Cost Assessment of Water Resources Degradation (CAWRD)

Case Study Workshop

Environmental Valuation Technique # 1

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Athens, June 23-25, 2014

Environmental Valuation Techniques

Plan of the Presentation

Total Economic Value of a Resource

Valuation Techniques 1st part

Benefit Transfer

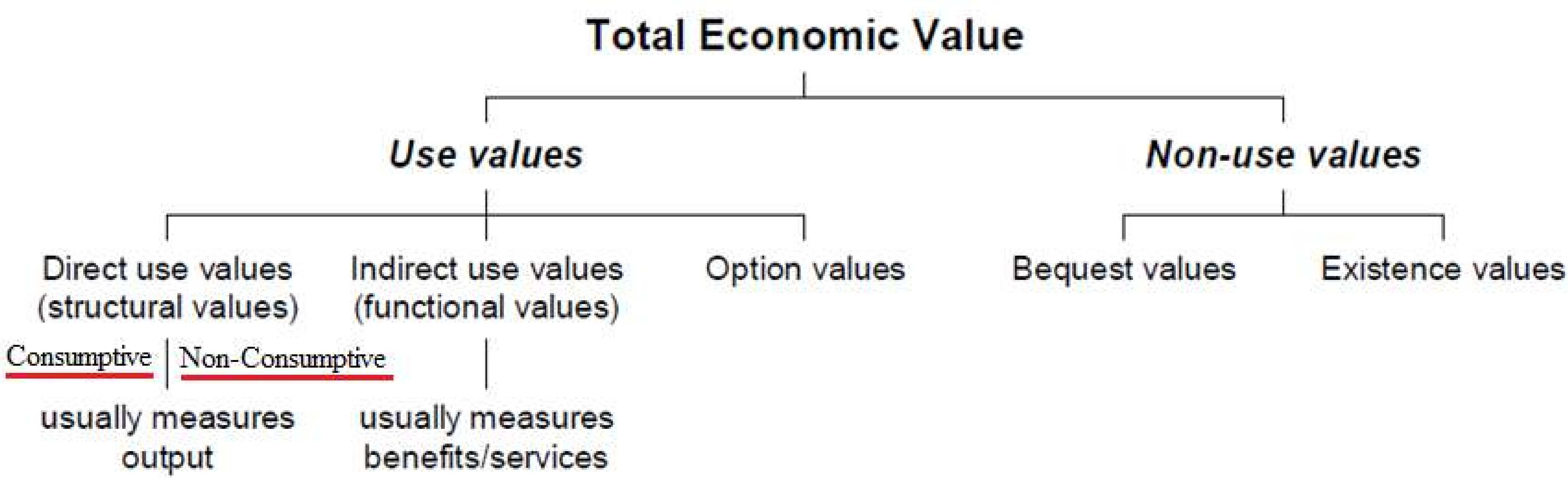
Cost/Benefit Analysis

Environmental Valuation Techniques

TEV of a Resource

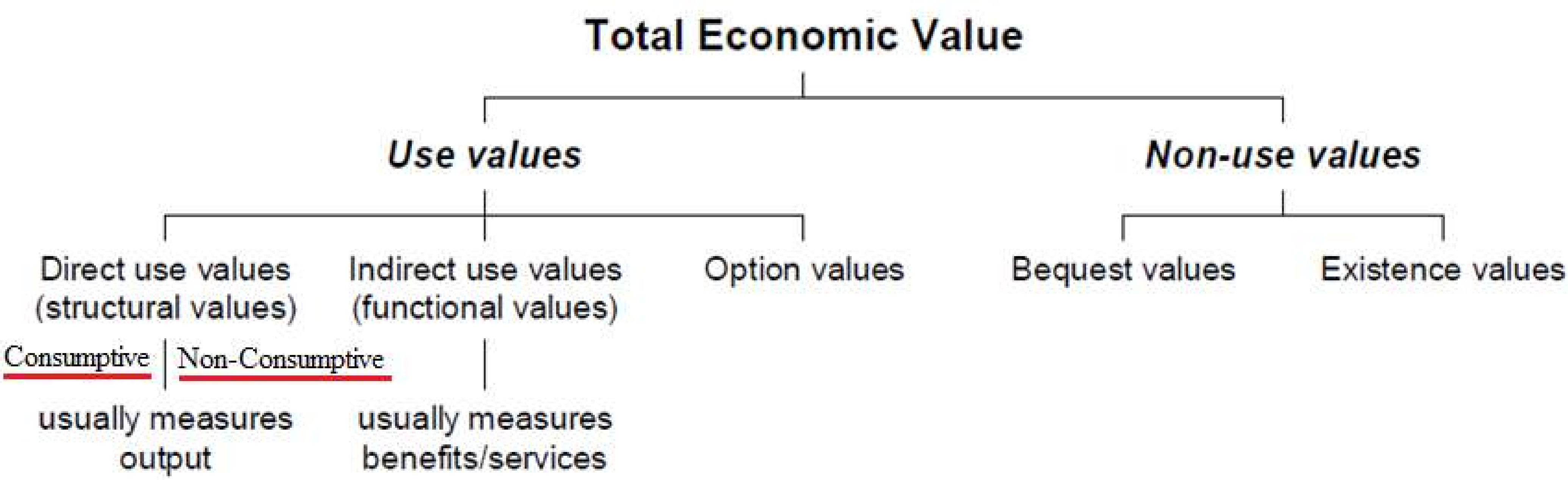
Environmental Valuation Techniques
TEV of a resource

Distinction between use value and non-use value



Environmental Valuation Techniques
TEV of a resource

Direct Use Value: Consumptive and non-Consumptive value of the resource



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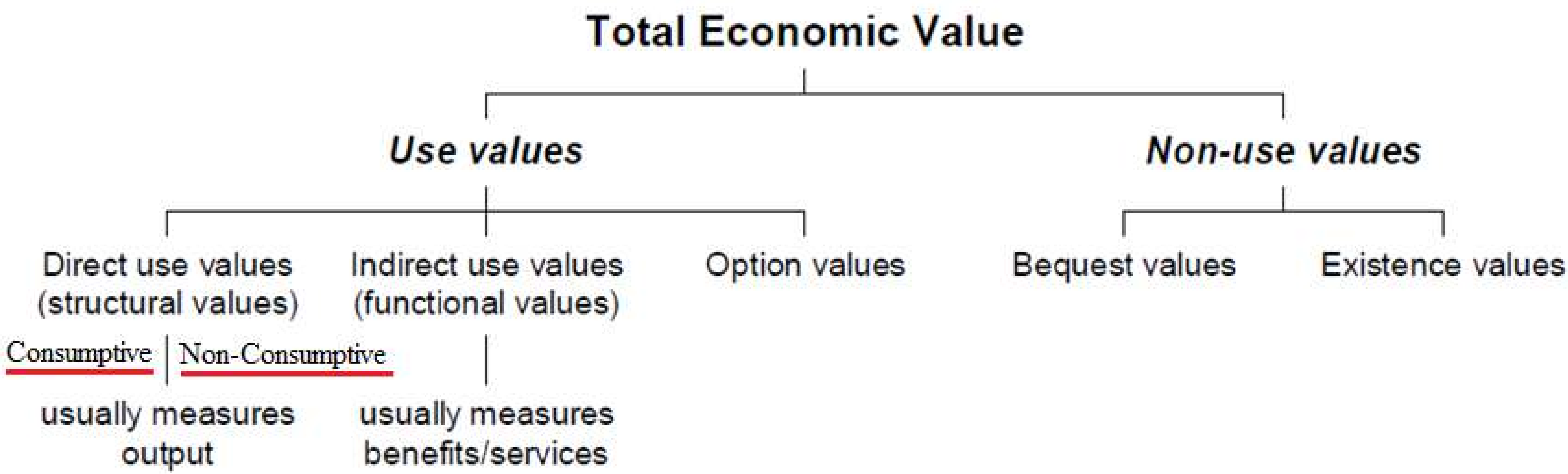
TEV of a resource

- Indirect use value arising from the use of the services of a resource



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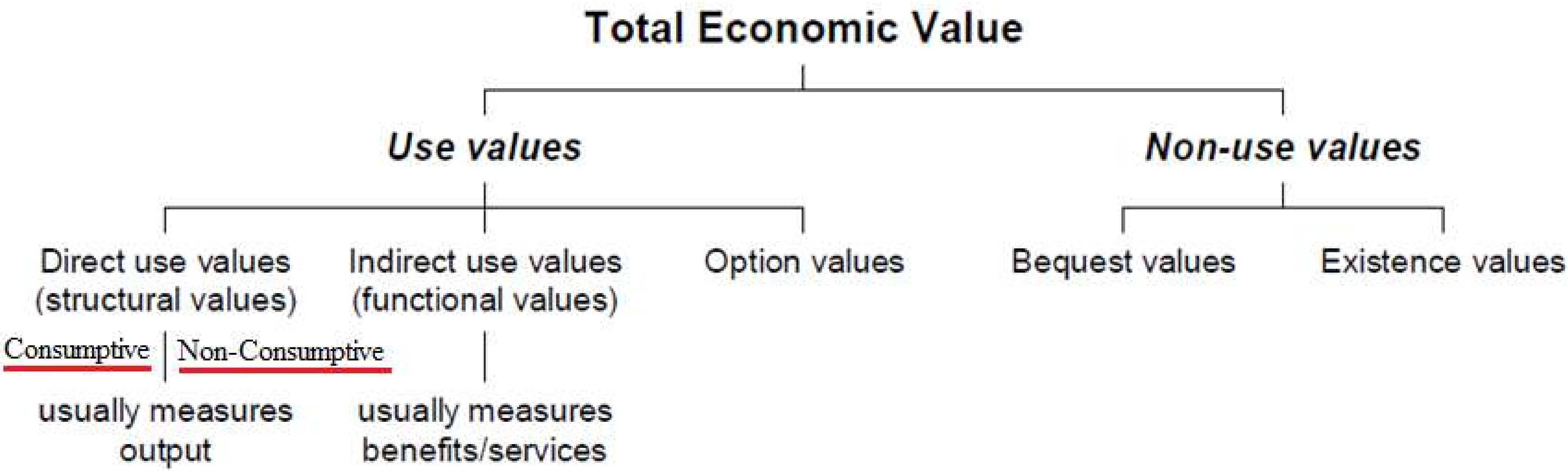
TEV of a resource

Potential, option or passive value arising from the potential use of a good in the future: e.g., The Option Value was calculated after the Exxon Valdez Disaster



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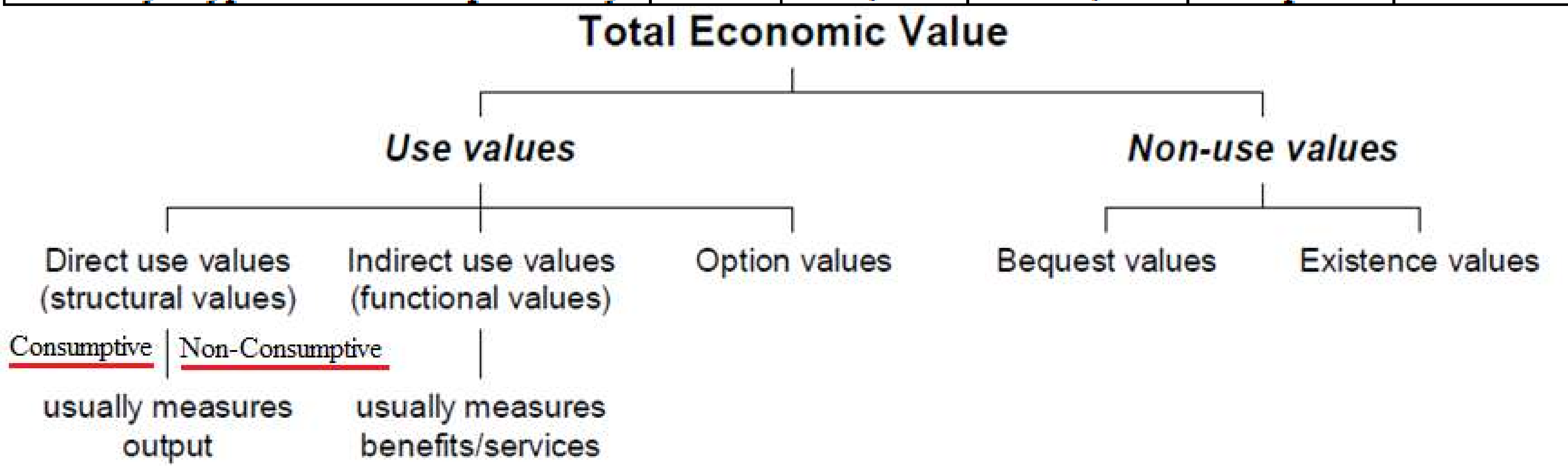
TEV of a resource

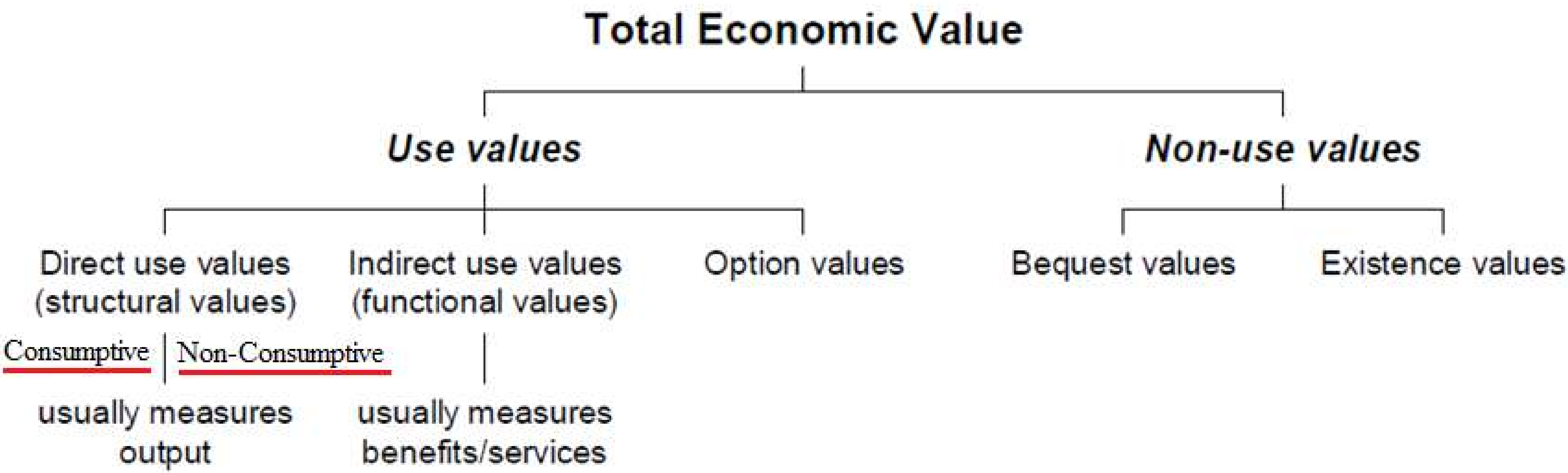
Passive Value associated with oil spills

Oil spill Survey or Study Case	Survey Date	Oil Spill Size		In-country WTP per Household	
	Year	Km spread	Metric tons	US$ Base Year 2005	
USA/Canada: Nestucca	1991	Minor	1,000	Mean	191
USA: Exxon Valdez	1992	>1,100	38,800	Median	39
Norway: Blucher latent oil spill[1]	1994	100 length	1,500	Mean	641
Belgium: hypothetical oil spill study[2]	2001	0 - 65	53,000	Median	135
Norway: hypothetical oil spill study[3]	2004	1,500	60,000	Midpoint	148



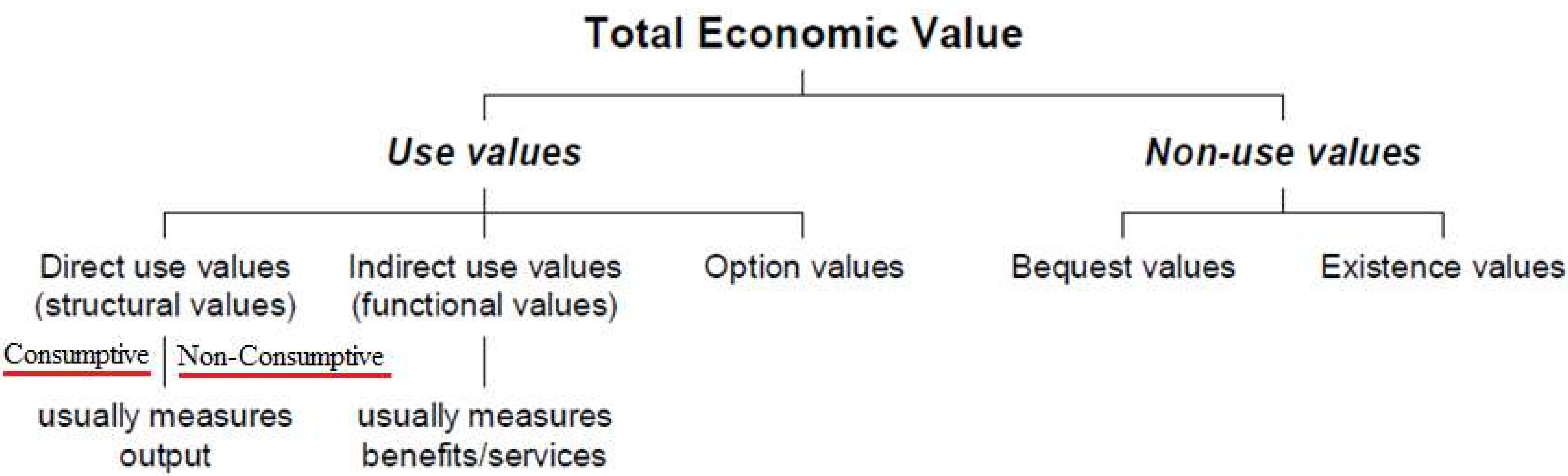
Environmental Valuation Techniques
TEV of a resource

Altruistic values are values that arise from wanting to bequest the resource (in good conditions) to future generations



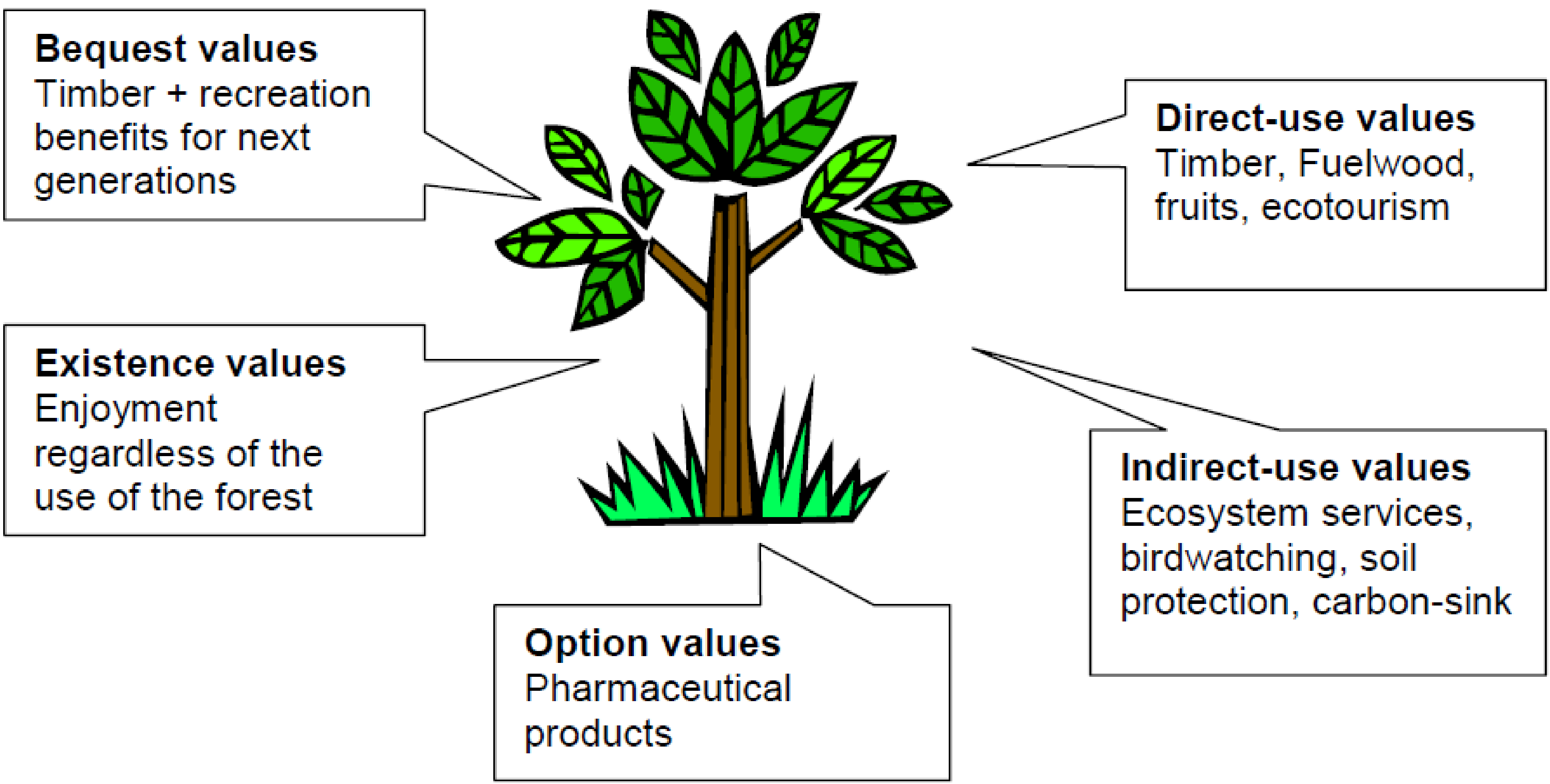
Environmental Valuation Techniques
TEV of a resource

Existence values or values are intrinsic: it is very difficult to calculate intrinsic value because we are in the realm of philosophy, spirituality and religion



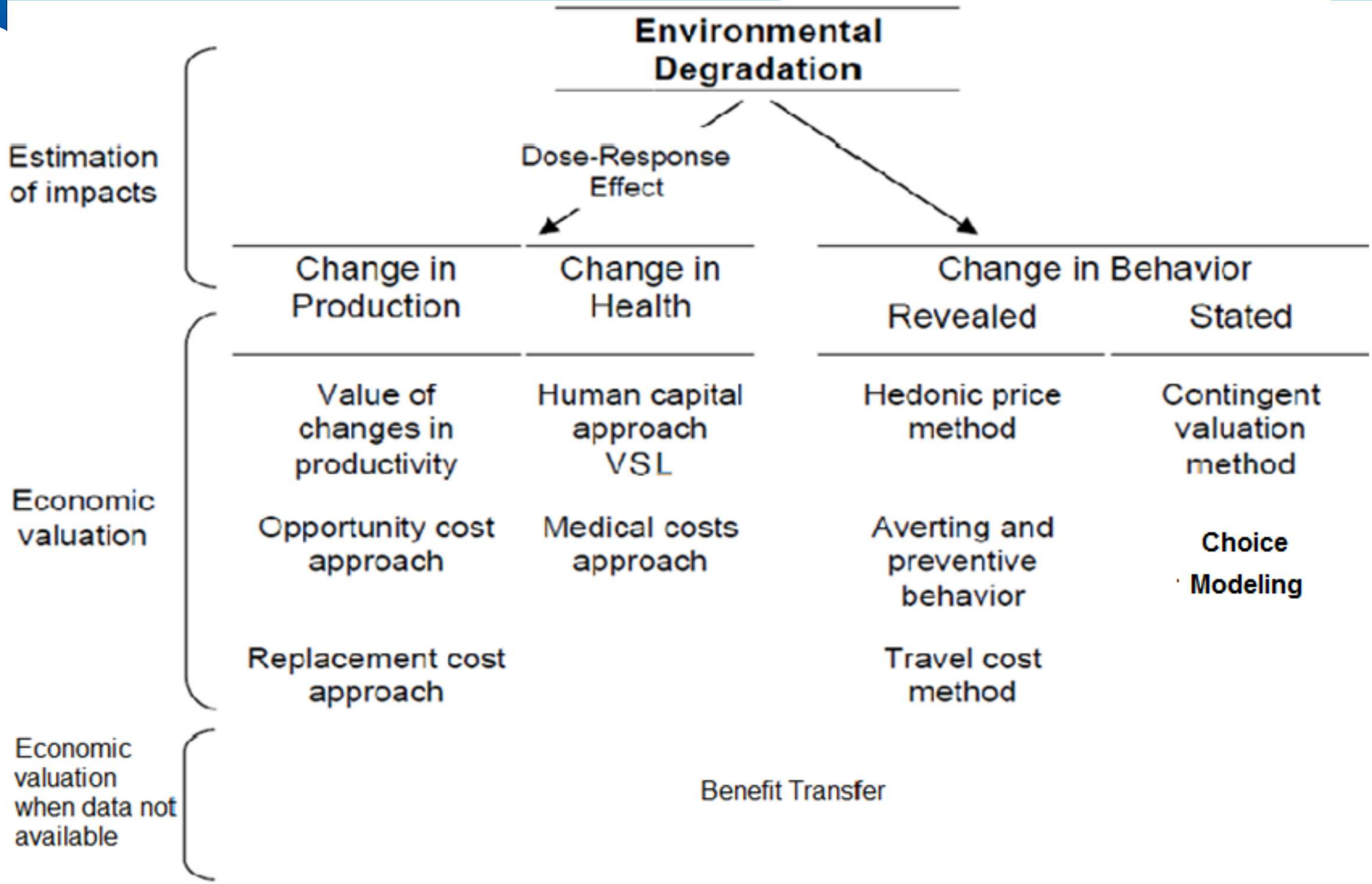
Environmental Valuation Techniques

TEV of a Tropical Forest



Valuation Techniques

Environmental Valuation Techniques
How to Detemine Degradation and Benefits



Environmental Valuation Techniques

Main methods for estimating impacts and performing valuation are grouped within 3 pillars

1- Change in production:

- Value of changes in productivity such as reduced agricultural productivity due to salinity and / or loss of nutrients in the soil;
- The opportunity cost of such shortfall of not re-selling the recycled waste;
- The replacement cost, damage cost avoided and substitute cost methods when for example the cost of construction of a dam to be replaced by a dam that was silted.

Environmental Valuation Techniques

Main methods for estimating impacts and performing valuation are grouped within 3 pillars

2- Change in Health

Impact: The lab studies, dose-response function or epidemiological studies to establish a causal relationship between pollutant (inhalation, ingestion, absorption or exposure) and disease.

Mortality: The value associated with mortality through two methods: the future shortfall due to premature death or Human Capital Approach, and the hedonic pricing to reduce the risk of premature death. Also called Value of Lost Life (VOLL).

Morbidity: The approach to medical costs such as the costs when a child under 5 years is taken to the hospital to be cured of diarrhea.

Environmental Valuation Techniques
Main methods for estimating impacts and performing valuation are grouped within 3 pillars

3- Change in Behavior

Revealed preferences by deriving the costs associated with behavior:

- **hedonic method** where for instance the lower value of land around a landfill is derived;
- trying to derive **travel costs** to visit a specific place like Lake Titicaca; and
- **preventive behavior** as when a household buys bottled water or a filter for drinking water.

Environmental Valuation Techniques

Main methods for estimating impacts and performing valuation are grouped within 3 pillars

3- Change in Behavior

Stated preference where a contingent valuation is used to derive willingness to pay through a survey for example, improve the quality of water resources.

Choice modeling where respondents are asked to choose their preferred option from a set of alternatives with particular attributes (a variation on the WTP without a monetary value). Other forms also exist such as choice experiments.

Environmental Valuation Techniques

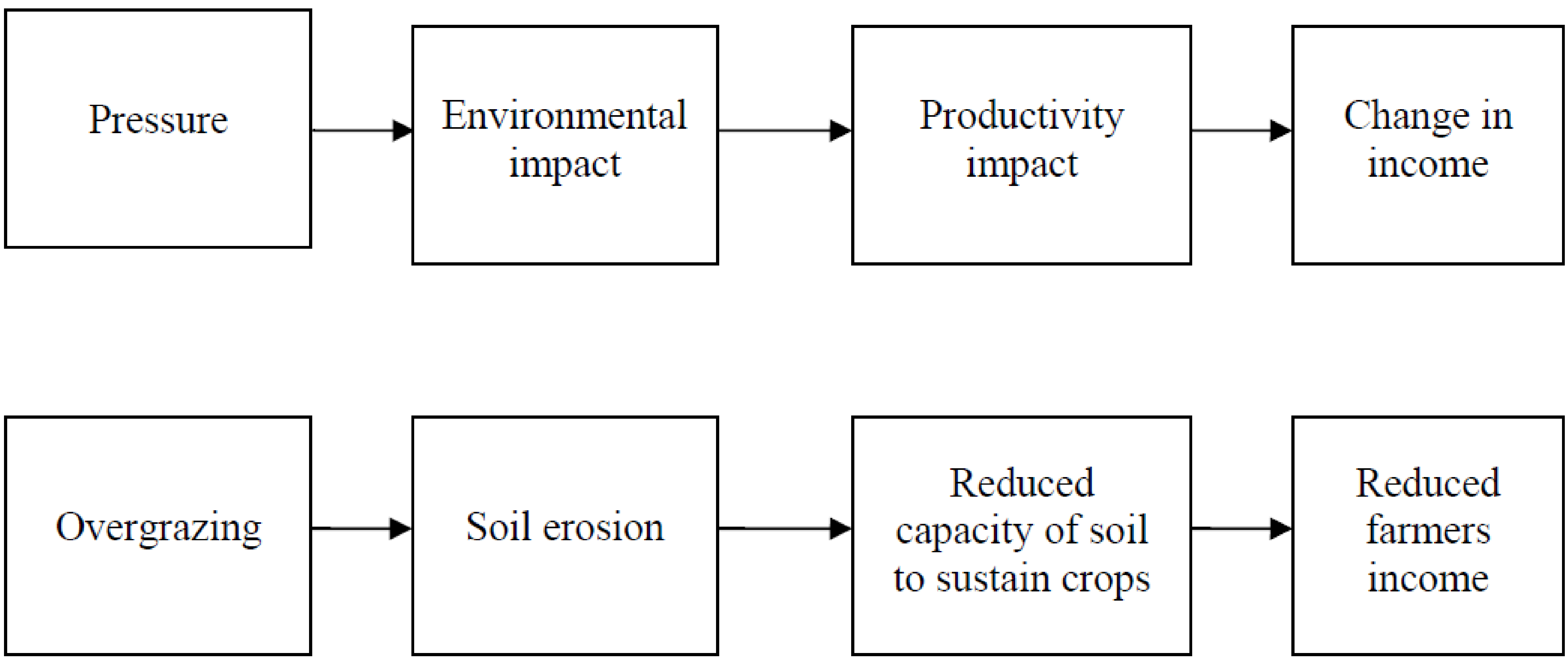
Change in Production

If a natural resource is a factor of production, then changes in the quantity or quality of the resource will result in changes in production costs, and/or productivity of other inputs. This may affect the price and/or quantity supplied of the final good.

Environmental Valuation Techniques

Change in Production

Cause/Effect relation: link degradation to change in production



Environmental Valuation Techniques

Change in Production

Application of the method

- Soil erosion
- Soil salinity due to irresponsable irrigation
- Air pollution
- Acid rain
- Pollution affecting fisheries

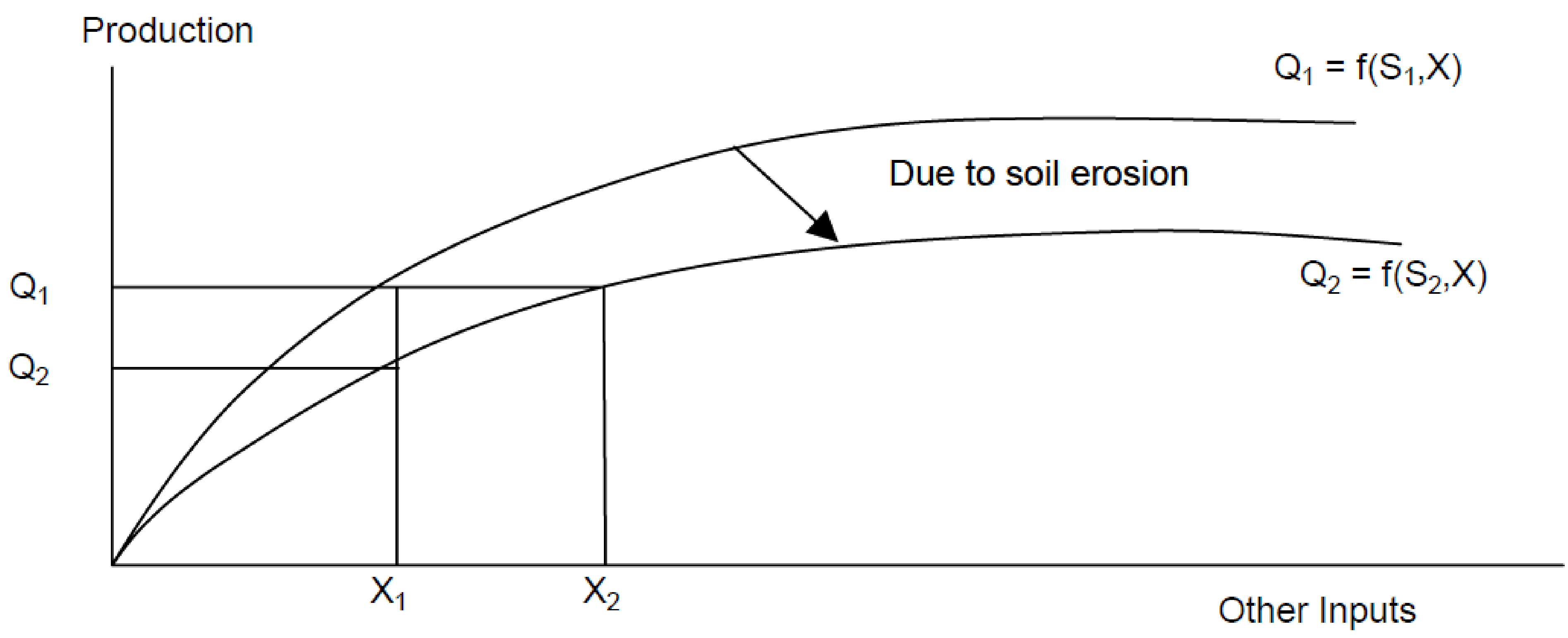
Environmental Valuation Techniques

Change in Production

Theory underpinning the method:

-Determining physical impact

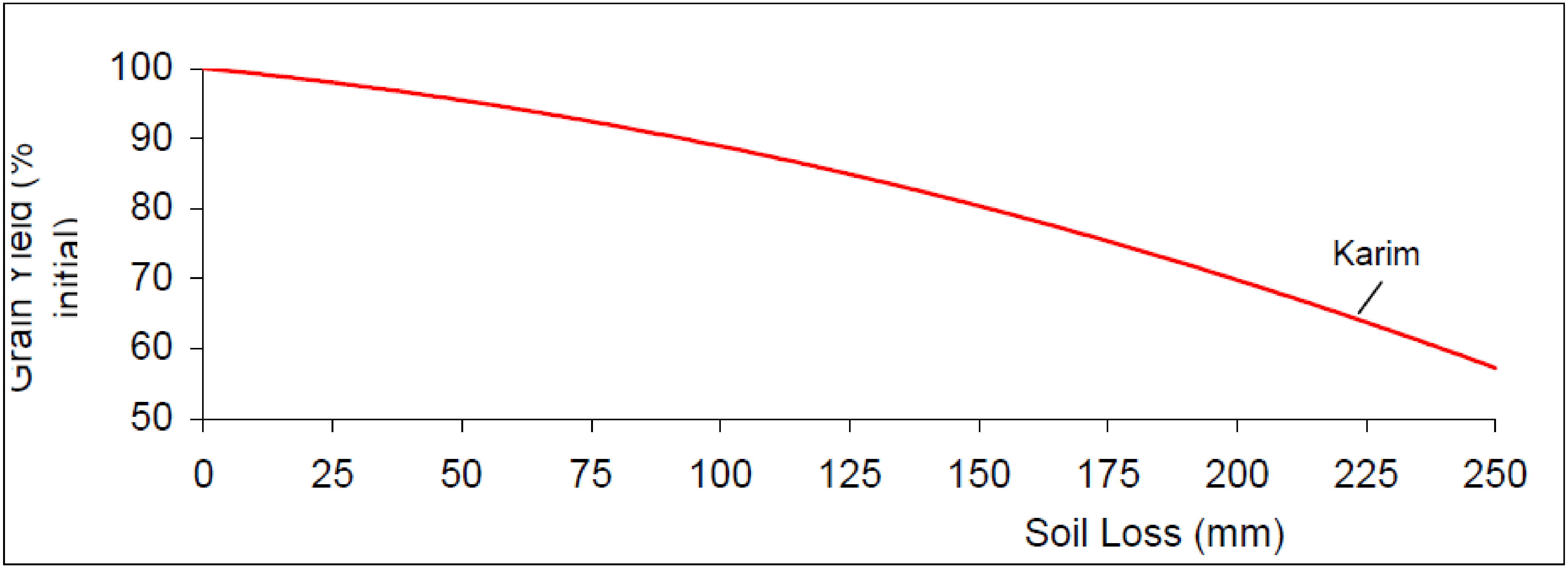
-Assign a market value



Environmental Valuation Techniques

Change in Production

Pagiola and Bendaoud (1995) in Morocco in DM



	Annual Value*	Present Value (no erosion)*	Present Value (erosion at 5mm per year)*
Revenues	4,740	51,600	49,000
Cost of Inputs (inc. fertilizer, seed, herbicide, labor, harvesting costs)	1,610	17,500	17,500
Returns	3,130	34,100	31,500

Environmental Valuation Techniques

Change in Production

Opportunity Cost

The Opportunity Cost is the forgone net benefit, because the resource providing the service can no longer be used in its next-most-beneficial use.

Environmental Valuation Techniques

Change in Production

The opportunity cost approach is a very useful technique when benefits of certain uses, such as preservation, protection of habitats, cultural or historical sites, cannot be directly evaluated. For example, in the Yasuni ITT proposal in Ecuador in 2007, the government was ready to forego the revenue from the extraction of 850 million barrels of oil (taking into account the benefits from conservation of biodiversity, the rights on the indigenous population, and the carbon dioxide emissions avoided), but the government asked for external contributions from other countries to cover half the ‘opportunity cost’ (that is, half the foregone revenues that would be obtained by extracting and selling the oil).

Environmental Valuation Techniques

Change in Production

Replacement cost, damage cost avoided and substitute cost methods

These methods estimate values of ecosystem services based on the costs of avoiding damages due to lost services, the cost of replacing ecosystem services, or the cost of providing substitute services. These methods assume that the costs of avoiding damages or replacing ecosystems or their services provide useful estimates of the value of these ecosystems or services.

Environmental Valuation Techniques

Change in Health

The change in health covers:

- Unimproved water and sanitation and poor hygiene
- Poor solid waste management
- Ambient and interior pollution
- Chemical production and agro-industrial waste, etc.

Environmental Valuation Techniques

Change in Health

Quantitative Approach:

The Process of Health Impact

Environmental Valuation Techniques

Change in Health

Quantitative Approach:

- Empirical approach on animals (if the pollutant is toxic)
- Clinical studies on a controlled population ensuring high precision dose / response
- Epidemiological study of people in real circumstances which do not need to extrapolate doses or species

Environmental Valuation Techniques

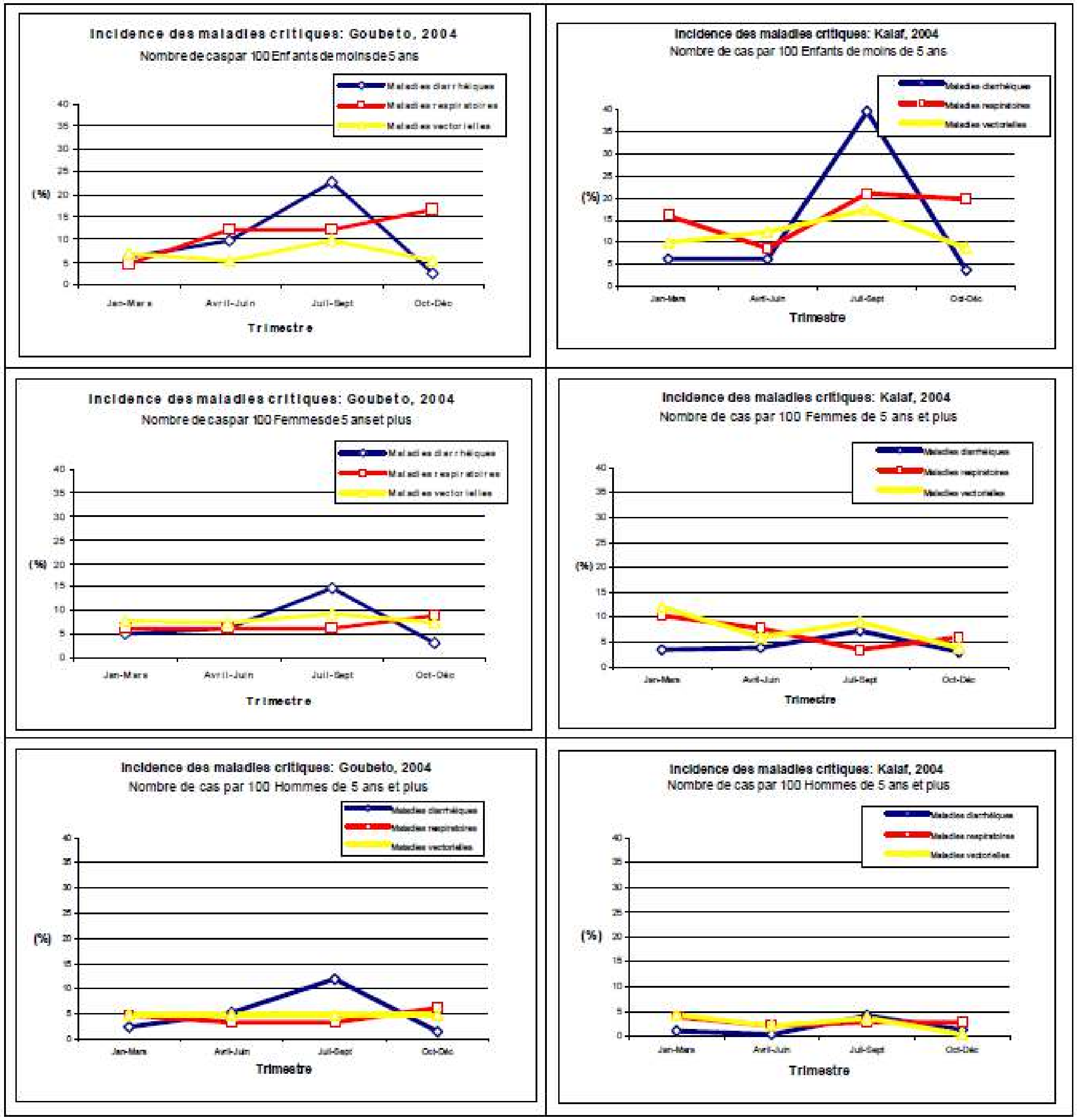
Change in Health

Air Dose-response

Annual Health Effects and Pollutant standards	Age Group or % reduction	Effects of 1 µg/m^3 annual average ambient concentration				
		PM_{10}	$PM_{2.5}$	Pb	SO_2	NO_2
PM_{10} until reaching 20 µg/m^3						
Premature mortality	Under 5 years	0.084				
Chronic bronchitis	Per 100,000 of >15 years	0.87				
Hospital admissions	Per 100,000 of >15 years	1.2				
Emergency room visits	Per 100,000 of >15 years	23.5				
Restricted Activity Days (RAD)	Per 100,000 of >15 years	5,750				
Acute Lower Respiratory Infection	Per 100,000 of < 5 years	169				
Respiratory symptoms	Per 100,000 of >15 years	18,300				
$PM_{2.5}$ until reaching 7.5 µg/m^3						
Premature mortality	% reduction		0.8			
Pb until reaching 1 µg/m^3						
Premature mortality	Per 100,000 adult males >45 years			35		
IQ Point Loss (points)	Per 1 child < 5 years			0.98		
Hypertension cases	Per 100,000 adult males >15 years			7,260		
Doctor's Visits: ½ the cases	Per 100,000 adult males >15 years			3,630		
RAD: 1 day	Per 100,000 adult males >15 years			3,630		
Non-fatal heart attack cases	Per 100,000 adult males >45 years			34		
Hospital admissions: 3 days	Per 100,000 adult males >45 years			17		
Emergency room visits: 1 day	Per 100,000 adult males >45 years			17		
RAD: 4 days	Per 100,000 adult males >45 years			136		
SO_2 until reaching 50 µg/m^3						
Premature mortality	% reduction				0.048	
Respiratory symptoms	Per 100,000 of < 5 years				0.0018	
Chest discomfort	Per 100,000 of >15 years				0.01	
NO_2 until reaching 40 µg/m^3						
Lung cancer	% reduction					0.108

Environmental Valuation Techniques

Epidemiological study on critical diseases in Djibouti: Before



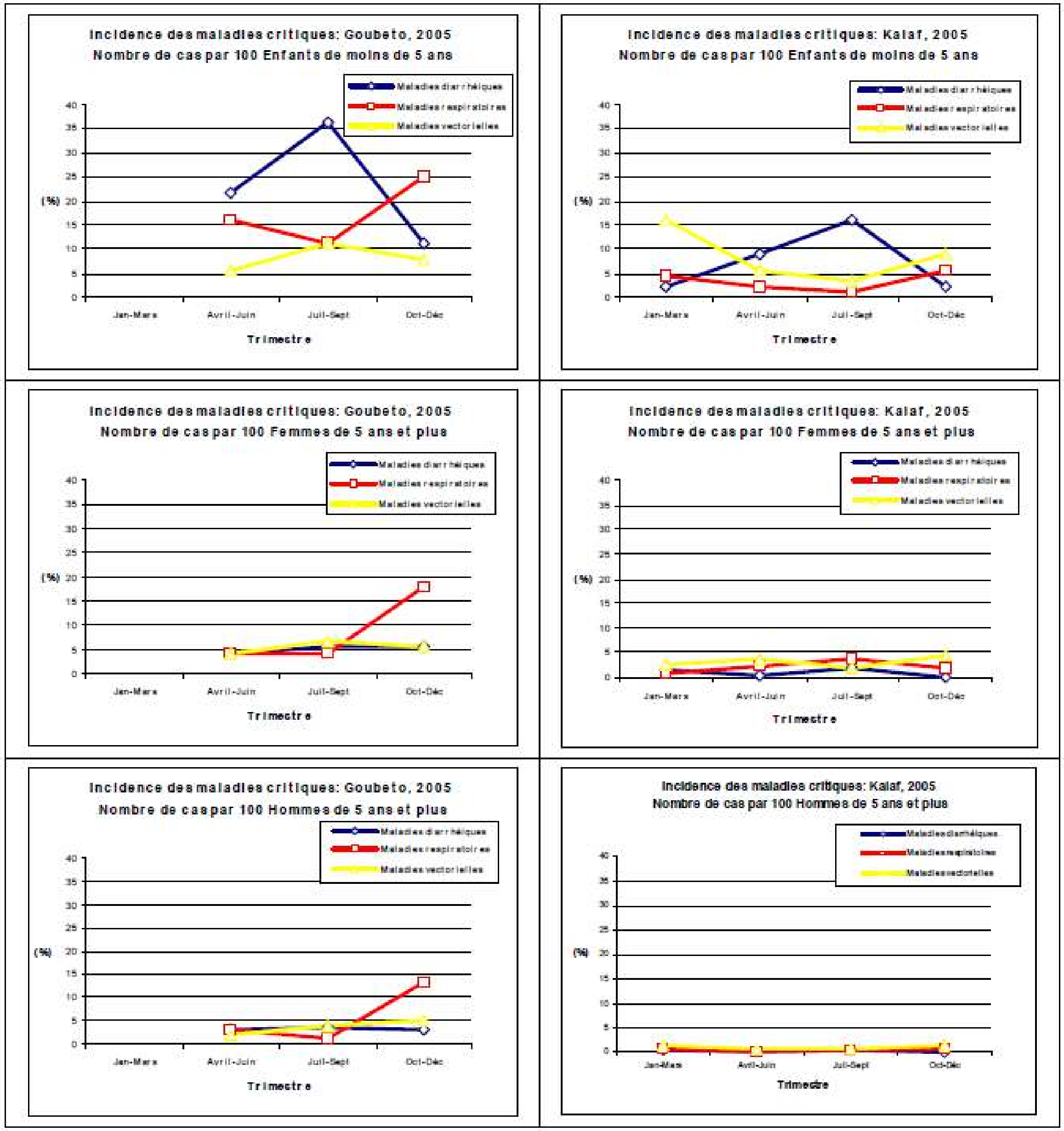
Environmental Valuation Techniques

Epidemiological study on critical diseases in Djibouti: Determinant of diseases

Maladies / Déterminant par village	Sujet et effectif	Diarrhée			Toux (avec fièvre)			Paludisme		
		Prévalence	OR IC 95 %	^{2} RRR	Prévalence	OR IC 95 %	^{2} RRR	Prévalence	OR IC 95 %	^{2} RRR
Goubeto Scolarisation des mères	Enfants < 5 ans									
A été à l'école	25	32,0 %	0,69 (0,27-1,78)	*0,59*	44,0 %	4,02 (1,00-6,4)	*2,54*	0,0 %	0,00	*0,28*
N'a pas été à l'école	89	40,5 %	1,00	-20,9 %	23,6 %	1,00	-86,5 %	1,1 %	1,00	***
Kalaf Scolarisation des mères	Enfants < 5 ans									
A été à l'école	4	25,0 %	0,83 (0,08-8,45)	*0,02*	0,0 %	0,00	*1,47*	0,0 %	0,00	*0,05*
N'a pas été à l'école	77	28,6 %	1,00	-12,5 %	27,3 %	1,00	-100,0 %	1,3 %	1,00	-100 %
Goubeto Malnutrition (mod./sév.)	Enfants < 5 ans									
Normal	77	32,9 %	0,53 (0,21-1,33)	*1,85*	26,3 %	0,76 (0,28-2,03)	*0,30*	1,3 %	***	*0,33*
Malnutrition	25	48,0 %	1,00	-31,5 %	32,0 %	1,00	-17,8 %	0,0 %	1,00	***
Kalaf Malnutrition (mod./sév.)	Enfants < 5 ans									
Normal	37	27,0 %	1,03 (0,36-2,95)	*0,00*	27,0 %	1,03 (0,36-2,95)	*0,00*	2,7 %	***	*0,93*
Malnutrition	34	26,5 %	1,00	-2,1 %	26,5 %	1,00	-2,1 %	0,0 %	1,00	***
Goubeto Stockage de l'eau	Population									
État naturel	345	17,1 %	0,70 (0,45-1,1)	*2,38*						
Dépôt divers	181	22,7 %	1,00	-24,5 %						
Kalaf Stockage de l'eau	Population									
Etat naturel	57	10,5 %	0,41 (0,17-0,98)	*4,24*						
Dépôt divers	503	22,3 %	1,00	-52,7 %						
Kalaf Stockage de l'eau	Femmes ≥ 5 ans									
Eau potable séparée	67	14,9 %	0,41 (0,2-0,86)	*5,84*						
Pas de séparation	190	30,0 %	1,00	-50,3 %						
Kalaf Filtration de l'eau	Population									
Oui	89	14,6 %	0,56 (0,3-1,05)	*3,31*						
Non	450	23,3 %	1,00	-37,4 %						
Goubeto et Kalaf Type d'habitation	Femmes ≥ 5 ans									
Local moderne en dur	260	19,6 %	0,65 (0,44-0,97)	*4,43*						
Daboyta/paillote	286	27,3 %	1,00	-28,1 %						
Goubeto et Kalaf Distance : cuisine/WC	Enfants < 5 ans									
4 mètres et plus	70	27,1 %	0,49 (0,24-0,98)	*4,08*						
Moins de 3 mètres	74	43,2 %	1,00	-37,2 %						
Kalaf Type d'habitation	Population									
Local moderne en dur	14				7,14	0,22 (0,03-1,7)	*2,52*			
Daboyta/paillote	546				25,82	1,00	-72,3 %			
Goubeto Moustiques	Femmes ≥ 5 ans									
Moustiquaire non imprégnée	221							1,8 %	0,29 (0,05-1,7)	*2,13*
Fumigation avec bois	34							5,9 %	1,00	-69,2 %
Moustiquaire non	221							1,8 %	0,50	*0,39*

Environmental Valuation Techniques

Epidemiological study on critical diseases in Djibouti: After



Environmental Valuation Techniques

Applying Health Techniques:

- Human Capital Approach (HCA)
- Value of life lost (VOLL)
- The Burden of Disease Metric (DALY)
- Cost of Illness (COI)

Environmental Valuation Techniques

Applying Health Techniques

Human Capital Approach (HCA)

- The HCA considers individuals as units of human capital that produce goods and services for society. It values human life and time spent ill or recovering using forgone earnings. As such, it measures loss of productivity resulting from an individual's death (Work Loss Days-WLD) and injury (Restricted Activity Days-RAD)

- HCA = (# of Life Years Lost due to premature death or due to illness) $\times$ (Average Wage Rate)

Environmental Valuation Techniques

Applying Health Techniques

Human Capital Approach (HCA)

The following steps need to be followed when applying the HCA

- Specify the type of economy for the population of interest
- Specify the characteristics of the economy for the population of interest
- Specify the family and community structure
- Specify the unit of analysis
- Specify the desired measure of productivity changes
- Estimate the maximum loss in productive time as a result of the health outcome. This requires information as to the groups of patients that are working and requires decisions about value of time of children and retired people

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Applying Health Techniques

Human Capital Approach (HCA)

There are various problems associated with the HCA. This approach faces difficulty in accurately estimating forgone earnings, since employee's compensation includes pension plans, health insurance, flexible hours, and not just wages. It assumes full employment and no substitutability of labor. It also assumes a dominant cash economy where market prices exist, which is not the case in developing countries.

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Applying Health Techniques

VOLL: complicated & expensive; Benefit Transfer

To derive the value of life lost life (also known as the value of statistical life), which is the valuation of the reduction of risk from dying from a premature death, the hedonic pricing method (HPM) is used. It involves the valuation of incremental morbidity or mortality by identifying wage differentials due to risk differences. It is based on the theory that workers have to be paid a premium to undertake jobs that are inherently risky, which can be used to estimate the implicit value individuals place on sickness or premature death.

Environmental Valuation Techniques

Applying Health Techniques

Impacts on health from environmental degradation are expressed as the disability-adjusted life year (DALYs).

a common measure of disease burden for various illnesses and premature mortality. Illnesses are weighted by severity and time (disease length)

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Applying Health Techniques

- DALY = YLL + YLD
- Where:
- YLL = years of life lost due to premature mortality
- YLD = years of life lost due to disability
- The YLLs are the mortality component of the DALYs, and are proportional to the number of deaths and the average age of death:
- YLL = Number of Deaths * Life expectancy at age of death

The YLDs are the morbidity component of the DALYs, and are proportional to the number of incident cases and the severity of the disease:

- YLD = Number of Cases * Disease Duration * Disability Weight

Environmental Valuation Techniques
Applying Health Techniques

Social weighting

- The basic formulas for YLDs, YLLs and DALYs may be extended by applying so-called social weighting functions. Unlike the basic formulas, the application of social weighting implies that not all life years lost are valued equally. Social weighting is therefore not accepted by all authors.

Age weighting

- The initial Global Burden of Disease study, and many ensuing studies, applied non-uniform age weights, implying that the value of life depends on age. A higher weight is given to the healthy life years lived between the age of 9 and 54, as this period of life is considered to be socially more important than the younger and older life spans (Murray, 1994).

  The standard age weighting formula is as follows:
- Weight = 0.1658 * age * $e^{(-0.04 * age)}$

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Applying Health Techniques

Time discounting

- Time discounting discounts the years of healthy life lived in the future, at a rate of (usually) 3%. The incorporation of a time discount rate reflects similar practices in economic assessments, and would prevent policy makers from saving resources for a possible future eradication program, instead of investing in currently available, but less effective, intervention measures (the so-called "disease eradication and research paradox";

Time discounting formula is as follows:

- Weight = e^$^{(-0.03 * [age - a])}$
- **Where a is the age at onset or death.**

Environmental Valuation Techniques
Applying Health Techniques

Cost of Illness (COI)

- The cost of illness approach involves measuring two types of costs: (1) the direct costs or the costs of medication, hospitalization, and doctors' visits; and (2) the indirect costs or the forgone labor earnings due to days spent in bed, days missed from work, and days when activity was restricted due to illness. The latter are calculated following the HCA approach mentioned earlier.

مع خالص شكري وامتناني

Thank you for your attention

Merci pour votre attention

For additional information please contact:

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