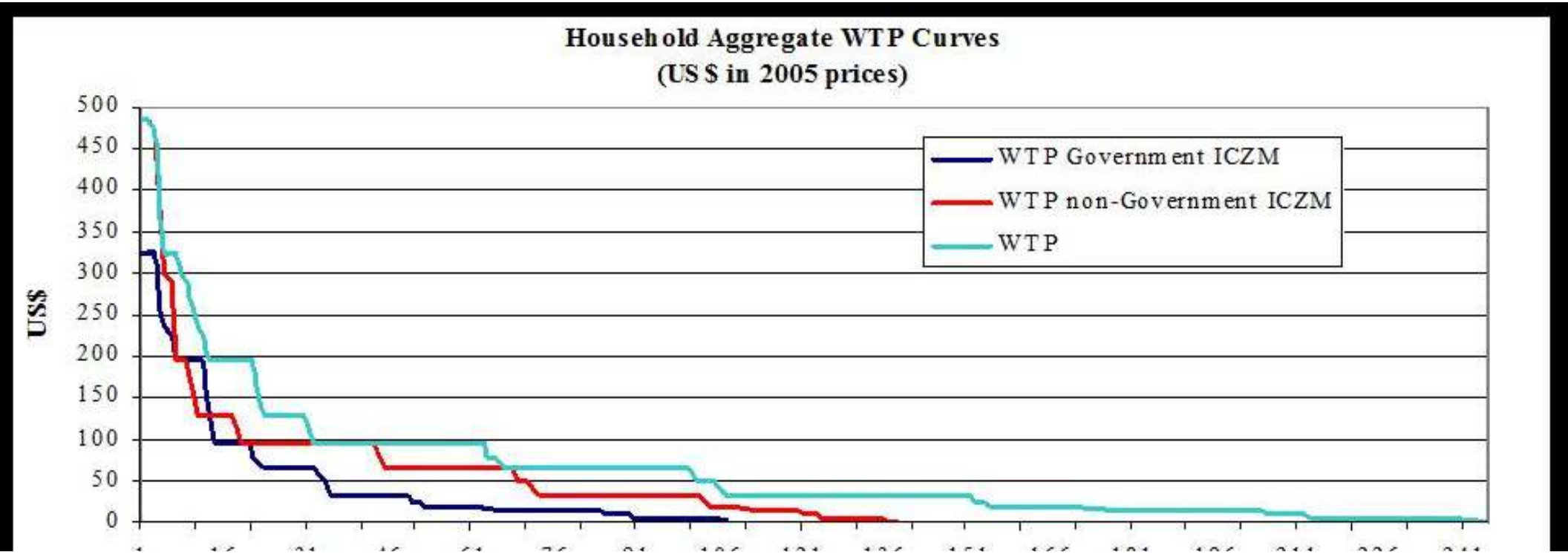
The Contingent Valuation Method (CVM) is the most widely used method for estimating non-use values. It is called "contingent" valuation, because it is contingent on simulating a hypothetical market for the good in question. It involves directly asking individuals how much they would be willing to pay (WTP) to preserve or use a given good or service or the amount of compensation they would be willing to accept (WTA) to forgo specific environmental services. The CVM can be used to estimate economic values for all kinds of ecosystem and environmental services, for both use and non use values.

Environmental Valuation Techniques
Stated Preference

- The CVM has been applied to estimate the values of landscape, recreation, beaches, water quality, nature conservation, endangered species, visibility and air quality, etc. Yet, the CVM is the most controversial of the non-market valuation methods, whereby many economists, psychologists and sociologists, for many different reasons, do not believe that the dollar estimates that result from CV are valid. In addition, many jurists and policy-makers will not accept the results of CV. However, studies have shown that a carefully composed and tested study, where the circumstances are not too distant from the experience of the respondent and the issue is not too emotive, can produce answers of value.

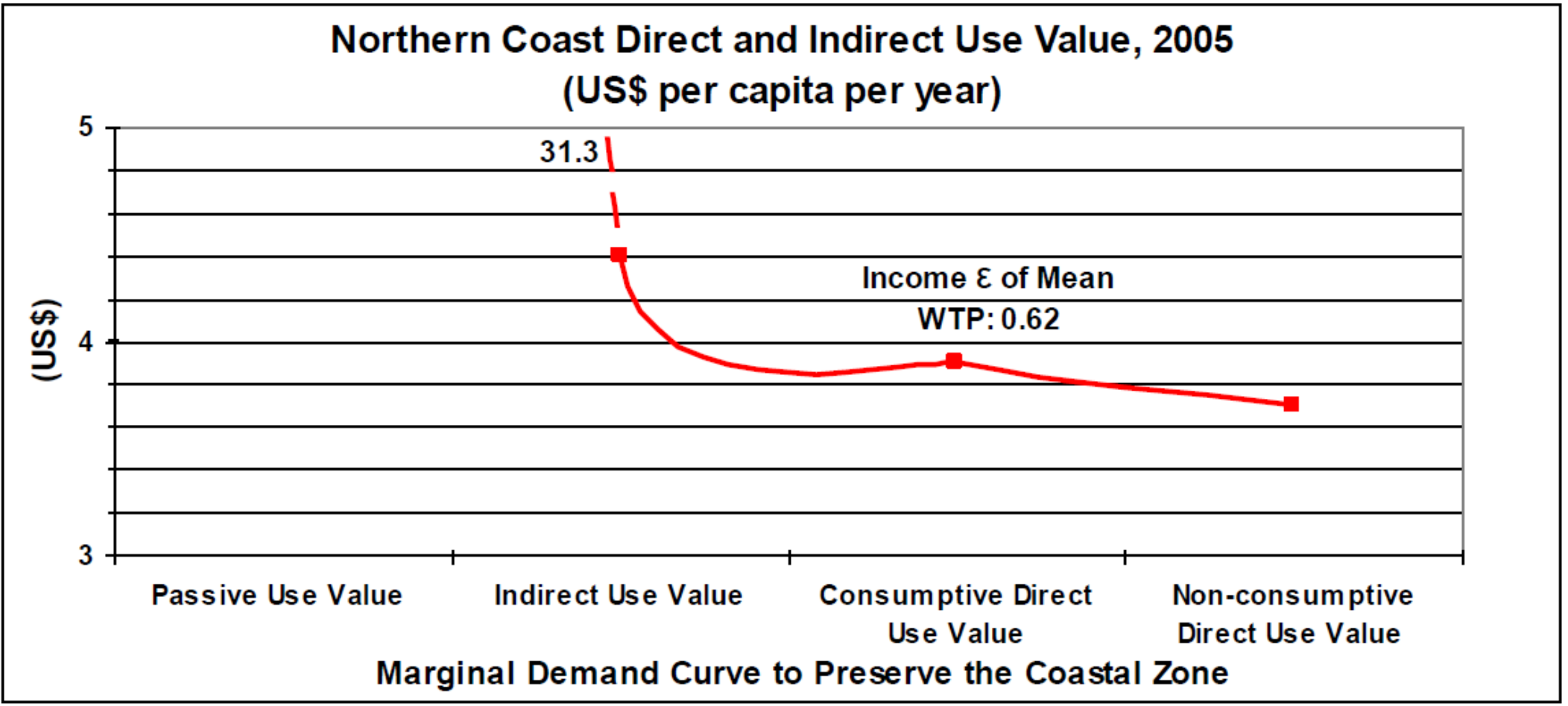
Environmental Valuation Techniques
Revealed Preference
WTP to Preserve a Coast

- Acceptability rate is 64%;
- WTP Mean: $41/year/HH; $12/Year/per capita
- WTP Median: $12.9/year/HH; $2.4/year/per capita



Environmental Valuation Techniques
Revealed Preference
WTP to Preserve a Coast

Income Elasticity is 0.62: a 10% increase in income is associated with a 6.2% increase of the WTP.



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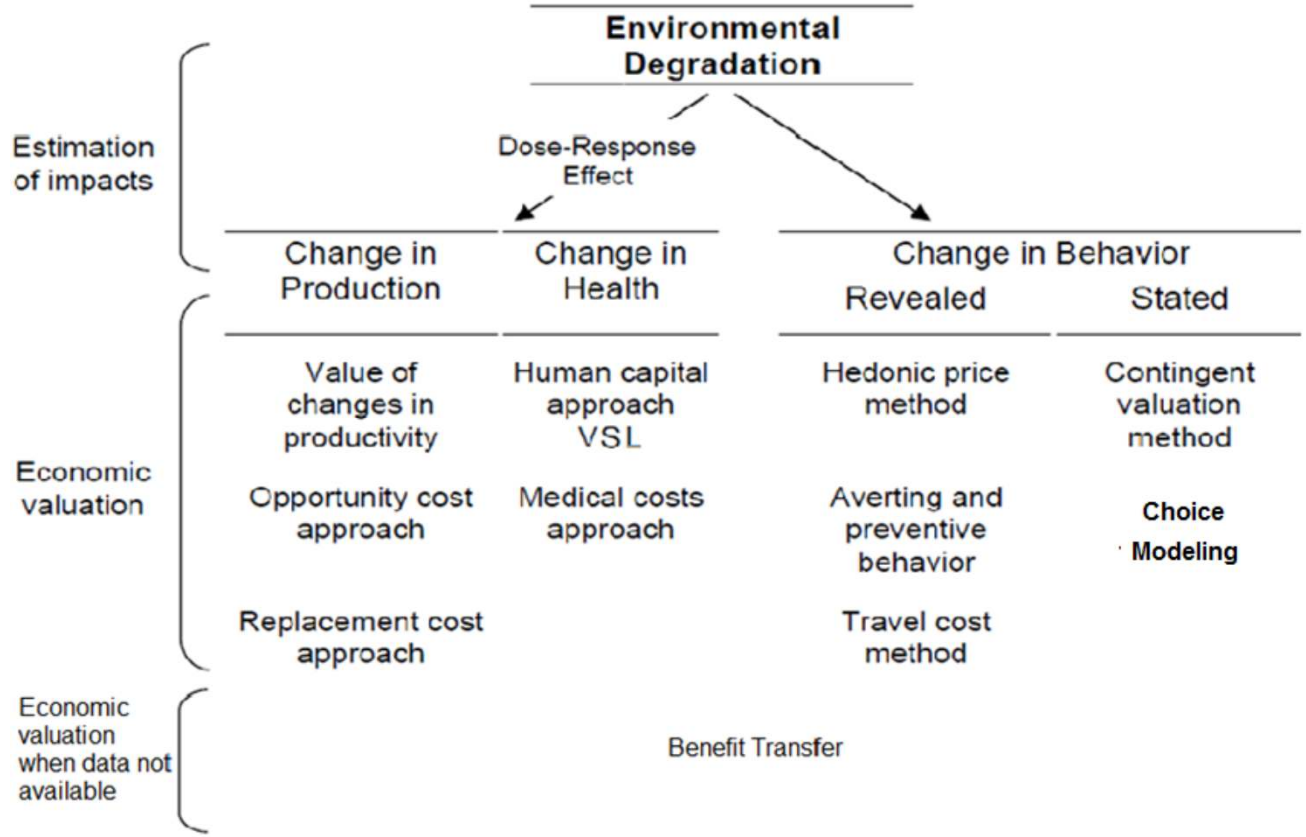
Benefit Transfer

The benefit transfer method involves transferring values that have been estimated for a similar good or service from another location/context to the current location/context. It represents a useful method under budget and time constraints.



Environmental Valuation Techniques
Benefit Transfer

There are two approaches for the benefit transfer:

i) The unit value transfer;

- The transfer of the single unit value;
- The transfer of the unit to adjust for differences in income value.

ii) the transfer function;

- The transfer function of the benefit;
- Meta Analysis.

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Benefit Transfer

The transfer of a single unit value means the willingness to pay / household / year, from the study site to the policy site.

$VAPp' = VAPe$

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Benefit Transfer

The transfer of the unit to adjust for differences in income value.

$VAPp' = VAPe\ (Yp / Ys)ß$

Yp = income in the country policy

Ye = income in the country of study

ß = elasticity for different environmental goods are generally smaller than 1, and often range between 0.4 to 0.7%.

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Benefit Transfer

The transfer function of the benefit

$$VAPij = b0 + b1Gj + b2\ Hij + e$$

VAPij = willingness to pay household i on site j,
Gj = the set of characteristics of the property of the environment on the site j
Hij = the set of characteristics of household i on site j, and B0, B1 and B2 are sets of parameters, and e is the random error.

Environmental Valuation Techniques
Benefit Transfer

The results of several valuation studies could be combined in a meta-analysis

Regression of a meta-analysis would be similar to the previous equation, but with an independent variable added; Cs = characteristics of the study (and the dependent variable would VAPs = mean willingness to pay studies).

Environmental Valuation Techniques

Cost Benefit Analysis

Environmental Valuation Techniques
BCA

Cost benefit analysis (CBA) is one of the most widely used techniques to assess policies, programs and projects.

- NPV
- IRR
- Ratio PV B/C

Environmental Valuation Techniques
BCA

The valuation of benefits (reduced CAWRD over a year) was used to derive the cost of remediation that are calculated for selected priority sub-categories. After determining the alternative remediation cost, the most suitable cost is selected and used in a cost/benefit analysis (CBA) to determine the profitability of the project. The cost/benefit analysis allows to present the decision-maker/investor with the most efficient choice. Three indicators are taken into account in analyzing the CBA to determine the profitability of the project:

Environmental Valuation Techniques
BCA

The net present value (NPV) is the difference between benefits and total discounted costs;
The internal rate of return (IRR) is the discount rate that resets the NPV or the interest rate that makes the NPV of all cash flows equal to zero, and
The present value B/C ratio, which is the ratio of the present value of benefits over the present value of costs over the life of the project must be equal or greater than 1.

Environmental Valuation Techniques
BCA

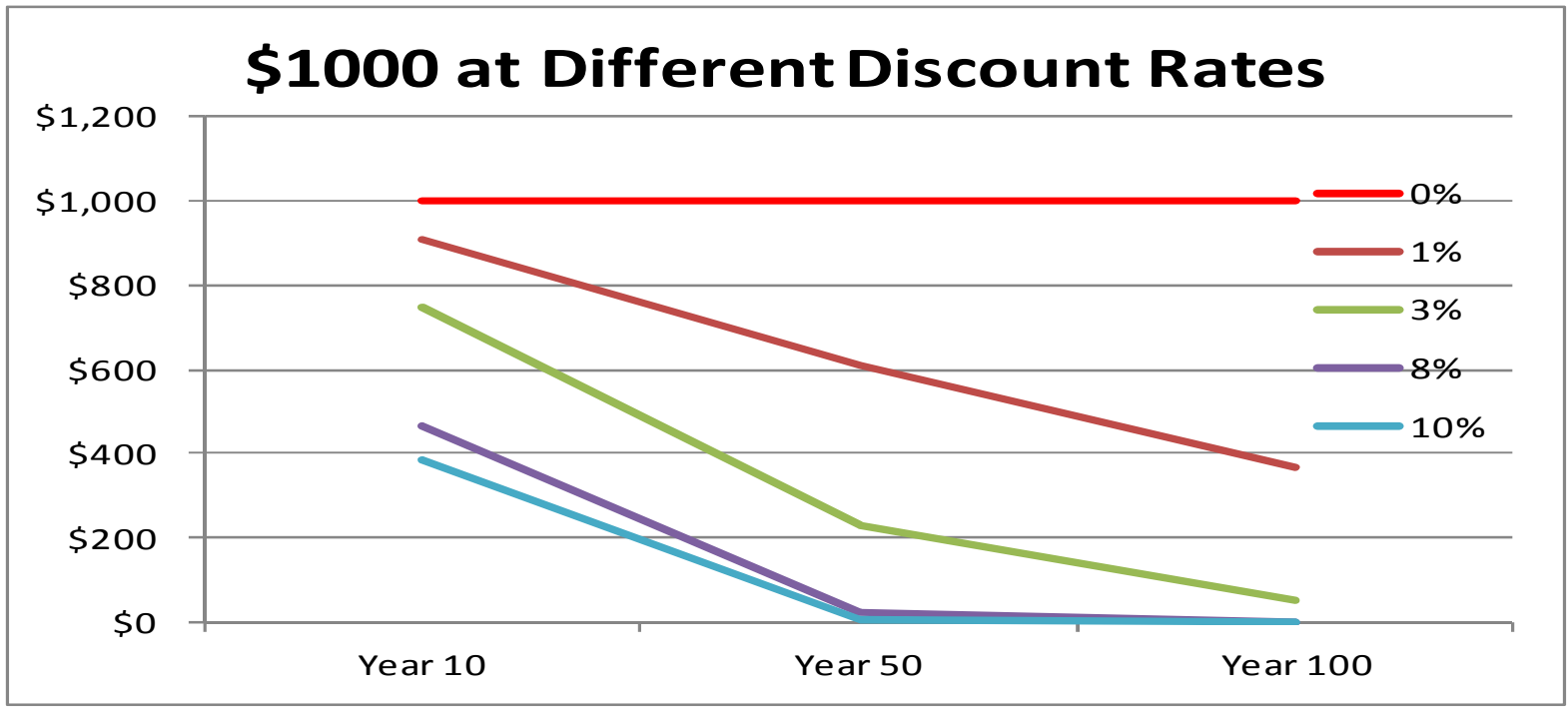
The discount rate in a SCBA reflects society's preferences between present and future consumption. A high discount rate implies that society has a stronger preference for present consumption over future consumption, while a low discount rate implies that society has a stronger preference for future consumption over present consumption. The choice of a discount rate is often controversial. Environmentalists argue against high discount rates, which they believe are associated with environmental degradation. Economists tended to use long-term interest rates on government bonds as a measure of opportunity cost of capital.

Environmental Valuation Techniques
BCA

How is a discount rate in the future?

What is the value of $ 1000 in the future with different discount rate?

Discount rate	Years in the Future		
	Year 10	Year 50	Year 100
0%	$1,000	$1,000	$1,000
1%	$910	$608	$370
3%	$744	$228	$52
8%	$463	$21	$0.45
10%	$386	$9	$0.07



Environmental Valuation Techniques

BCA

Actual discount rate used in Developed Countries

Country	*Agency*	*Discount rate (per cent)*
Philippines		15[a]
India		12[a]
Pakistan		12[a]
International Multi-lateral Development Banks	World Bank	10–12[a]
	Asia Development Bank	10–12[a]
	Inter-American Development Bank	12[a]
	European Bank for Reconstruction and Development	10[a]
	African Development Bank	10–12[a]
New Zealand	Treasury and Finance Ministry	8[g]. From 1982 to 2008 it was 10[abf]
Canada	Treasury Board	8[c]. From 1976-2007 was 10 (and test 8–12 per cent)[ab]
China (People's Republic)		8[a]
South Africa		8 (and test 3 and 12 per cent)[d]
United States	Office of Management and Budget	7 (and test 3 per cent). Used 10 per cent until 1992.[a]
European Union	European Commission	5 From 2001–2006 was 6 per cent[a]
Italy	Central Guidance to Regional Authorities	5[a]
The Netherlands	Ministry of Finance	4 (risk free rate).e
France	Commissariat General du Plan	4. From 1985-2005 used 8 per cent[ab]
United Kingdom	HM Treasury	3.5 (declining to 1 per cent for costs and benefits received more than 300 years in the future) from 2003.[a] From 1969–78 used 10 per cent[a]
Norway		3.5. From 1978–98 used 7 per cent[ab]
Germany	Federal Finance Ministry	3. From 1999–2004 used 4 per cent[ab]
United States	Environmental Protection Agency	2–3 (and test 7 per cent)[a]

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BCA

Discount rates used for private analysis BCA: preference factors and 10% which is the rate of borrowing.

Social discount rate used for environmental goods and services: intergenerational factors and uncertainties, and 3% rate used.

However, the BCA, it would be better to use a single discount rate for costs and benefits.

مع خالص شكري وامتناني

Thank you for your attention

Merci pour votre attention

For additional information please contact:
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