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NATIONAL ADAPTATION PLAN GLOBAL SUPPORT PROGRAMME

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Prioritization of Climate Change Adaptation Options

The Role of Cost-Benefit Analysis

Session 5: Conducting CBA Step 4 (Introduction to economic valuation)

Accra (or nearby), Ghana
October 25 to 28, 2016

8 steps

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Step 1: Define the scope of analysis.

Step 2: Identify all potential physical impacts of the project.

Step 3: Quantify the predicted impacts: With and without project

Step 4: Monetize impacts.

Step 5: Discount to find present value of costs and benefits.

Step 6: Calculate net present value.

Step 7: Perform expected value and/or sensitivity analysis.

Step 8: Make recommendations.

8 steps

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Outline of presentation

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1) When market prices are known
   - Calculating the cost of input
   - Calculating the benefit of an output
2) When market prices are not known
3) Benefit transfer methodology

Outline of presentation

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Calculating the cost of an input

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Consider the following situation.

As a result of the large number of road accidents along a winding road in Ghana, the Government of Ghana considers improving the road.

Or:

As a result of the projected increased electricity demand, the Government of Ghana considers increasing supply capacity by adding a new coal-fired power plant to the power supply system.

Each of these projects will require 1,000 tons of steel and 1,000,000 hours of labor.

We know the market price of steel and the market price of labor.

But what's the *economic* cost of these inputs?

Suppose there is a tax on the input

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Consider the following situation:
There is a tax on each unit of input going into the project.

Suppose the following:

QG is the quantity (tons) of steel procured by the project

P1 is the market price of steel

T is the tax on each ton of steel

Financial cost (to project developer):	**(P1+T)*QG**
Economic cost to society:	**(P1+T)*QG – T*QG = P1*QG**

Economic cost < Financial cost

Taxes are called transfer payments.

Transfer payments are not included in the economic analysis.

Treatment of transfer payments

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Canada (1998):

In [economic] analysis, we count resources that are created or used up. Resources that are simply transferred from one pocket to another are not counted as costs or benefits.

Australia (2007):

Payments which redistribute income but which do not reflect either the value of a good to a consumer or the costs of its supply (…) are excluded from a cost-benefit analysis.

New Zealand (1998):

A transfer payment is a payment for which no good or service is obtained in return e.g., a social welfare benefit. Transfer payments may change the distribution of wealth, but do not of themselves give rise to direct economic costs or benefits for the economy as a whole. They should therefore be excluded from CBA.

Suppose there is a negative externality with steel

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Consider the following situation:
The production of steel generates water pollution.

Suppose the following:

QG is the quantity (tons) of steel procured by the project

P1 is the market price of steel.

EC is the external cost of each ton of steel produced. Suppose this external cost is not internalized in the market price of steel.

Financial cost (to project developer):	**P1*QG**
Economic cost to society:	**(P1+EC)*QG**

Economic cost > Financial cost

Job creation and multipliers

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It is common (and wrong) in the economic analysis of development projects to use *multipliers* to account for multiplier effects (especially in analyses prepared by project developers or by those who stand to gain the most from project approval). These multiplier effects are occasionally referred to as *secondary* effects, *indirect* effects, or *spill-over* effects.

3 fundamental problems with using multipliers

Job creation and multipliers

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Problem 1

- When a project hires labor, it is a cost for society, not a benefit.
- Suppose a project is going to hire skilled labor of which there is currently a shortage.
- Is the project going to create net jobs for this type of labor?
- No. It will simply displace some workers from existing job to work for the project. And the project will be able to do that by offering a higher salary to attract that labor. Hence, wages for this type of labor will go up, but no job is created.

Job creation and multipliers

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Problem 1

The use of multipliers implicitly assumes that the economy is at less than full employment (and therefore that there is sufficient room in the economy to realize secondary or spill-over effects).

If the economy is at or close to full employment, it is not possible to increase net national income since no additional factor inputs can be allocated to production.

Job creation and multipliers

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Problem 2

- Suppose now that a project is going to hire unskilled labor of which there is currently significant unemployment.
- It does not mean that this job creation is a benefit of the project. It is still a cost for society. However, the cost for society is less than the cost (wage) paid by the project to this labor (shadow price is less than market price).
- We use the shadow wage of labor.

Job creation and multipliers

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Problem 3

Perhaps more importantly, the use of multipliers implicitly assumes that if the project is not implemented, there is no other project that can be undertaken. Put slightly differently, all development projects will have so-called multiplier effects (in an economy less than fully employed). Hence, upon choosing a project among many projects (or an option among many options), applying a multiplier to all projects (or to all options) provides the same result as applying no multipliers. But in fact, when examining a project in isolation of all other projects or options, the use of multipliers implicitly assumes that only the project under examination could yield multiplier effects, whereas other projects or options would not.

Outline of presentation

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1) When market prices are known

   Calculating the cost of input

   Calculating the benefit of an output

2) When market prices are not known

3) Benefit transfer methodology

Calculating the benefit of an output

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Let's go back to our fisheries example where there may be an adaptation measure which could offset (partially or totally) the impact of climate change.

We have already identified and quantified the impact of this measure.

How would you monetize this impact?

Outline of presentation

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1) When market prices are known

   Calculating the cost of input

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2) When market prices are not known

   Change of productivity methodology

   Revealed preferences methodologies

   Stated preferences methodologies

3) Benefit transfer methodology

Outline of presentation

Empowered lives.
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1) When market prices are known
   - Calculating the cost of input
   - Calculating the benefit of an output

2) When market prices are not known
   - Change of productivity methodology
   - Revealed preferences methodologies
   - Stated preferences methodologies

3) Benefit transfer methodology

Change of productivity methodology

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This methodology is generally applied in the specific case where the environmental impact represents a change in a component of the environment (or ecosystem) which has a direct consumptive value.

This impact will be measured by a change in the production of a good for which there is already a market, and therefore market prices.

Market prices or shadow prices will be used to assess the economic impact of this change in productivity.

Change of productivity methodology

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Examples where appropriate to use this methodology:

- **Water pollution may impact fisheries yield;**
- **Reservoir sedimentation may impact power production;**
- **Floods may impact agriculture production;**
- **Sickness (from air pollution for example) impacts labor force productivity.**

Change of productivity methodology

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Proceeds in two steps:

Step 1: Establish the link or the relationship that exists between a change in environmental quality and the resulting impact on production.

This is generally called a dose-response function.

Examples of dose-response functions:

- **Relationship between fisheries yield and water pollution;**
- **Relationship between reservoir sedimentation and power production;**
- **Relationship between floods and agricultural production.**

Change of productivity methodology

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Proceeds in two steps:

Step 2: Once the change in production is established, market prices (or shadow prices which are market prices corrected for the presence of subsidies, taxes or for any other market imperfections) are then used to estimate the economic value of the estimated change in production.

Change of productivity methodology

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Consider this example.

As a result of a projected increase in the number of days without rain, maize production could be adversely impacted.

Agricultural experts tell us that as a result, maize yield could fall from the existing 1 ton per ha, to approximately 0.5 ton her ha over the next 20 years (fictitious numbers).

However, agricultural experts also tell us that 50% of this impact could be offset if farmers were to switch from maize only to a compost maize-soya intercrop with bunding.

Net benefits of maize have been estimated to be GHS300 per ton.

How would you estimate the potential benefits of this adaptation measure?

Outline of presentation

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2) When market prices are not known
   - Change of productivity methodology
   - **Revealed preferences methodologies**
   - Stated preferences methodologies

3) Benefit transfer methodology

Revealed preferences methodologies

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These methodologies aim to provide an economic assessment of environmental impacts by observing actual behavior of individuals, and what this behavior reveals about their preferences for changes in environmental quality.

Revealed preferences methodologies

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Methodologies	Revealed behavior	Types of application
Cost of illness	Expenditures to treat illness	Health; morbidity
Avertive behavior / defensive expenditure	Time costs; purchases to avoid harm	Health; mortality and morbidity
Cost of treatment	Expenditures to offset the change in environmental quality	Agricultural productivity, water supply
Hedonic pricing	Property purchased	Property value
Travel cost	Participation in recreation activity	Recreational demand

Revealed preferences methodologies

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Cost of illness

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This methodology is generally applied in the specific case where the change in environmental quality has an impact on human health.

Examples:

- **Reduction in air quality may increase the number of asthma attacks;**
- **More water pollution may increase the number of cases of gastro-intestinal diseases.**

Cost of illness

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Proceeds in two steps:

Step 1: Establish the link or the relationship that exists between a change in environmental quality and the resulting impact on health.

This is also called a dose-response function.

Examples of dose-response functions:

- **Link between air pollution and asthma attacks (e.g. for every increase of 1 microgram/m3 of PM-10, how many more cases of asthma attacks can we expect?);**
- **Link between water pollution and gastro-intestinal diseases.**

Cost of illness

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Proceeds in two steps:

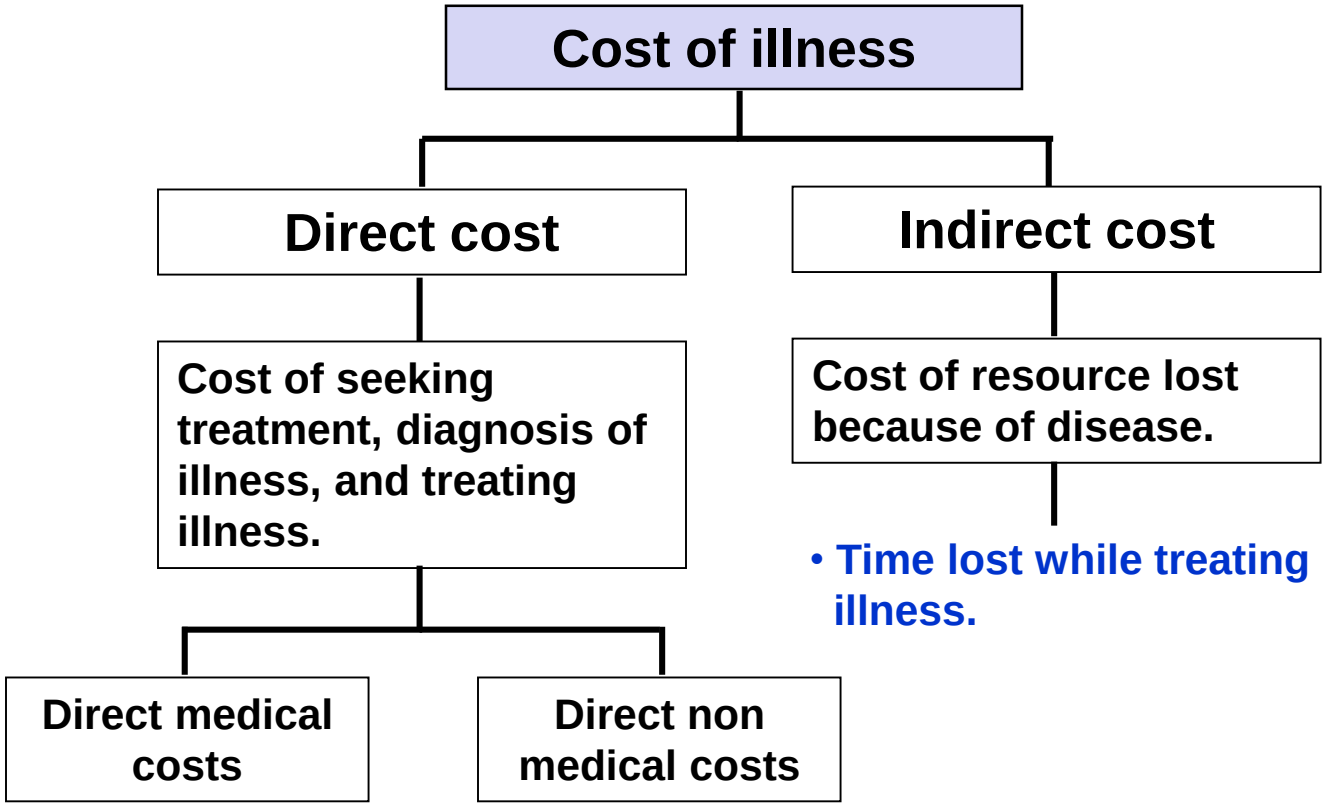
Step 2: Once the health impact has been established, market prices (corrected for the presence of subsidies, taxes or for any other market imperfections) are then used to estimate the economic costs of providing medical services to address these health impacts.

Types of medical costs:

- **Cost of hospital stay per day; and**
- **Cost of medicine.**

If working days are lost because of sickness, we would add the costs of these lost working days.

Cost of illness



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Revealed preferences methodologies

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Avertive behavior

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This methodology is generally applied where the change in environmental quality may have an impact on human health (as for the cost of illness methodology)

However, individuals may undertake expenditures to avoid being ill (i.e. preventing illness instead of treating illness).

Examples of avertive behavior:

- **People buy bottled water to avoid the risk of falling sick drinking contaminated water;**
- **People buy air purifiers;**
- **Motorcyclists wear a mask to protect themselves from car exhaust fumes.**

Avertive behavior

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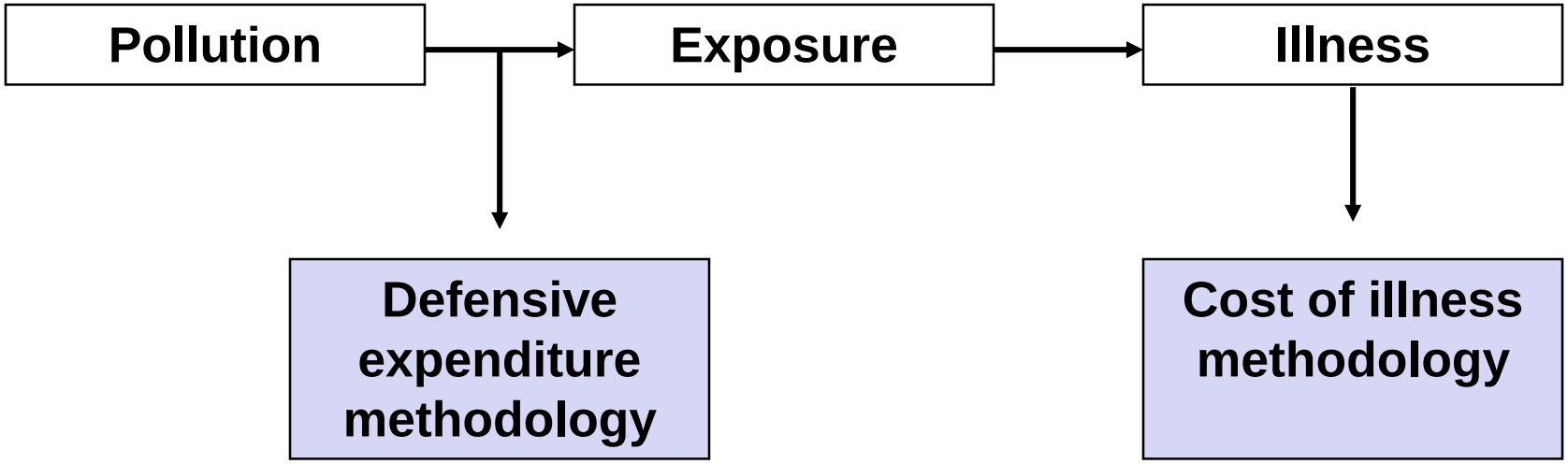
When to use it

Difference between defensive expenditure and cost of illness methodologies:



Avertive behavior

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Proceeds in three steps:

Step 1: Establish the link or the relationship that exists between a change in environmental quality and the resulting impact on health.

Step 2: Once the health impact has been established, observe what individuals do (behavior) to avoid the potentially adverse health impact.

Step 3: Use the estimated expenditures associated with this behavior (defensive expenditure) as an estimate (or a proxy) of the benefits of avoiding the adverse change in environmental quality.

Revealed preferences methodologies

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Hedonic pricing	Property purchased	Property value
Travel cost	Participation in recreation activity	Recreational demand

Cost of treatment

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This methodology is generally applied in the specific case where individuals aim to offset the adverse change in environmental quality using additional or complementary inputs in the production of the goods or services.

Examples:

- **Significant river sedimentation may increase the cost of water supply company because of the need to use additional inputs to control (or remove) sediments from the raw water;**
- **Farmers may increase the use of fertilizers in order to offset the impact of soil erosion on the productivity of their land.**

Revealed preferences methodologies

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Proceeds in three steps:

Step 1: Establish the link or the relationship that exists between input and output, including a change in environmental quality.

Step 2: Use this relationship to assess the quantity of other inputs that must be used to offset the change in environmental quality.

Step 3: Estimate the economic value of those additional inputs. The market price of those inputs (corrected for the presence of subsidies or taxes or for any other market imperfections) can be used to assess this economic cost.

Revealed preferences methodologies

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Hedonic pricing

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This approach recognizes that the price that consumers are willing to pay for some traded commodities (such as houses, or land) depends on a large number of variables, including environmental quality.

Examples:

- **Consumers are willing to pay less for a house that is located near a landfill than for the same house away from a landfill;**
- **Consumers are willing to pay more for a house located near to a nice beach than a dirty beach.**

Revealed preferences methodologies

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Travel cost

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- **This methodology attempts to assess the value of changes in ecosystem services by using the travel costs and opportunity cost of time that an individual incurs to visit a recreation site.**
- **It may be inferred that the recreational value of a site (for example a beach) must at least exceed that the travel and time costs incurred by individuals to reach the site.**

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   - Change of productivity methodology
   - Revealed preferences methodologies
   - **Stated preferences methodologies**

3) Benefit transfer methodology

Stated preferences methodologies

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These methodologies aim to provide an economic assessment of environmental impacts using data on hypothetical choices made by individuals responding to a survey and stating their preferences.

Different methodologies:

- **Contingent valuation;**
- **Choice experiment.**

Contingent valuation

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This approach, implemented by means of surveys, aims to assess how individuals would hypothetically react to changes in environmental quality.

In particular, it elicits from respondents how much they would be willing to pay to access improved environmental quality or avoid a hypothetical reduction in environmental quality.

Contingent valuation

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5 key issues

1. How to select the population of respondents to the contingent valuation survey?
2. What type of interview format should be used in the survey: in person, telephone or mail?
3. What type of questions should be used to elicit respondents' valuation of the change in environmental quality (elicitation procedure)?
4. What change in the environmental quality is being valued?
5. Which vehicle would be used to extract payment for the change in environmental quality (payment vehicle)?

Methodologies for economic valuation

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It will take some time, resources and expertise to implement these methodologies.

What to do if we don't have enough time or resources to implement one or some of these methodologies?

One possible approach is the benefit-transfer methodology. This methodology is discussed in the next presentation.

Outline of presentation

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1) When market prices are known

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2) When market prices are not known

3) Benefit transfer methodology

   What is benefit transfer?

   Justification for the use of benefit-transfer

   Typical applications

   How accurate is benefit-transfer?

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What is benefit transfer?

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"The transfer of existing estimates of non-market values to a new study which is different from the study for which the values were originally estimated." (Boyle and Bergstrom, 1992)

"Transfer economic value of a public good from *study site (primary valuation study) to policy site (where you are doing analysis*)." (Rosenberger and Loomis, 2003)

What is benefit transfer?

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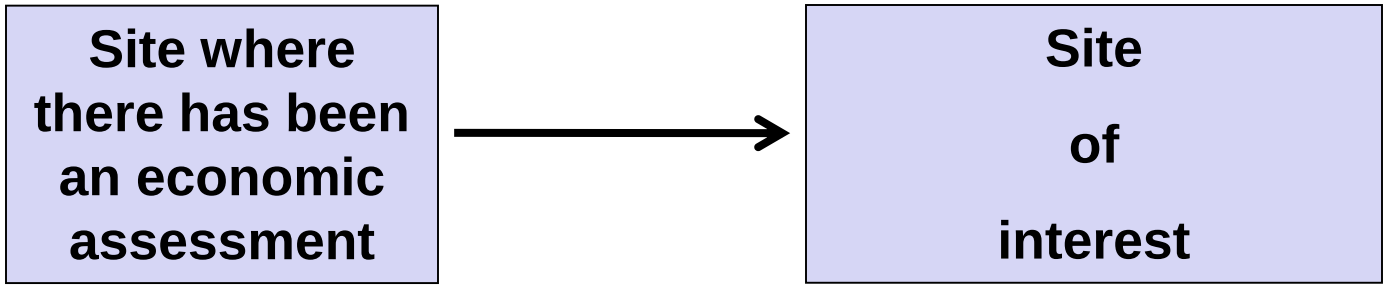
Site where there has been an economic assessment		Site of interest
"Study site"		"Policy site"
Take estimated values from the study site	Transfer →	Obtain values for the policy site

What is benefit transfer?



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Note:

- **Transfer in space: From study site to policy site.**
- **Transfer in time: From past studies to current study.**
  - **Adjustments for changes in values over time.**
  - **Accounting for possible changes in preferences (and therefore WTP) over time.**

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Justification for the use of benefit transfer

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- When there is not enough time or resources to undertake primary data collection to support original study.
- To generate preliminary (plausible?) or 'back-of-the-envelope' estimates of economic values.
- When the expected magnitude of the economic values does not appear to be an important determinant of the overall outcome of the economic analysis.

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Typical applications

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Typical application 1:

Valuation of ecosystem services

A project or policy aims at protecting wetlands of Ghana which would otherwise disappear. What is the benefit of protecting X hectares of wetlands?

Economic value of wetlands

	Mangrove Sediment	Unvegetated Marsh	Salt / Brackish Marsh	Freshwater Woodland	Freshwater	Total
North America						
Quantity (1)	510	16,906	2,575	192	3,258	22,931
Value (2)	30,014	550,980	29,810	1,728	64,315	676,846
Value per ha	59	33	12	9	20	30
Latin America						
Quantity	4,224	9,223	1,707	289	1,010	12,230
Value	8,445	104,782	3,129	531	6,125	123,012
Value per ha	2	11	2	2	6	10
Europe						
Quantity	0	2,374	500	66	330	3,271
Value	0	268,333	12,051	253	19,503	300,141
Value per ha	0	113	24	4	59	92
Asia						
Quantity	1,439	8,011	1,027	2	657	9,697
Value	27,519	1,617,518	23,806	29	149,597	1,818,534
Value per ha	19	202	23	15	228	188
Africa						
Quantity	3,686	4,632	487	48	310	5,477
Value	84,994	159,118	2,466	334	9,775	256,687
Value per ha	23	34	5	7	32	47
Australasia						
Quantity	2,253	4,641	461	167	4,090	9,361
Value	34,696	147,779	2,120	960	83,907	269,462
Value per ha	15	32	5	6	21	29
World						
Quantity	12,112	45,788	6,758	765	9,657	62,967
Value	185,667	2,848,575	73,382	3,836	333,223	3,444,682
Value per ha	15	62	11	5	35	55

Typical applications

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Typical application 1:

Valuation of ecosystem services

A project or policy aims at protecting wetlands which would otherwise disappear. What is the benefit of protecting X hectares of wetlands?

Key issue: How similar is the wetland of the policy site to the wetlands of the study sites? "Similar" here means not in terms of their physical characteristics (location, size, age, etc.) but in terms of the *goods and services* they provide.

Typical applications

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Typical application 2:

Value of statistical life (VSL)

A flood control project will reduce annual mortality risk in a given area of Ghana from 1/100,000 to 1/1,000,000. What is the benefit per statistical life saved?

Typical applications

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Typical application 2:

Kochi et al. (2006) conducted a meta-analysis of VSL studies from high income countries drawing on 18 contingent valuation studies and 42 hedonic wage studies. The authors report an average VSL of $5.4 million (2000 USD).

If risk preferences, discount rates, and survival probabilities were the same in all countries, then the VSL should simply be proportional to income:

$$VSL_{Ghana} = VSL_{USA} * \left[\frac{Y_{Ghana}}{Y_{USA}}\right]^{\varepsilon}$$

Where Y is GDP per capita in PPP terms and ε is income elasticity.

Typical applications

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Typical application 2:

Step 1: It is noted that the reported $5.4 million is measured in dollars of 2000. Using US GDP deflator available in the *World Development Indicators Database*, this figure amounts to approximately $7.1 million in 2015.

Step 2: One must obtain GDP per capita measured in PPP. The IMF's *World Economic Outlook Database 2015* reports a GDP per capita of $56,084 and $4,291 for the USA and Ghana respectively. This provides a GDP per capita ratio of 0.0765.

Step 3: Income elasticity. Analyses suggest income elasticity between 1.0 and 1.5.

Typical applications

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Typical application 2:

	$\varepsilon = 1$	$\varepsilon = 1.5$
VSL_{Ghana} millions	543,222	150,258

Remember: If risk preferences, discount rates, and survival probabilities were the same in all countries, then the VSL should simply be proportional to income.

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3) Benefit transfer methodology
   - What is benefit transfer?
   - Justification for the use of benefit-transfer
   - Typical applications
   - How accurate is benefit-transfer?

Unit value transfer methods

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Two key issues:

How similar are the characteristics of the study site(s) and policy site?

What is the quality of the research from the study site?

Unit value transfer methods

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How similar?

How does the affected good or service compare to the resource referenced in existing studies?

What population group(s) was considered in the original study (e.g. was is a specific user group or all the resident of a given area)?

How similar are the demographic and socio-economic characteristics of the study site and policy site?

Were baseline conditions in the study site relatively similar as in the policy site?

Are attitudes, perceptions, level of knowledge the same at the policy and study site? Could these have changed over time since the research at the study site has been completed?

How accurate is benefit transfer

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1. **Good news: In all likelihood, we typically don't know.**

   The actual value for a policy site is unknown (otherwise there would be no need for benefit-transfer).

   Hence, it is very rare that original values for a policy site can be compared with values obtained from a benefit transfer exercise for that same policy site and for that same good and/or service.

2. **How much is accuracy needed for our level of confidence to be sufficient enough to proceed with recommendation?**

Unit value transfer methods

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Database of interest

EVRI: Environmental Valuation Reference Inventory

ENVALUE

EUROFOREX Database

NOAA´s databases on Marine and Coastal resources

UK Defra Environmental Valuation Source List

USDA NRCS (Natural Resource Conservation Service)

US Recreational Value Database

American Economic Association EconLit database

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